

Three Phase Reference Standard – Accurate Power and Energy Measurement

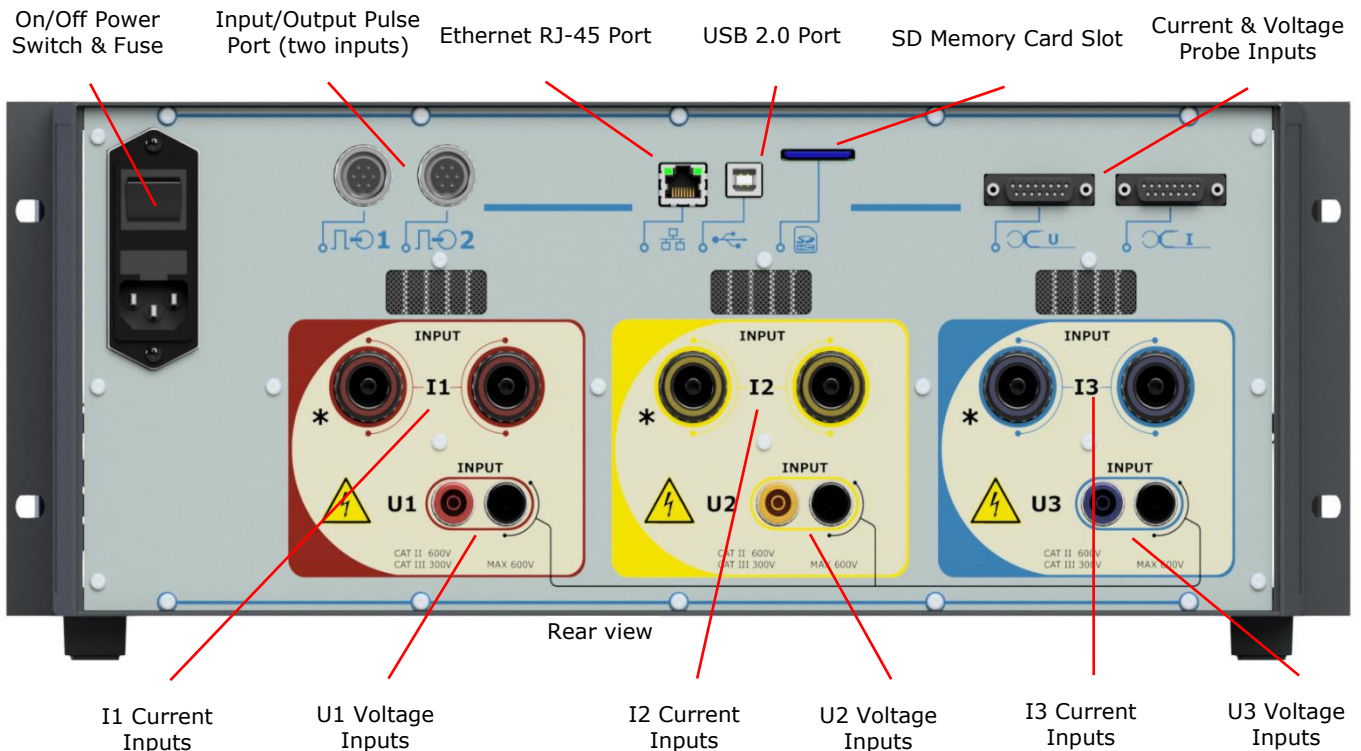
Calmet TS23

- Measures power and energy in 0.02 or 0.04 accuracy class
- Voltage range: 0.05...600V and 0.1...40kV
- Current range direct input: 1mA...120A and with current clamps: 120A, 1200A, 30/300/3000A
- Display of vector diagram, phase sequence, waveform oscilloscope, harmonics spectrum bar and trend charts for analysis of the mains conditions
- Testing of Electricity Meters and CT/PT Transformers
- The measurement system may be used either as a stand-alone reference standard meter class 0.02, 0.04 in laboratory or test bench station or as portable working standard for measurements on site
- Data readout and test system control via USB, Ethernet and Bluetooth and Calmet TS PC soft
- Modern SD flash memory card up to 32GB for storage of customer data and measurement results
- Large 7" color Touchscreen
- Two pulse inputs for simultaneously testing of 2 meters or testing in two quadrants



Front view

Calmet TS23 is three phase reference standard of accuracy 0.02% (or 0.04%). It can be used in laboratory or on site for electricity meter testing. Due to pulse input / output TS23 can be used as reference standard meter for Test Bench Stations. It can measure voltage, current, power and energy up to 3x120A and 3x600V AC.



