

# CP CU1

Coupling unit for line and ground testing



# Line and ground test system – CPC 100

The CPC 100 is a multifunctional test set for primary assets. When combined with the CP CU1 it covers the following tests:

- > Line impedances of overhead lines and power cables for distance relay parameterization
- > Mutual coupling impedances between parallel lines
- > Ground impedances of large substations (fall-of-potential or 3-point test)
- > Step and touch voltages
- > Reduction factor
- > Coupling of power lines into signal cables



CPC 100

HGT1 – Handheld grounding tester



CP GB1 – Grounding box

# + CP CU1

## Safe testing

Measurements on power lines require special safety precautions. The CP CU1 ensures the galvanic isolation of the user from the line under test for enhanced protection.

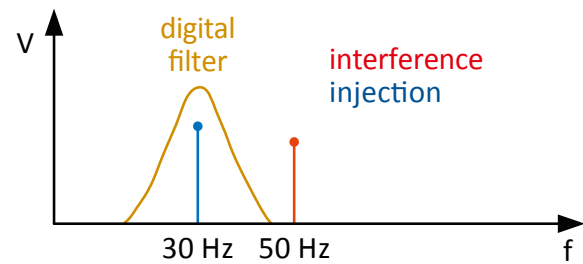
In addition the CP GB1 features high current surge arrestors to protect the CP CU1 and the CPC 100 from unexpected overvoltages on the line under test. Up to 30 kA can be safely diverted to ground.

## Accurate and light-weight

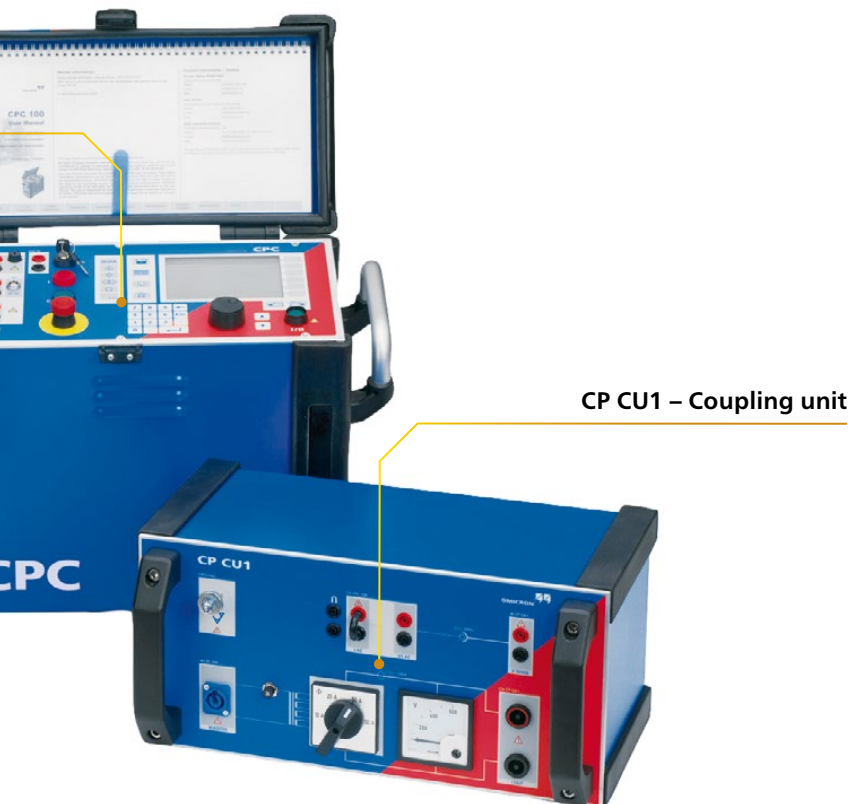
Overhead lines can be subjected to high interference. Accurate line impedance measurements therefore require effective noise suppression.

For this reason the CPC 100 employs frequency selective measurement. This means that a test current with a frequency different from power frequency is injected into the line.

Using a digital filter for the current and voltage measurements allows power frequency interference to be suppressed effectively and the test parameters to be determined accurately.



