

The Calmet C300 Calibrator sets a new benchmark for 0.02 accuracy in Electrical Power Standards

Application note No10

What is the Electrical Power Standard?

The modern Electrical Power Standard is a Three Phase Power Calibrator-source with possibility of accurate voltages, currents, phase shifts, frequency setting and with additional features:

- ▶ Power Quality Source function enables:
 - ▶ generation of special voltage and current waveforms (harmonics, interharmonics, subharmonics),
 - ▶ simulation of voltage, current, phase shift and frequency variations as a function of time (dips, swells, interruptions, flicker),
- ▶ Automatic Test System function for checking of electricity meters, measurement of industrial transducers, current clamps, current transformers and protection relays in fully automatic way.

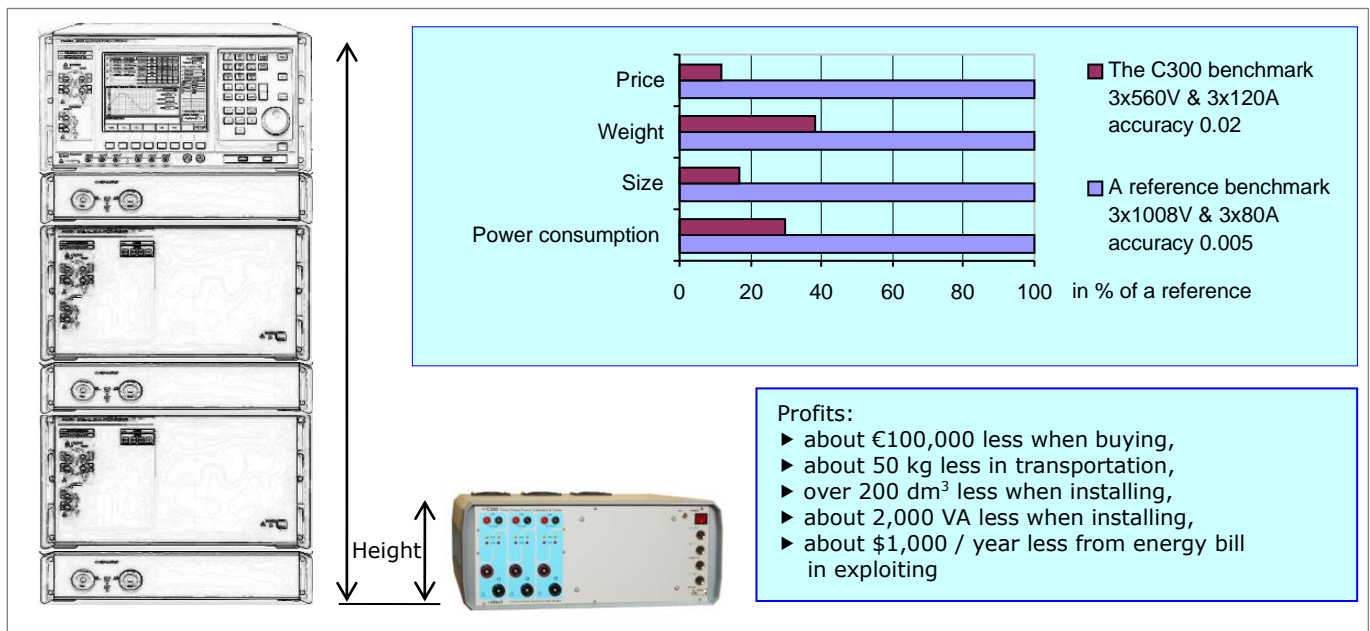
What is the C300?

The C300 is a single-box solution for reference-standard, three phase signals generation to test power quality analyzers, electricity meters, protection relays and similar equipment with sufficient accuracy to guarantee the repeatable results, that international standard demands.

It consists of independent three voltages and three currents channels, that can source up to 560V and 120A with typical accuracies as good as 0.02% or 200ppm. It can work both for single phase configuration with currents up to 360A and for three phase balanced and unbalanced configurations with currents up to 120A without need to use an additional current amplifier options.