Rear view

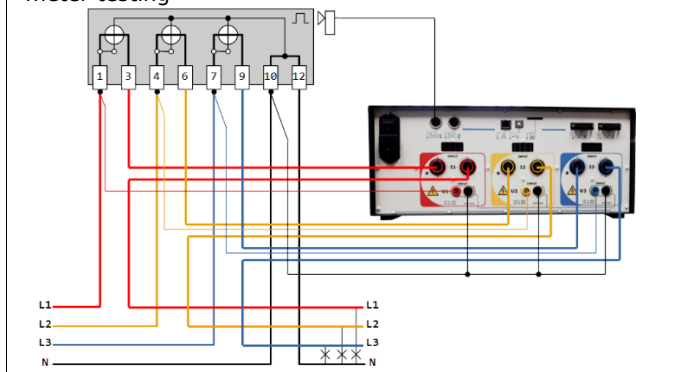
Calmet TS23 Reference Standard Meter applications are:



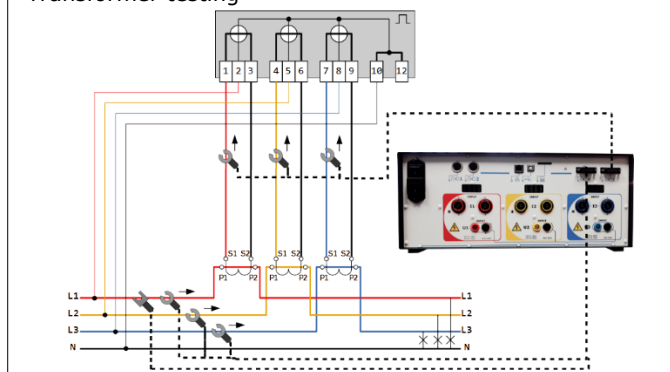
- testing of electricity meters according to the EN 50470, IEC 62052 and IEC 62053 standards directly on site or laboratory including measure of meter error, register error, start up current, no load test and maximum power meter error,
- verification of power network wiring with measurement of power network parameters with vector diagram display,
- testing of Current Transformers (CT) and Potential Transformers (PT) according to EN 60044 directly on site including measure of CT/PT ratio error and phase error as well as CT/PT burden measurement simultaneously in three phases,
- measuring of power quality parameters,
- acting as Reference Standard Meter in 3-phase Meter Test Bench Station.

Examples of applications

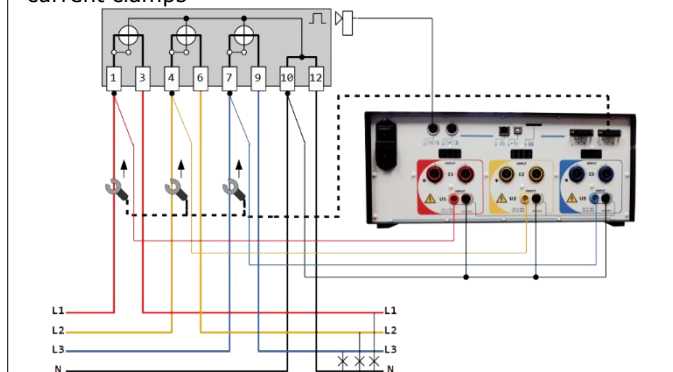
TS23 as a stand-alone reference standard for electricity meter testing



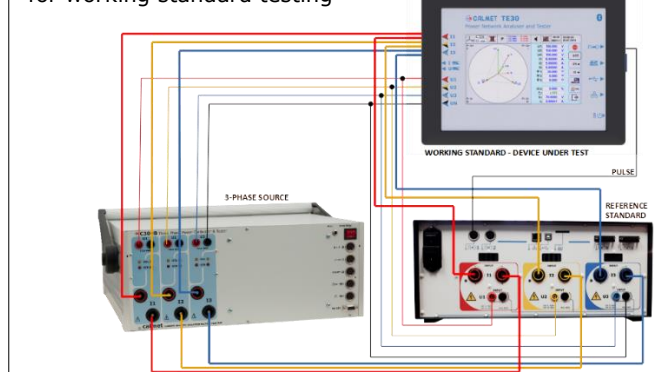
TS23 as a stand-alone reference meter for Current Transformer testing