Conventional testing equipment uses noise suppression methods which require much higher test currents. Thus the equipment is much larger and heavier. The heaviest component of our test solution is 29 kg / 64 lbs– perfect for easy handling and for being shipped around the world!



## Your benefits

- > High Accuracy: Frequency selective measurement and digital filtering
- > Safety: Galvanic isolation and protection from overvoltages
- > Light-weight and easy to handle
- > Intuitive reporting and assessment with dedicated templates
- > One unit for line and ground testing

[www.omicronenergy.com/CPCU1](http://www.omicronenergy.com/CPCU1)



# Line impedance measurement

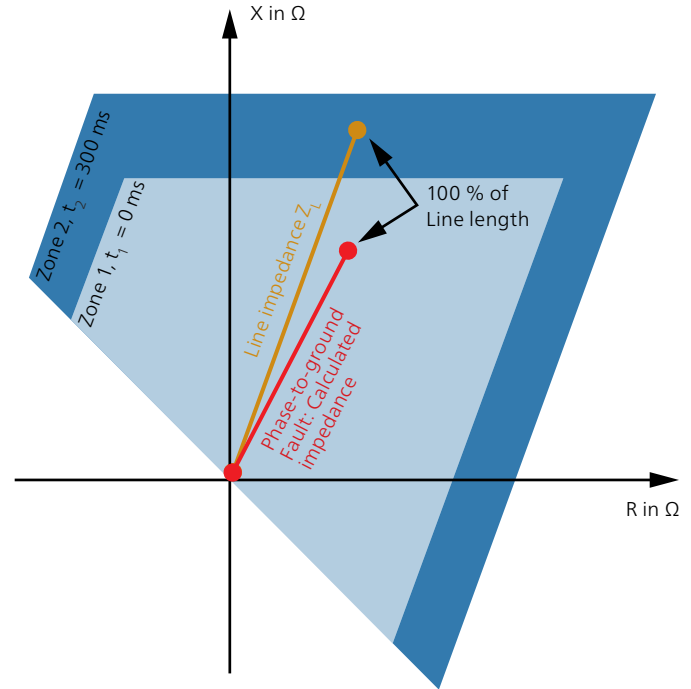
## Line parameters for distance protection

Correct line parameters are crucial for reliable and selective distance protection. The set of parameters contains the positive and the zero sequence impedance ( $Z_1$ ,  $Z_0$ ) as well as the k-factor ( $k_L$ ,  $R_E/R_L$  and  $X_E/X_L$ ,  $k_0$ ).

These parameters are often calculated from software tools, which do not provide actual line parameters due to unknown soil properties, such as different soil resistivities, pipelines or other unknown conductors. This leads to under- or overreach of your distance protection relay resulting in outage and loss of grid stability.

## Zone under- and overreach

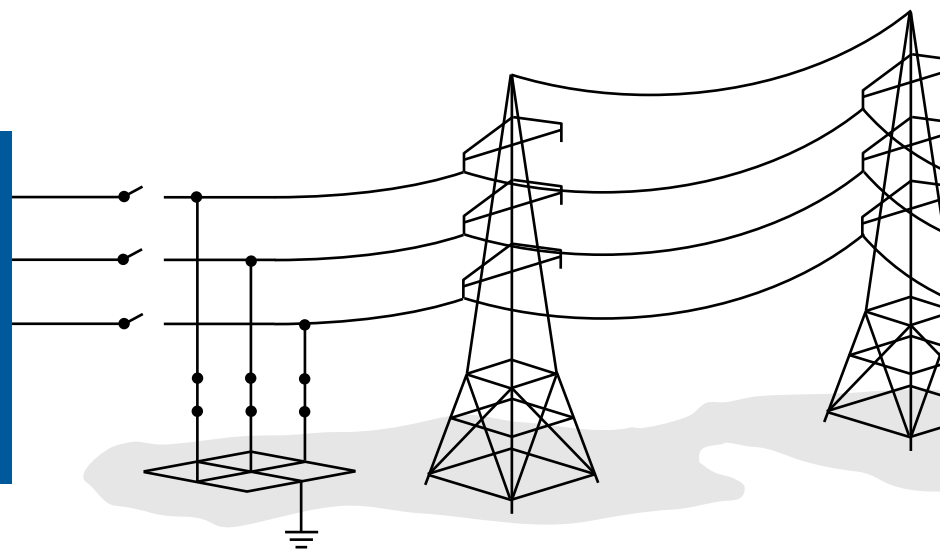
The most frequent faults on power lines are ground faults. In particular, inaccuracies from software calculation effect this kind of fault. The example on the right shows a zone overreach for a ground fault due to an incorrect k-factor setting. In this case the assumed k-factor is higher than the actual one. Therefore, a ground fault at the remote end of the line is seen incorrectly in the first zone.