The C300 is a smart reference-quality instrument, that uniquely combines accuracy and wide range of output signals, high output load capacity, comprehensiveness, small dimensions, light weight construction and cost-efficiency. The C300 makes easy to add such disturbances as flicker, harmonic and interharmonic distortion to either or all of its six output channels, providing sufficient flexibility to meet any international power-quality standards today or for the foreseeable future, including the ability to freely combine such disturbances as harmonics, interharmonics and variations as a function of time.

Features comparison of Electrical Power Standards for 0.005 and 0.02 accuracy class

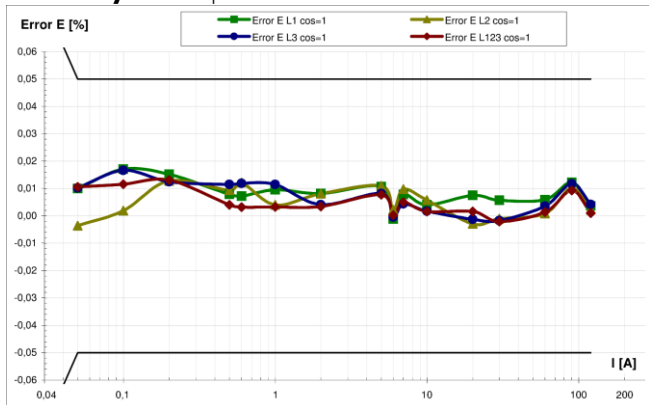


The most accurate, comprehensive, flexible and cost-effective three phase source of electrical power quality and energy signals in single case

The most accurate solution in single case and medium accurate solution among the Electrical Power Standards: C300

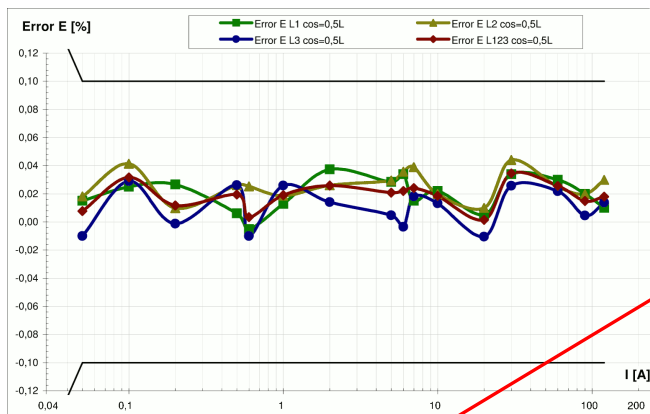
After twenty years of our experience in the field of power calibrators, Calmet launched the C300 Three Phase Electrical Power Standard. Actually, the C300 combines source stability with reference accuracy 0.02 in a single product in a single case.

Accuracy at $\cos\varphi=1$



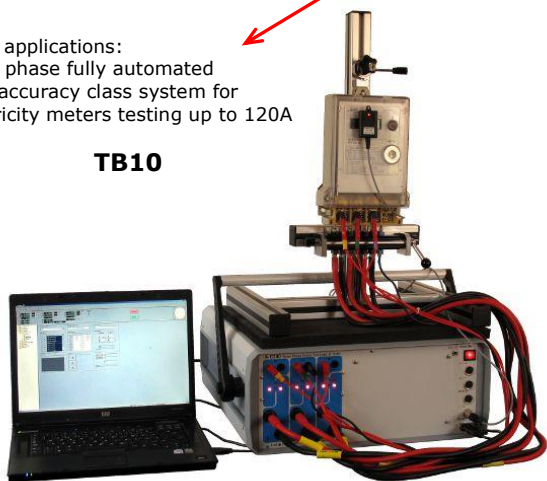
Energy error diagrams of the C300 as a function of current settings in 0.05...120A range for balanced L123 and unbalanced L1, L2 and L3 loads at 230V/50Hz and power factor $\cos\varphi=1$ (top figure) and 0.5L (bottom figure), achieved in automatic test procedure using Calpro300TS software and reference meter Radian RD31

Accuracy at $\cos\varphi=0.5L$



C300 applications: three phase fully automated 0.02 accuracy class system for electricity meters testing up to 120A