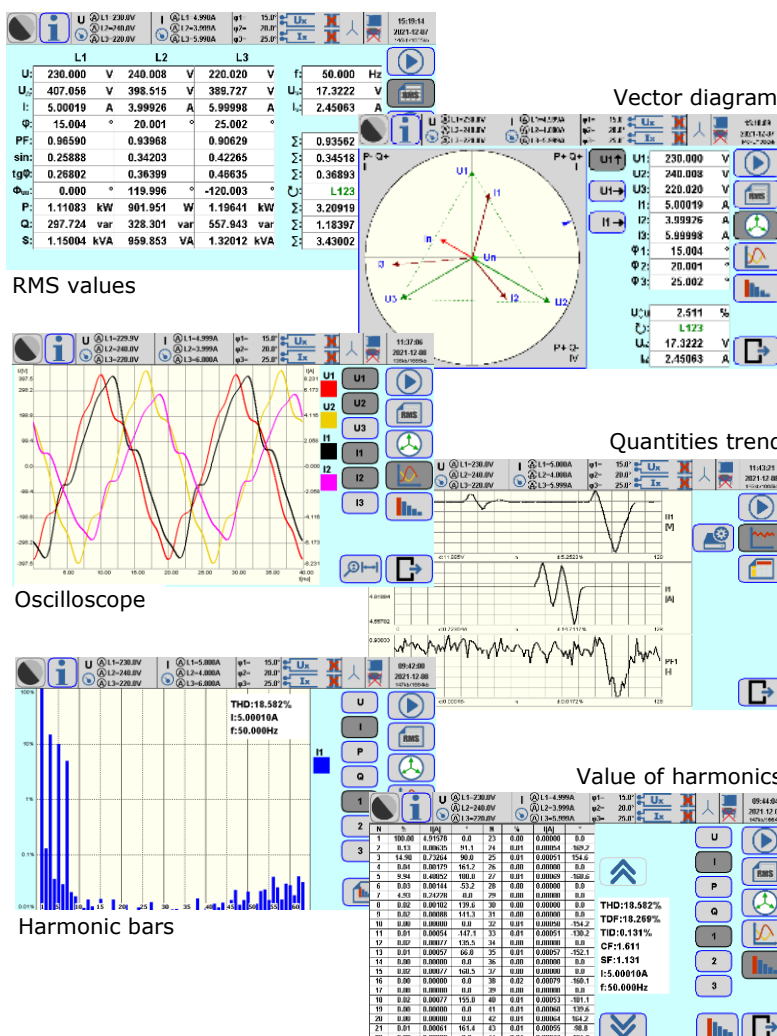
TS23 as a reference meter with current measured by current clamps



TS23 as a reference standard for working standard testing



TS23 measurement possibilities



Color Touchscreen for easy operation enables:

- measurement of power network parameters: voltages U₁, U₂, U₃, U₁₂, U₂₃, U₁₃, U_N, currents I₁, I₂, I₃, I_N, frequency f, phase angles ϕ_1 , ϕ_2 , ϕ_3 , power factors PF₁, PF₂, PF₃, Σ PF, factors $\sin\phi_1$, $\sin\phi_2$, $\sin\phi_3$, $\Sigma\sin\phi$, $\tan\phi_1$, $\tan\phi_2$, $\tan\phi_3$, $\Sigma\tan\phi$, angles between voltages $\angle U_{12}$, $\angle U_{13}$, powers P₁, P₂, P₃, Σ P, Q₁, Q₂, Q₃, Σ Q, S₁, S₂, S₃, Σ S,
- visualization of measurement results in form of: table, vectors, trend chart, oscilloscope (waveform) or bar chart (harmonics of U, I, P, Q),
- storage results in built, removable SD memory card, in memory 8GB – 32GB can be saved over 10000 complete results with administrative data,
- readout of stored results,
- making SCREENSHOT and save it in memory or print on portable wireless printer,
- printout of results on portable wireless printer,
- transferring data to the personal computer via USB, Bluetooth or Ethernet interface.