Incorrect k-factor (tendency to overreach)

### Measurement advantages:

- > Tune your distance relay by performing a line impedance measurement
- > Safe and quick determination of  $Z_1$ ,  $Z_0$  and k-factors.
- > Mutual coupling Impedance measurement between parallel lines



## Test set-up

The test set-up for a line impedance measurement is shown below. The loops A-B, B-C and A-C are measured to determine  $Z_1$ . The loop ABC-G is measured to determine  $Z_0$ . K-factor formats commonly used in distance relays are then calculated from these two values.

### Testing with the CPC 100

The main unit CPC 100 unit generates the frequency variable test current and measures current and voltage by applying digital filtering for high accuracy. The complex loop impedance is then calculated accordingly.

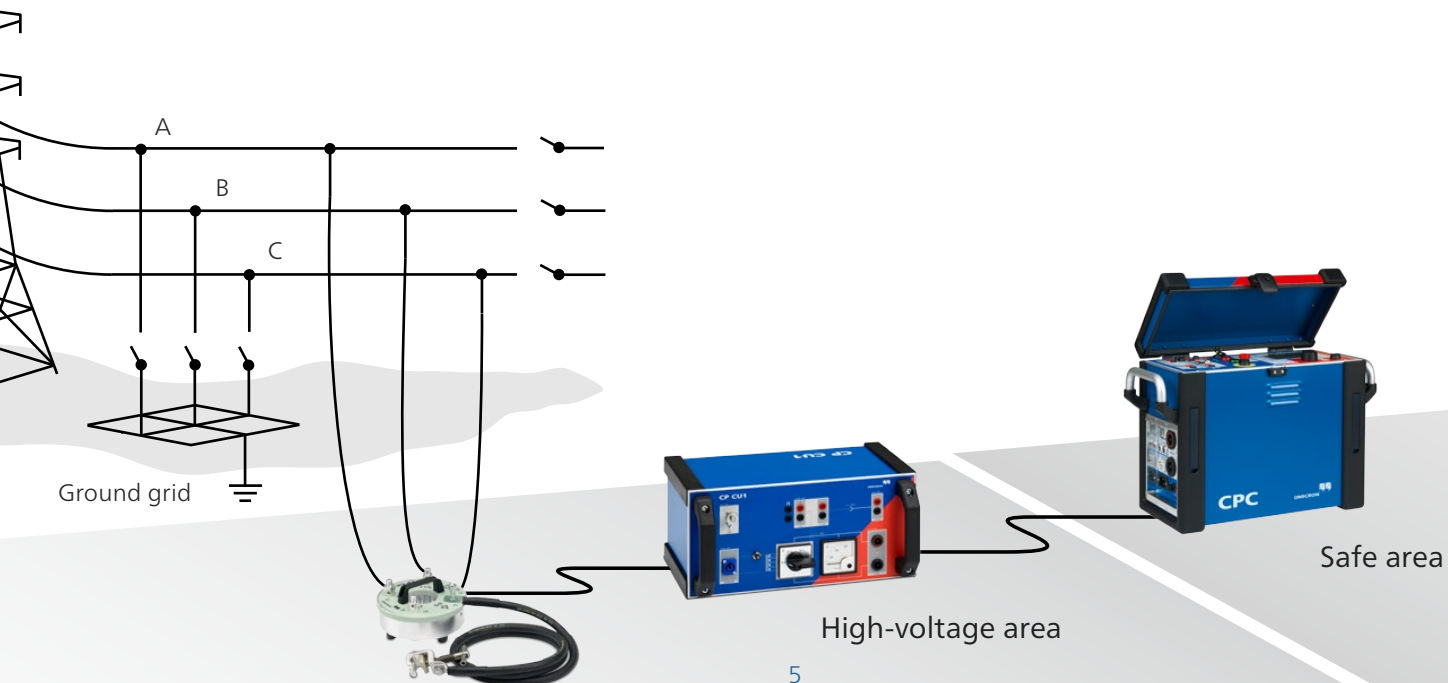
The CP CU1 provides galvanic isolation between the line under test and the CPC 100 as well as impedance matching for short and long lines.