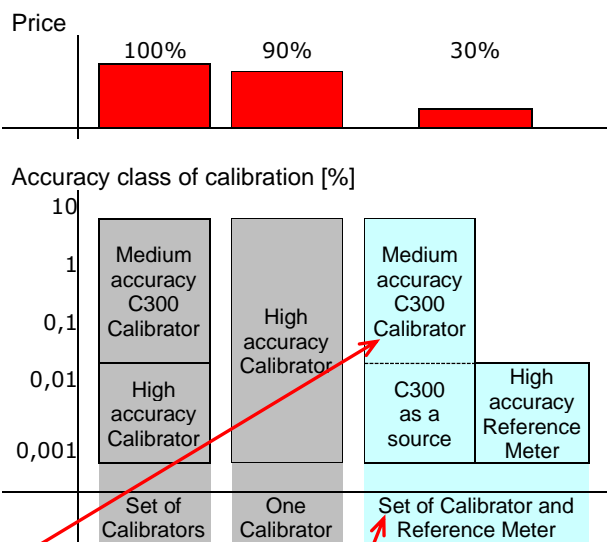
TB10



Traditionally, power and energy calibration under sinusoidal and nonsinusoidal conditions has been accomplished by placing a reference meter and a Device Under Test (DUT) in series or in parallel, downstream of a common voltage/current source. Today, there are different ways to run this calibration. Using a new class of instrument, the Electrical Power Standard, the signal may be directly sourced to the DUT. Those test signals are accurate, traceable, sinusoidal or distorted in specified combinations and compliant with modern EN 61000-4-30 and IEC 50160 standards for power quality and EN 50470 for electricity meters.

There is a following question today:

How do you choose a calibration set for power and energy calibration and testing?

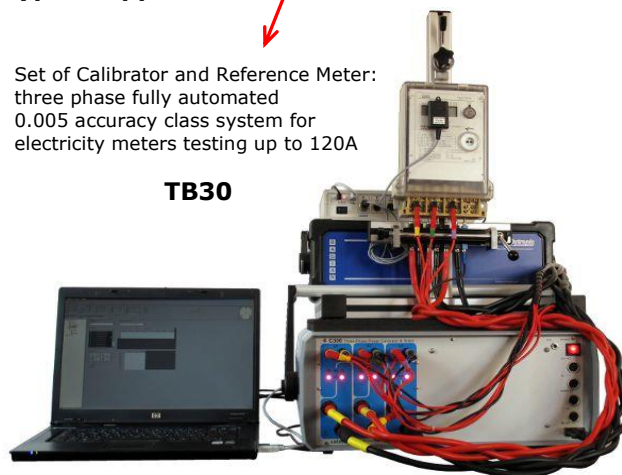


Set of medium accuracy class Calibrator and high accuracy class Reference Meter is a cost-effective and more flexible solution because high accuracy Calibrator – the most accurate Electrical Power Standard has a very high price, weight, size and power consumption

Typical applications

Set of Calibrator and Reference Meter: three phase fully automated 0.005 accuracy class system for electricity meters testing up to 120A

TB30



The most reasonable solutions for a 0.02 and 0.005 accuracy class in power and energy calibration

Comprehensive functionality

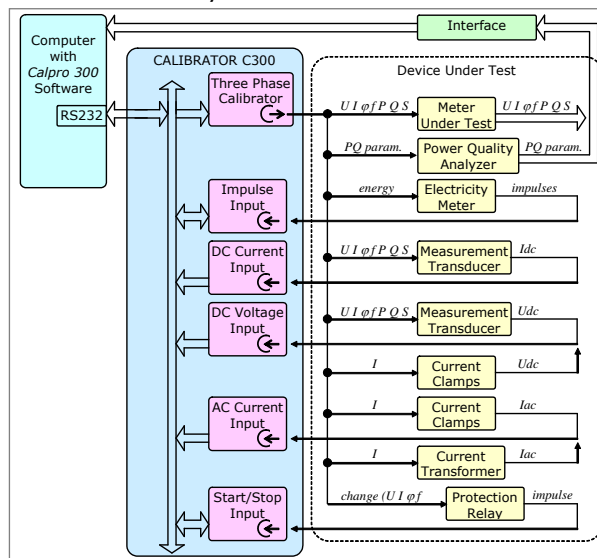
Who needs a C300?