Parameter	Range	Accuracy ¹⁾²⁾³⁾⁴⁾	
		class 0.02	class 0.04
Voltage (Direct)	0.05...600V	±0.02% ⁵⁾	±0.04% ⁵⁾
Voltage (VoltLiteWire 40kV)	0.1...40kV	±0.1%±Em	
Current (Direct)	0.01...120A 0.001...0.01A	±0.02% ±0.02%*	±0.04% ±0.04%*
Current (Clamps CT10AC)	0.1...12A 0.003...0.1A	±0.2% ±0.2%*	
Current (Clamps CT100AC)	0.1...120A 0.01...0.1A	±0.2% ±0.2%*	
Current (Clamps CT1000AC)	10...1200A 0.3...10A	±0.2% ±0.2%*	
Current (Flexible Clamps FCT3000AC)	0.3...30A/3...300A/30...3000A	±0.1%±Em	
Current (AmpLiteWire 2000A)	1...2000A	±0.1%±Em	
Power and energy (Direct)	0.01...120A / 10...600V 0.001...0.01A / 10...600V	±0.02% ±0.02%*	±0.04% ±0.04%*
Power and energy (Clamps CT10AC)	0.1...12A / 10...600V 0.01...0.1A / 10...600V	±0.2% ±0.2%*	
Power and energy (Clamps CT100AC)	0.1...120A / 10...600V 0.01...0.1A / 10...600V	±0.2% ±0.2%*	
Power and energy (Clamps CT1000AC)	10...1200A / 10...600V 1...10A / 10...600V	±0.2% ±0.2%*	
Power and energy (Flexible Clamps FCT3000AC.B)	0.3...30A/3...300A/30...3000A / 10...600V	±0.1%±Em	
Power and energy (VoltLiteWire 40kV + AmpLiteWire 2000A)	1...2000A / 0.5...40kV	±0.1%±Em	
Frequency	40...70Hz	±0.003Hz	
Phase shift (Direct)	-180...+180°	±0.01° ⁵⁾⁶⁾	±0.02° ⁵⁾⁶⁾
Phase shift (Clamps)	-180...+180°	±0.1° ⁵⁾⁷⁾	
Power factor cosφ and sinφ	0...±1	±0.001 ⁵⁾⁶⁾⁷⁾	
Temperature coefficient (Direct)	0.001% per 1°C in range -10...+50°C		
Time stability (for Energy Direct)	Short term [1h] = 0.01%, long term [1 year] = 0.03%		
Power short term [1h] stability (Direct)		±0.005%	±0.010%
Power long term [1 year] stability (Direct)		±0.010%	±0.025%
Power temperature coefficient per 1°C (Direct)		±0.001%	±0.002%

¹⁾ % - related to the measuring value, %* - related to the measuring range final value (is underlined)

²⁾ absolute extended uncertainty under confidence level of 95% covers reference uncertainty of standards, stability in 12 months, influence quantities (ambient temperature +20...+26°C, humidity and power supply voltage 85...265V, frequency 47...63Hz)

³⁾ Em - sensor basic error, Em=1%+0.1%* (Flexible Clamps FCT3000AC), Em=2%+0.2%* (VoltLiteWire 40kV and AmpLiteWire 2000A)

⁴⁾ power and energy errors related to apparent power

⁵⁾ in voltage range 10...600V (Direct)

⁶⁾ in current range 0.01...120A (Direct)

⁷⁾ in current range: 0.1A...12A (Clamps CT10AC), 0.1A...120A (Clamps CT100AC), 10A...1200A (Clamps CT1000AC)

Specifications for the power quality parameters

Parameter	Range	Accuracy ¹⁾
Harmonics in voltages, currents, P and Q powers	amplitude	0...100% of input
	phase	-180...+180°
Total harmonic distortion THD in voltages and currents	0...100% of input	1 st ...63 rd
Total interharmonic distortion TID in voltages and currents	0...15% of input	40...3200Hz
Signal voltage ⁵⁾	0...15% of input	40...3200Hz
Voltage asymmetry	0...100%	