The CP GB1 protects the test equipment and the user from any unexpected overvoltage on the line under test. Furthermore it allows a direct connection to the power line for a convenient execution of the test.

A dedicated test template provides the positive and the zero sequence impedance as well as the k-factor in commonly used formats. Furthermore it shows the actual zone reach for each fault type based on the measured values and relay parameters that are currently being used.

### Mutual coupling

With this unique testing equipment, the mutual coupling impedance between parallel lines can also be determined to consider coupling effects for correct parameterization.



# Grounding system testing

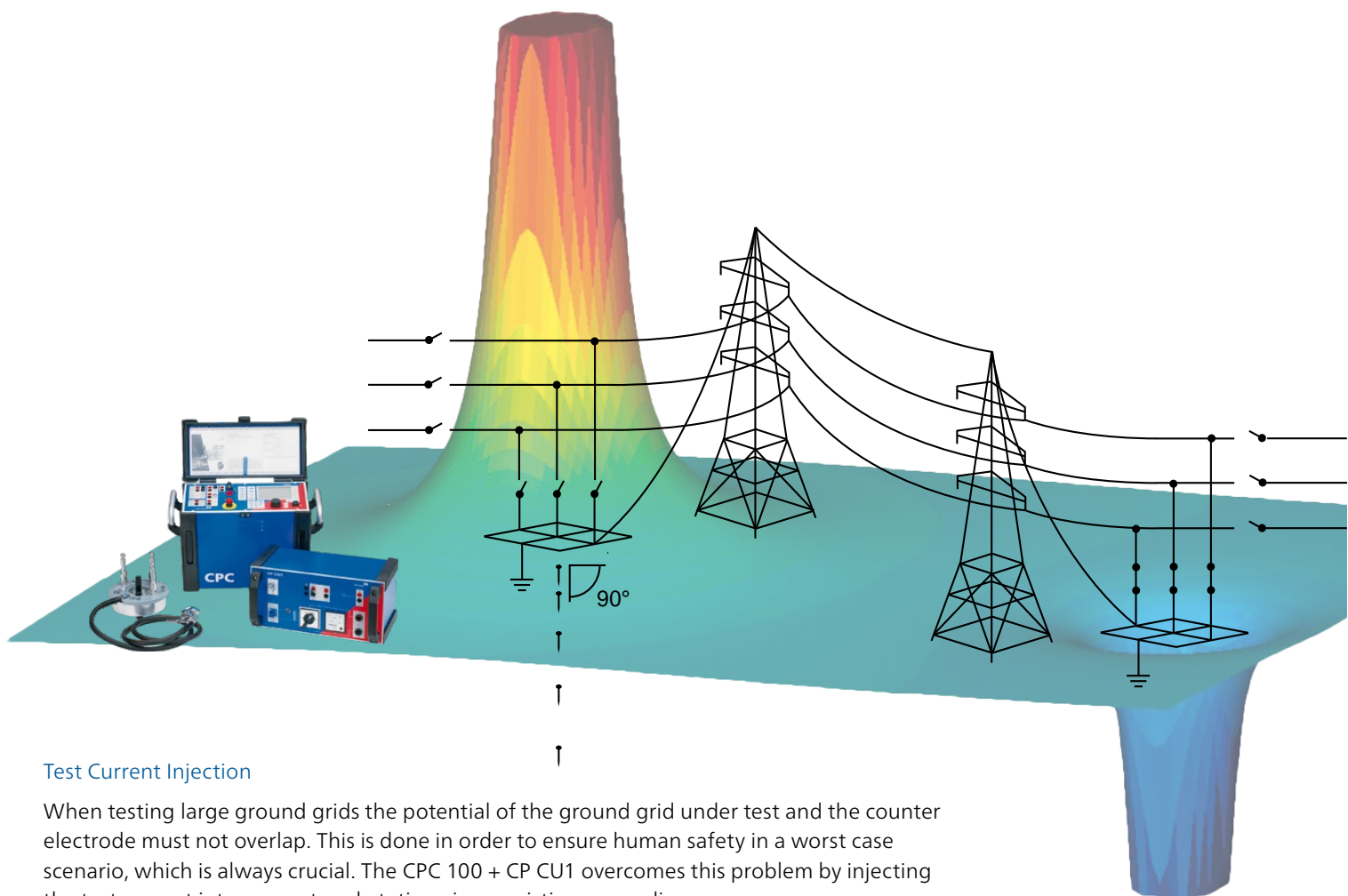
## Personnel safety

In the event of a ground fault hazardous step and touch voltage can occur inside and outside of a substation. Ground tests prove the effectiveness of grounding systems and guarantee safety of people inside and outside the substation.

A fall-of-potential measurement is usually performed to determine the condition of the entire ground grid. On top of that, step and touch voltages are measured at exposed locations in order to ensure human safety. \*

## Ground Impedance measurement (3-point test)

\* For the fall-of-potential measurement according to EN 50522 and IEEE 81 the voltage between the ground grid and ground electrodes in different distances to the ground grid is measured until reference ground is reached. PTM instantly transforms the test results into a voltage and impedance chart which allows the ground potential rise and the ground impedance to be determined.