The C300's main application is adjusting, calibrating and verifying measuring instruments, that measure electrical energy and electrical power quality parameters in power engineering. Validation of energy measurements and electrical power quality and the devices, that make them is required in many places, such as:

- ▶ in National Measurement Institutes to provide precise sinusoidal/non-sinusoidal, constant/variable time signals and phantom power in research applications,
- ▶ in R&D Centers to validate the function and accuracy of prototypes and first series,
- ▶ in manufacturing plants to ensure that measurements are correct and repeatable on every manufactured unit,
- ▶ in laboratories to calibrate measurement instruments used as secondary standards,
- ▶ in energy plants to perform measurement and verification of equipment on site,
- ▶ in service to make sure, that instruments work accordingly to the specification.

The C300 was designed to produce high accuracy electrical power quality signals and their fast changes in time simultaneously, what is additionally required to test modern protective relays.

Automatic test system



The C300 Calibrator was designed so that:

- ▶ all current ranges are available through the same terminals in 3 x 0.005...120A and
- ▶ provides the ability to run all current outputs in parallel to generate up to 360 amps in single phase circuit

The C300's workload coverage

The C300 covers a wide workload of electrical power test instruments, including:

- ▶ Meters as AC voltmeters, AC ammeters, Frequency meters, Phase angle meters, Power factor meters, Wattmeters, VARmeters, VAmeters,
- ▶ Power quality analyzers and recorders, flickermeters,
- ▶ Electricity meters as Watthour, VARhour, VAhour meters and Electricity meter testers,
- ▶ Power, voltage, current and PF measurement transducers,
- ▶ Current transformers for measurements and clamps,
- ▶ Protective relays as ANSI#21 Distance relays, ANSI#27/59 Under/over voltage relays, ANSI#32 Directional power relays, ANSI#50/51 Time overcurrent relays, ANSI#81 Frequency relays and more protective relays

DUT's – Devices Under Test



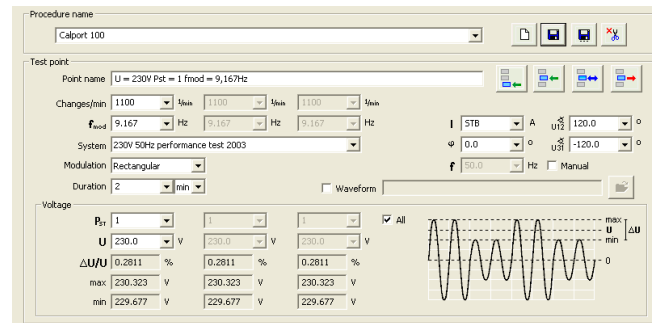
Complex measurements – the C300 Calibrator as a Power Quality Source

Flicker

Flicker is a specific measurement, which sets out to measure the human sensitivity of a flickering light caused by supply voltage fluctuation around of a nominal value. Flickermeter testing is defined in EN 61000-4-15.

The C300 generates voltage changes for performance testing independently on three voltage outputs and displays the results in P_{st} / P_{It} severity including combined frequency/voltage changes, harmonic/interharmonic distortion and phase jumps.

Power Quality/Flicker/Procedure edition field

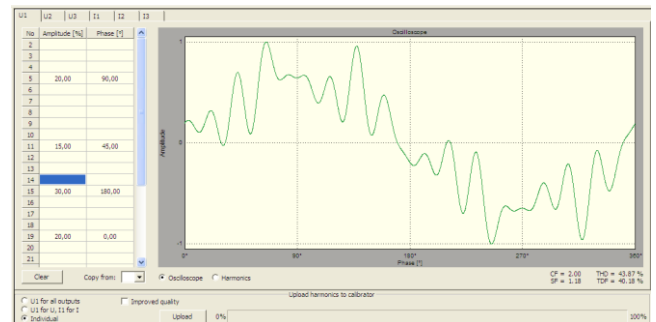


Harmonics

Harmonics are voltages and currents with a frequency, that is an integral multiple of the fundamental frequency. Harmonic testing is defined in EN 61000-4-7 and EN 61000-4-13.