¹⁾ absolute extended uncertainty under confidence level of 95% covers reference uncertainty of standards, stability in 12 months, influence quantities (ambient temperature +20...+26°C, humidity and power supply voltage 85...265V, frequency 47...63Hz)

²⁾ of input for 80-140Hz frequency range of harmonics with linear rise to 0.4% of input for 3200Hz

³⁾ for 80-140Hz frequency range of harmonics with linear rise to 8° for 3200Hz

⁴⁾ of input for 80-140Hz frequency range of interharmonics with linear rise to 5% of input for 3200Hz

⁵⁾ the highest non-harmonic amplitude and frequency

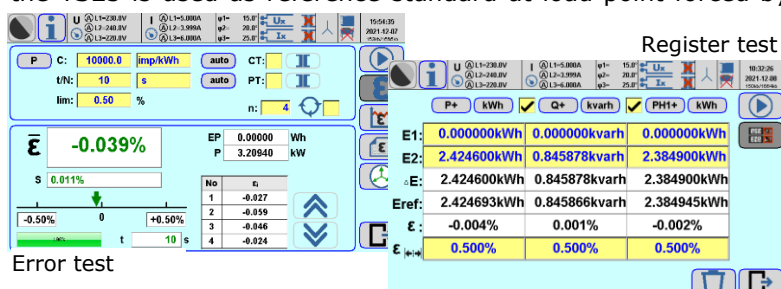
The TS23 as a tester of electricity meters and instrument transformers

Testing of electricity meters (DUT – Device Under Test) directly on site or in laboratory may be realized in different situations:

- voltage and current circuits of the DUT are powered from power net – in this case the TS23 is used as a reference standard in manual operation mode,
- voltage and current circuits of the DUT are powered from external source (like C300B calibrator or TS33 / TS41 automatic test system) – in this case the TS23 is used as reference standard at load point forced by source,

with using following functions:

- calculating meter error (partial errors, average error, standard deviation) directly in [%] with method of settings time of measurement or number of pulses,
- measuring energy for verification of meter counters directly in [%],



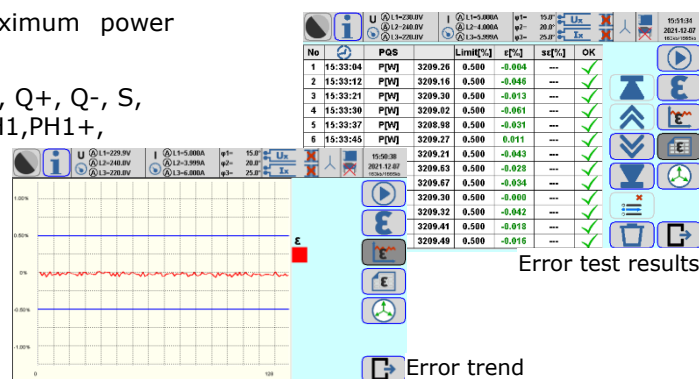
The screenshot displays the TS23 software interface, which is used for testing electricity meters and instrument transformers. It features several tabs and data fields:

- Register test:** Shows energy measurements in kWh and kvarh for different meters (E1, E2, Eref) and their errors (E, Eref).
- Error test:** Displays the calculated meter error as a percentage (-0.039%) and a standard deviation (0.011%).
- Settings:** Includes fields for measurement time (t), number of pulses (n), and limits (lim).
- Units and Conversion:** Shows various units like kWh, kvarh, and their conversion factors.

- maximum power measuring for testing of maximum power meters,
- ✓ for different kind of measuring powers P, P+, P-, Q, Q+, Q-, S, as well as for the first harmonic of these powers PH1, PH1+, PH1, QH1, QH1+, QH1-,
- ✓ with visualization in form of table or trend chart.