## Test Current Injection

When testing large ground grids the potential of the ground grid under test and the counter electrode must not overlap. This is done in order to ensure human safety in a worst case scenario, which is always crucial. The CPC 100 + CP CU1 overcomes this problem by injecting the test current into a remote substation via an existing power line.

## Step and touch voltage measurement

Step and Touch voltage measurements according to EN 50522 or IEEE 81 are performed at locations inside and outside the substation. PTM automatically assesses the measurements according to EN 50522 or IEEE 80.

Tests can be executed quickly and easily since long test cables for connecting to the main device are no longer necessary.

Measurement advantages:

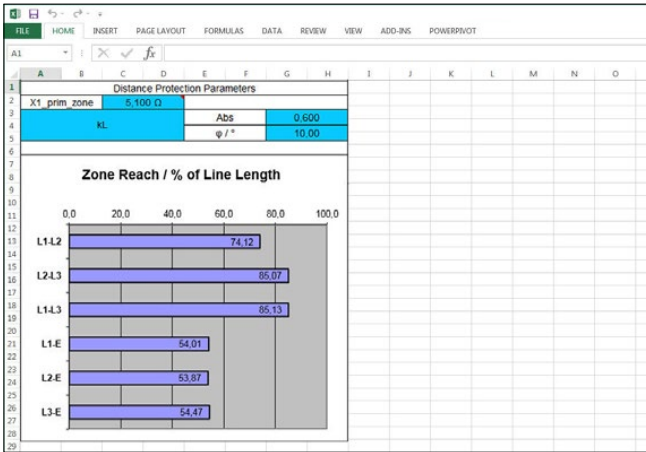
- > Determine true test values by power line injection
- > Ground Impedance and Step and Touch voltage Testing with PTM and HGT1
- > Automated GPS Tracking
- > Offline Usage of BING maps
- > Charts and Final results instantly available
- > Real time assessment Reduction factor measurement on ground wires and cable shields

## Voltage measurement

Primary Test Manager (PTM) and HGT1 enable you to quickly, simply and conveniently measure ground impedance as well as step and touch voltage. Due to a new approach there is no operational personal required at the CPC 100 anymore. Together, the test director and assistants perform all measurements out in the field in order to avoid miscommunication and selection of inadequate test points.



# Software supported testing

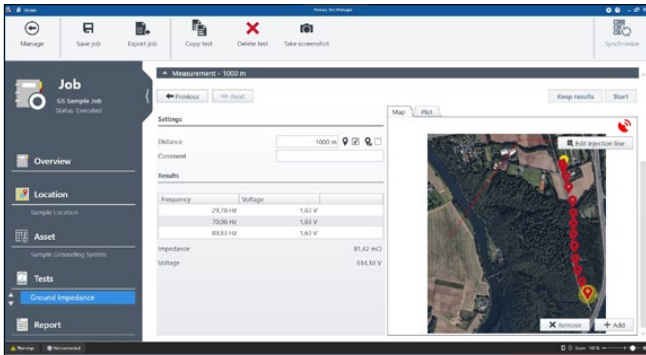


## Test templates

We provide dedicated Microsoft Excel™ test templates for line and ground testing. This allows reporting and test data assessments to be performed quickly and easily.