The C300 can generate multi-harmonic distortion with independent superposition of harmonic components in each phase of current and voltage, with levels 0...100% and phase angle 0...360° of the first harmonic.

Waveform/Harmonics/Waveform edition field

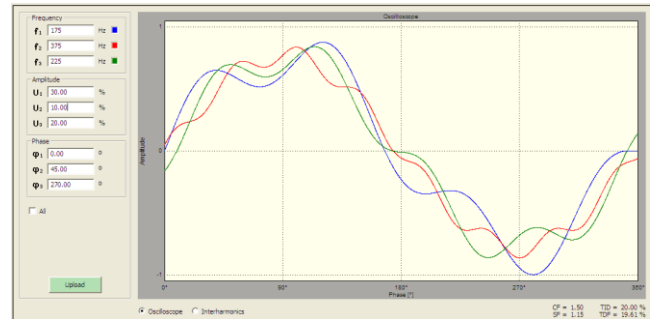


Interharmonics

Interharmonics are voltages and currents with a frequency, that is a non-integral multiple of the fundamental frequency. For example, in 50Hz supply system, 150Hz is a harmonic (the third) but 175Hz is an interharmonic. Interharmonic testing is defined in EN 61000-4-7 and EN 61000-4-13.

The C300 can generate interharmonics at a user-definable frequency up to 3200Hz, amplitude and phase angle on each voltage outputs.

Three phase voltages with different interharmonics



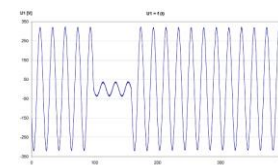
Dips, Interruptions, Swells and Shocs

Dips are a temporary reduction of the voltage below nominal (Interruptions below 1% nominal) and Swells are a temporary increase of the voltage above nominal up to 200% nominal for a time from 10ms up to several minutes. Shocs (Inrush current) are a temporary increase of the current above nominal when first turned on of an electrical device. Dips, Interruptions and Swells testing is defined in EN 61000-4-11 and EN 61000-4-34.

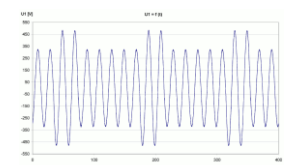
The C300 can generate a user-definable fast and slow changes of three phase voltage and current independently on each channel.

C300 output signals recorded by digital oscilloscope

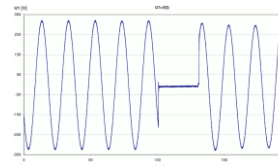
Single voltage dip



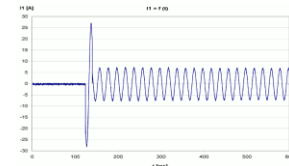
Periodic voltage swells



Single voltage interruption



Single current shoc



Complex measurements – the C300 Calibrator as a Power Quality Source cont.

Complex signals and real configurations

Full verification of measurement devices requires, that complex combinations of signals (for flickermeters acc. to EN 61000-4-30) and real configurations (for electricity meters acc. to EN 50470) are used correctly.

The C300 can generate a compound signals variable in time (for example fluctuations) under nonsinusoidal conditions (for example with interharmonics) and in configurations with balanced/unbalanced voltages and balanced/unbalanced loads to ensure that performance is maintained under real world conditions.

Power Quality/Fast Ramp/Procedure edition field

The screenshot shows the 'Test point' configuration window. The procedure name is 'Fluctuations with asymmetry angles+loads and interharmonics'. The test point is '230V L1+219.99V L2+230.01V L3 120ms'. The configuration includes voltage (U) and current (I) settings for three phases (1, 2, 3). The voltage settings are: U1: 230.000 V, U2: 219.990 V, U3: 230.010 V. The current settings are: I1: 120 A, I2: 3 A, I3: STB A. The power factor is set to 30°. The frequency is 50.1 Hz. The waveform is set to 'cos sin'. The interharmonics are set to 'L1-175Hz+L2-375Hz+L3-225Hz.ihm'. The power settings are: P: 23902.3 W, Q: 13800.0 var, S: 27800.0 VA. The duration is set to 120 ms.