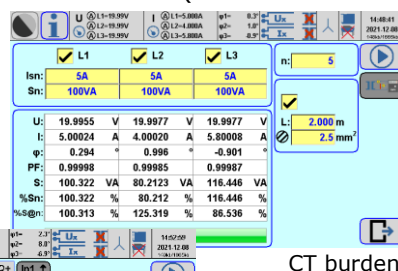
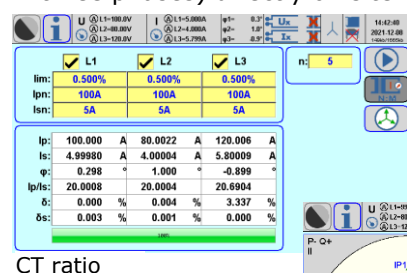
In manual operation mode additionally may be used innovation functions:

- ✓ automatic identification of meter constant,
- ✓ automatic determining time of measurement or number of pulses.



Specifications for impulse input/output			
Parameter	Voltage range	Frequency range	Resolution
Impulse Input for counting pulses (two inputs)	0...2V/4...30V	0.0001Hz...210kHz	0.001% $\text{@t} \geq 1\text{s}$
Impulse Output for Calmet TS23 testing	28V/100mA open collector	0.0001Hz...210kHz	

Testing of instrument transformers - TT function (LV and MV current CT and potential PT simultaneously in three phases) directly on site:



- function of calculating transformer ratio error directly in [%],
- function of phase error calculation,
- function of transformer burden measurements,
- vector diagram of primary and secondary currents.

CT ratio

CT burden

Primary and secondary current vector diagram

Specifications for Burden measurement of PT and CT Transformers			
Parameter	Current range	Voltage range	Accuracy ¹⁾²⁾
CT Burden	0.01...12A (Direct)	1...10V (Direct)	$\pm 0.2\%$
CT Burden	0.1...120A (Clamps CT100AC)	0.05...1V (Direct)	$\pm 0.2\%*$
PT Burden	0.01...12A (Direct)	1...10V (Direct)	$\pm 0.4\%$
PT Burden	0.001...0.01A (Direct)	0.05...1V (Direct)	$\pm 0.4\%*$
PT Burden	0.1...12A (Clamps CT100AC)	10...600V (Direct)	$\pm 0.1\%$
PT Burden	0.001...0.01A (Direct)		$\pm 0.1%*$
PT Burden	0.1...12A (Clamps CT100AC)		$\pm 0.2\%$
Parameter	Primary current/voltage range	Secondary current/voltage range	Accuracy ¹⁾²⁾³⁾
CT Ratio	0.2...120A (Clamps CT100AC)	0.1...12A (Clamps CT100AC)	$\pm 0.4\%$
CT Ratio	10...1200A (Clamps CT1000AC)	0.01...12A (Direct)	$\pm 0.2\%$
CT Ratio	0.3...30A/3...300A/30...3000A (Flexible Clamps FCT3000AC.B)	0.001...0.01A (Direct)	$\pm 0.2%*$
CT Ratio	1...2000A (AmpLiteWire 2000A)		$\pm 0.2\%$
PT Ratio	0.5...40kV (VoltLiteWire 40kV)	10...600V (Direct)	$\pm 0.1\% \pm \text{Em}$

1) % - related to the measuring value, %* - related to the measuring range final value (is underlined)
 2) absolute extended uncertainty under confidence level of 95% covers reference uncertainty of standards, stability in 12 months, influence quantities (ambient temperature +20...+26°C, humidity and power supply voltage 85...265V, frequency 47...63Hz)
 3) Em - sensor basic error, Em=1%+0.1%* (Flexible Clamps FCT3000AC.B), Em=2%+0.2%* (AmpLiteWire/VoltLiteWire sensors)

The TS23 - data management, PC Software, general parameters and accessories

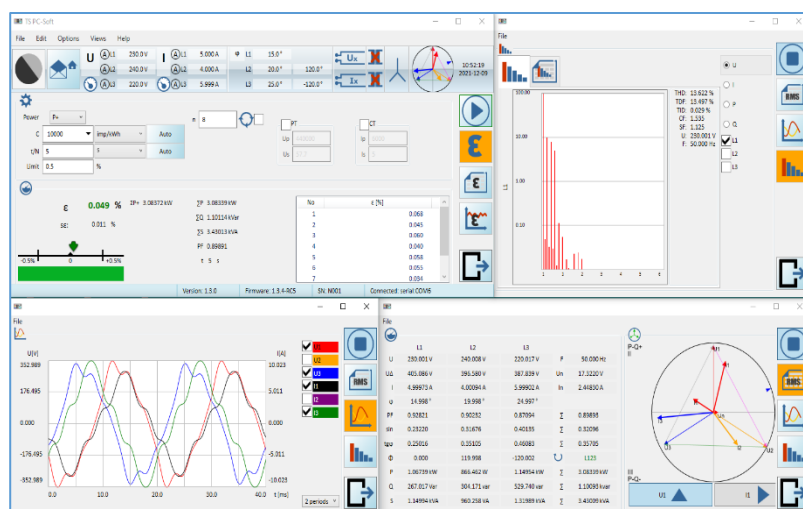
Data Management. The operator can store all measurements and test results in a modern SD memory card up to 32GB, for later visualization in LCD and printing directly from the TS23 using a wireless printer without the need of an external PC and putting the SD card into it.