## Line impedance

The line impedance test template shows the actual zone reach of an arbitrary parameter set (X-value of the zone and k-factor) based on the measured impedances. The example on the left refers to the settings of the first zone (usually 80 % zone reach) which reveals a zone underreach for ground faults.



## Ground testing

Primary Test Manager (PTM) in combination with the HGT1 supports fully automated ground impedance as well as step and touch voltage measurements. Both tests feature GPS and offline usage of BING maps for convenient tracking of test points. PTM instantly creates impedance and voltage charts and calculates step and touch voltages with respect to maximum single line to ground fault currents. This allows real time assessment according to EN 50522 and IEEE 80.



## System-based protection testing with RelaySimTest

RelaySimTest is our easy-to-use software for system-based protection testing with CMC test sets. It applies power system simulations based on the measured line, ground and mutual coupling impedances and calculates realistic voltages and currents for multiple fault scenarios automatically. This unique approach reveals failures created during calculations used for the parameterization of protection relays as well as during the setup of a relay or a complete protection scheme.



# CPC 100: the all-in-one system

The CPC 100 covers a lot of other applications in and around substations as well as at the manufacturer's production site. This powerful device provides up to 800 A or 2 kV with up to 5 kVA over a frequency range of 15 Hz to 400 Hz or 400 A<sub>DC</sub>.

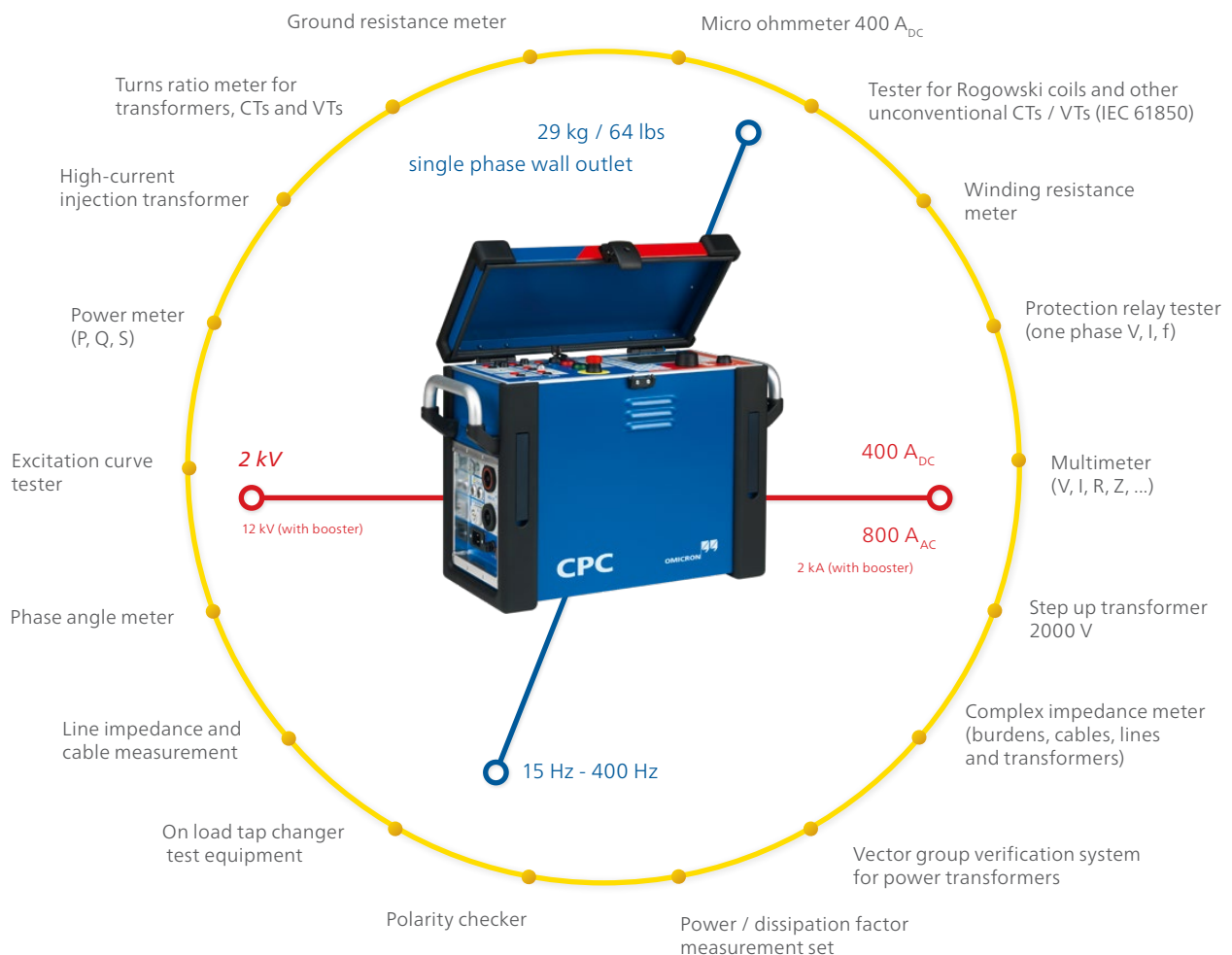
It can test various substation assets, thereby replacing several individual testing devices. This makes testing with the CPC 100 a time-saving and cost-effective alternative, especially as the application range of the CPC 100 is further expanded by a high number of valuable accessories.