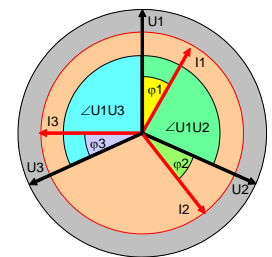
No	Point Name	U1 [V]	U2 [V]	U3 [V]	I1 [A]	I2 [A]	I3 [A]	φ1	φ2	φ3	*f12 [°]
1	230V L1+219.99V L2+230.01...	230.000	219.990	230.010	120	3	STB	30°	-10°	60°	110
2	230V L1+230.01V L2+219.9...	230.000	230.010	219.990	120	3	STB	30°	-10°	60°	110

Multi-phase operation

The C300 Calibrator offers self-contained single phase and three phase operation with three voltage and three current outputs without needed to use auxiliary units and options, for example amplifiers.

Voltage outputs U1, U2 and U3 of the three phase C300 system are connected in four-wire, WYE configuration. Each current output I1, I2 and I3 remains totally electrically isolated and provides currents in full current range from 1mA up to 120A through compact and internally connected 4mm/6mm banana sockets.

Voltage and current outputs of the C300 Calibrator



Energy option

The C300 Calibrator is used for calibration of single electricity meter and with a MPX8 for simultaneous calibration up to eight meters.

The user can choose the reference. The C300 energy accuracy is as good as almost any external reference standard – this solution is preferred for reasonably price systems with accuracy referenced to the C300 Calibrator. But for extremely high accuracy systems, the C300 user may choose to use an external reference standard. Measured energy is compared with the reference value and a percentage error reported for each device being tested.

MPX8 Eight-channel Meter Error Calculator

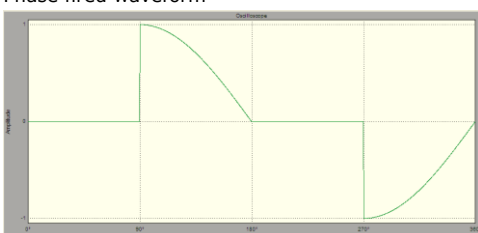


EN 50470 waveforms

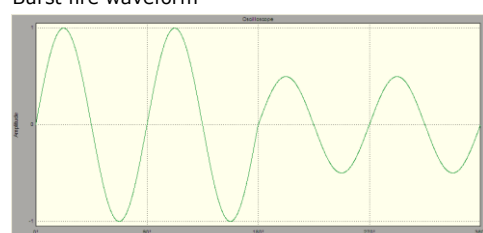
To make it more convenient to type test and calibrate watt hour meters, the waveforms required by the relevant standards (in the old EN 61036:2000, EN 62053:2003 and in the new EN 50470:2006) are preinstalled in the C300, for example:

- ▶ odd harmonics as a phase fired waveform with fired at 90° and 270°,
- ▶ sub-harmonics as a burst fire waveform with 2 cycles on and 2 cycles off.

Phase fired waveform



Burst fire waveform



Total solutions in power calibration

Calmet Ltd provides the broad range of calibrators and meters, software, service, support and training in power calibration. Visit www.calmet.com.pl for more information about Calmet calibration solutions.

Power calibrators and power quality calibrators

- ▶ simple calibrators with predefined settings
- ▶ simple calibrators with manual settings
- ▶ multifunction electrical power standards



Voltage, current and resistance calibrators

- ▶ for AC/DC voltage and current multimeters
- ▶ for insulation meters



Portable electricity meter testers on site

- ▶ from simple single phase testers
- ▶ to advanced three phase testers with additional functions of current transformers testing and power network quality analysing



Network quality analysers



Stationary and portable meter test systems

- ▶ single and multi position
- ▶ for electricity meters and relays



Calibration software



Calmet. Smart solution gives high quality and reasonable price.

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