The data management software TS PC Soft provides the ability to transfer the data between TS23 and an external PC. All results can be summarized and printed in a test report by putting the SD card into an external PC or downloaded through USB, Bluetooth or Ethernet.

The TS PC Soft software additionally provides the ability to manage data on an external PC or tablet:

- downloading of measurement results from the TS23 to a PC through communication port,
- archiving of measurement results and combining individual results into one collective file,

- printing of measurement results in a test reports,
- export of measurement results to Excel (directly to the XLSX file) and to the Windows clipboard.
- testing devices and performing measurements directly from a PC or tablet,
- sending files with results from the TS23 to a PC,
- simultaneous testing of a device and performing additional activities in separate program windows:
 - ✓ measurement of network parameters,
 - ✓ registration of trends for all measured network parameters,
 - ✓ measurements of harmonics and histograms (bar chart),
 - ✓ observation of oscilloscopes (waveform) and vector diagram,



TS PC Soft screens

General parameters	
Weight and dimensions (width x height x depth)	6.9kg and (448x178x256) mm – desktop case (there is available also 19" case)
Power supply	85...265V / 47...63Hz / <30VA
Safety: Isolation protection and Measurement Category	IEC 61010-1 and 300V CAT III
Degree of protection	IP-40
Operation / storage temperature	0...+50°C / -20...+60°C
Operation / storage relative humidity	<90% @ +0...+30°C and <75% @ +30...+50°C / <95% @ 0...+50°C

Calmet TS23 Reference Standard and Accessories

All completed Calmet TS23 Reference Standard set consists of:

- Calmet TS23 Reference Standard class 0.02 or 0.04,
- power cord,
- fuse T500mA 250V (2pcs),
- memory card SD 8GB,
- EA36 set of safety measurement cables (12pcs),
- C091A T3475-001 plug Amphenol for Reference pulse output,
- operation manual and warranty card,
- input (PC13/250) / output (PC17/250) pulse cables Amphenol ↔ BNC (2pcs),
- calibration certificate.





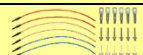












desktop case



19" rack case

Optionally for Calmet TS23 Test System are available:

• Calmet TS PC Soft with operation manual and USB B / USB A interface cable,		• CT10AC error compensated clamps up to 12A (3pcs),	
• TT function – Testing of CT and PT		• CT100AC error compensated clamps up to 120A (3pcs),	
• EA30 120A test leads (6pcs) with terminals set (18pcs),		• CT1000AC error compensated clamps up to 1200A (3pcs),	
• EA20 additional accessories for safety cables,		• FCT3000AC.B error compensated flexible clamps 30/300/3000A (3pcs),	
• CF106H photo head with holder for inductive meter and meter with LED,		• ALW2000AC.1 primary current sensor up to 2000A for LV and MV network (1pc),	
• DR200D miniature thermal printer with Bluetooth,		• VLV40kV.C.1 primary voltage sensor up to 40kV (1pc),	
• ER10H.3 1-position rack for hanging of meter with quick connection device 3-phase,		• ET31 transportation case for additional accessories,	
		• ET35 transportation case for TS23,	

*) all images are for illustrative purposes only and are subject to change

Calmet Sp. z o.o.
 Kukulcza 18, 65-472 Zielona Gora, Poland
 Phone +48 68 324 04 56 Fax +48 68 324 04 57
 E-mail: mail@calmet.com.pl Web access: http://www.calmet.com.pl