Despite its expansive capabilities, the CPC 100 is very simple to use.

Thus it is the ideal instrument for all major applications in the area of substation asset testing.

## Featured assets

- > Current transformers
- > Voltage transformers
- > Power transformers
- > Power lines
- > High-voltage cables
- > Grounding systems
- > Rotating machines
- > Switchgear and circuit breakers
- > IEC 61850 installations
- > Protection relays



# Technical data

## CPC 100\*



### Power specifications

Single-phase, nominal <sup>1</sup>	100 V <sub>AC</sub> ... 240 V <sub>AC</sub> , 16 A
Single-phase, permissible	85 V <sub>AC</sub> ... 264 V <sub>AC</sub> (L-N or L-L)
Frequency, nominal	50 Hz / 60 Hz

### Mechanical data

Dimensions (W × H × D) (cover without handles)	468 × 394 × 233 mm / 18.4 × 15.5 × 9.2 in
Weight (case without protection cover)	29 kg / 64 lbs

## CP GB1



Nominal ac spark-over voltage	< 1000 V <sub>rms</sub>
Impulse spark-over voltage	< 2000 V <sub>peak</sub>

### Short circuit proof with:

16 mm cylindrical or 20 mm ball studs	26.5 kA (< 100 ms) / 67 kA <sub>peak</sub>
25 mm ball studs	30 kA (< 100 ms) / 75 kA <sub>peak</sub>
Torsional moment for changing arrestors	> 15 Nm
Dimensions (Ø × H)	200 × 190 mm / 7.9 × 7.5 in
Weight	6.8 kg / 13.2 lbs (including grounding cable)

## HGT1



Voltage input	Max. 25 V <sub>rms</sub>
Power supply	1 × 3.7 V lithium polymer (Li-Po) battery
Dimensions (W × H × D)	90 × 180 × 45 mm / 3.5 × 7.1 × 1.8 in
Weight (including battery)	0.48 kg / 1 lb

## CP CU1



### Output ranges

Range	Current	Compliance voltage at > 45 Hz
10 A	0 ... 10 A <sub>rms</sub>	500 V <sub>rms</sub>
20 A	0 ... 20 A <sub>rms</sub>	250 V <sub>rms</sub>
50 A	0 ... 50 A <sub>rms</sub>	100 V <sub>rms</sub>
100 A	0 ... 100 A <sub>rms</sub>	50 V <sub>rms</sub>

### Measuring transformers

Transformer	Ratio	Accuracy at 50 Hz / 60 Hz
VT	600 V : 30 V	Class 0.1
CT	100 A : 2.5 A	Class 0.1

### Inputs

	Characteristic	Rating
V SENSE	Overvoltage category	CAT III (IEC 61010-1)
	Voltage range	0 ... 600 V <sub>rms</sub>
BOOSTER	Overvoltage category	CAT I
	Voltage range	0 ... 200 V <sub>rms</sub>
	Current range	0 ... 30 A <sub>rms</sub>
	Frequency range	15 Hz ... 400 Hz
	Fuse	30 A fast acting, automatic circuit breaker

### Output power

Characteristic	Rating
Maximum power	5000 VA (45 Hz ... 70 Hz), cos φ < 1.0 for 8 s at 230 V <sub>AC</sub> 5000 VA (45 Hz ... 70 Hz), cos φ < 0.4 for 8 s at 115 V <sub>AC</sub>
Continuous power	0 ... 1600 VA

### Accuracy

Range	Accuracy of absolute value	Accuracy of phase angle	V SENSE voltage	I OUT current	Current range
0.05 ... 0.2 Ω	1.0 ... 0.5 %	1.5 ... 0.8°	5 ... 20 V	100 A	100 A
0.2 ... 2 Ω	0.5 ... 0.3 %	0.8 ... 0.5°	20 ... 50 V	100 ... 25 A	100 A
2.0 ... 5 Ω	0.3 %	0.5°	100 V	50 ... 20 A	50 A
5.0 ... 25 Ω	0.3 %	0.5°	100 ... 250 V	20 ... 10 A	20 A
25 ... 300 Ω	0.3 ... 1.0 %	0.5 ... 1.5°	250 ... 500 V	10 ... 1.5 A	10 A

### Mechanical data

Dimensions (W × H × D)	450 × 220 × 220 mm / 17.7 × 8.7 × 8.7 in
Weight	28.5 kg / 62.78 lbs

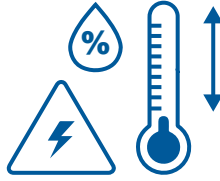
\* Additional information can be found in the CPC 100 brochure.

# We create customer value through ...

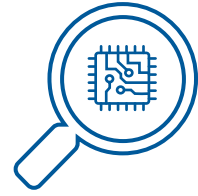
## Quality



Highest safety and security standards

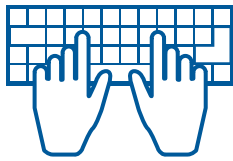


Up to 72 hours burn-in tests



100% routine testing for all components

## Innovation



>200 developers keep our solutions up-to-date



Reinvestment >15% in R&D

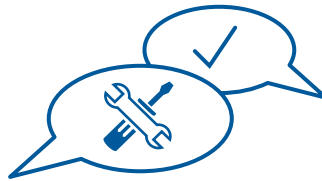


Up to 70% time saving through automation

## Support



Professional technical support



Cost-effective repair & calibration



25 offices worldwide

## Knowledge



>300 Academy trainings per year



OMICRON hosted training & events



Free papers & application notes

OMICRON is an international company that works passionately on ideas for making electric power systems safe and reliable. Our pioneering solutions are designed to meet our industry's current and future challenges. We always go the extra mile to empower our customers: we react to their needs, provide extraordinary local support, and share our expertise.

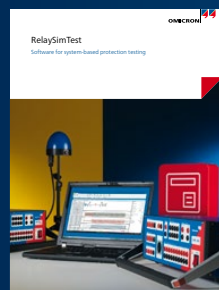
Within the OMICRON group, we research and develop innovative technologies for all fields in electric power systems. When it comes to electrical testing for medium- and high-voltage equipment, protection testing, digital substation testing solutions, and cybersecurity solutions, customers all over the world trust in the accuracy, speed, and quality of our user-friendly solutions.

Founded in 1984, OMICRON draws on their decades of profound expertise in the field of electric power engineering. A dedicated team of more than 900 employees provides solutions with 24/7 support at 25 locations worldwide and serves customers in more than 160 countries.

The following publications provide further information on the solutions described in this brochure:



CPC 100 Brochure



RelaySimTest Brochure

For more information, additional literature, and detailed contact information of our worldwide offices please visit our website.