CPC 100

Multi-functional primary test system for substation commissioning and maintenance
CPC 100 – The revolutionary all-in-one test system

The patented test system replaces numerous individual testing devices and offers new, innovative testing methods. This makes testing with the CPC 100 a time-saving and cost-effective alternative for conventional testing methods. Despite its expansive capabilities, the CPC 100 is very simple to use.

The powerful testing device provides up to 800 A or 2 kV (2 kA or 12 kV with accessories) with up to 5 kVA over a frequency range of 15 Hz to 400 Hz or 400 A_{dc}.

Its compact design (29 kg / 64 lbs) makes it easy to transport and ideal for on-site testing.

Using the CPC 100, electrical tests on various assets can be performed:

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

Quality & Experience

The usage of high-quality components & intensive routine testing in our factory have made the CPC 100 a reliable companion for for our customers worldwide.

The CPC 100 is being improved continuously in close cooperation with our customers. Its new accessories and continuous updates guarantee a future proof concept.
CPC 100 – The revolutionary all-in-one test system

- Micro ohmmeter
- 400 A_{dc}
- Ground resistance meter
- 400 A_{dc}
- Step up transformer
- 2000 V
- Winding resistance meter
- Protection relay tester
- (one phase V, I, f)
- Tester for Rogowski coils and other unconventional CTs / VTs (IEC 61850)
- Multimeter
- (V, I, R, Z, ...)
- Power / dissipation factor measurement set
- Vector group verification system for power transformers
- Complex impedance meter
- (burdens, cables, lines and transformers)
- 15 Hz - 400 Hz

29 kg / 64 lbs
single phase wall outlet

400 A_{dc}

800 A_{ac}

2 kA (with booster)
9 good reasons for one system

MULTIFUNCTIONAL

> Test several assets (e.g. CT, VT, CB, power transformer)
> Test different parts of an asset (e.g. core, windings, bushing, insulation)
> Perform numerous tests (e.g. ratio, polarity, burden, excitation current)

VARIABLE FREQUENCY

> Voltage and current injection with variable frequency
> Suppression of mains-related interference and disturbances
> Test results at different frequencies provide more detailed information about an asset
> Variable frequency testing is necessary for some standardized and advanced diagnostic tests

TESTING AND REPORTING

> Offline test preparation possibilities (time-saving and less error-prone)
> CPC 100 software automatically guides the user through the test
> Automated report generation
> Customizable test reports (e.g. different languages, customer logo)

WEIGHT SIZE

> Light-weight (29 kg / 64 lbs)
> Compact design
> Save costs on:
  > Transport
  > Handling
  > Storage

CONFORMITY TO STANDARDS

> CPC 100 fulfills highest safety requirements
> CPC 100 is CE tested
> CPC 100 tests according to IEEE and IEC standards
> Measurements with the CPC 100 deliver reliable and repeatable results due to high signal and measurement accuracy
Product Quality

- Durable case design for rough environments with test field accuracy
- Long lifetime due to high quality components
- Premium quality cables and clamps
- Comprehensive documentation (e.g. user manual with connection diagrams, software help function, videos, application notes)

Expand Ability

- Further applications can be covered by adding additional hardware accessories
- By upgrading the software:
  - Additional tests can be performed
  - Additional assets can be tested

Safety First

- Emergency switch-off button
- Protective Earth conductor connection check
- Overload detection
- Multiple isolated outputs
- Safety key lock
- Discharge circuit to de-energize DC test objects
- SAA1 - audible beeper dongle
- SAA2 - Warning Lamp Set
- SAA3 - 3-position remote safety switch
- Grounding box

Prepared for the Future

- Unconventional assets can be tested (e.g. Rogowski coils, low power CTs)
- Testing according to IEC 61850-9-2 (e.g. Sample Values, Merging Unit testing)
- Future applications areas will be covered by newly developed accessories and software
CPC 100 product family – Extended range of applications

The CPC 100 covers a lot of different applications in and around substations as well as at the manufacturer’s production site. Extended by a high number of valuable accessories the application range of the CPC 100 is further expanded. Thus it is the ideal instrument for all major applications in the area of primary testing.

**CPC 100**

Applications

- Current transformer testing (page 8 – 9)
- Voltage transformer testing (page 10 – 11)
- Power and distribution transformer diagnosis (page 12 – 13)
- Grounding system analysis (page 16 – 17)
- Switchgear / circuit breaker testing (page 22 – 23)
- Commissioning protection systems (page 24 – 25)
- Sampled Values testing (page 26 – 27)

Primary test system
CPC 100 product family – Extended range of applications

- HV cable and power line analysis (page 14 – 15)
- Gas Insulated Switchgear testing (page 20 – 21)
- Rotating machine diagnosis (page 18 – 19)
- Current transformer testing (page 8 – 9)
- Sampled Values testing (page 26 – 27)
- Voltage transformer testing (page 10 – 11)
- Switchbox / circuit breaker testing (page 22 – 23)
- Switchgear / circuit breaker testing (page 22 – 23)
- Grounding system analysis (page 16 – 17)
- Handheld grounding tester

Extended range with accessories

- Coupling unit
- HV-source
- Switch box
- Tan Delta test set (power factor)
- Compensation reactor
- Remote control
- Current booster
- Resonance circuit
- Grounding system analysis
- Handheld grounding tester
Current transformer (CT) testing

Why testing CTs?
Testing current transformers helps to detect installation related and in-service related problems, such as:

Installation related
- Transportation damages
- Wiring errors
- Manufacturing defects

In-service related
- Degradation of accuracy class
- Shorted turns
- Magnetized core
- Burden failures in secondary circuit
- Insulation material failures

With the CPC 100 many standard electrical tests for CTs can be performed with one single device saving testing time and labor costs. Additionally, unconventional CTs, like Rogowski coils and IEC 61850 integrated systems, can also be tested.

CT testing with the CPC 100
Supplied from a single phase wall outlet, the CPC 100 can generate up to 800 A\textsubscript{AC} (2000 A with CP CB2 current booster) for injecting into the CT’s primary side and testing its ratio, polarity and burden.

Excitation curve measurement
For excitation curve measurement, the CPC 100’s output is connected to the secondary terminals of the core. Within an automatic test run, the CPC 100 measures the excitation curve and displays the knee point voltage and knee point current at rated frequency (according to the relevant IEC or IEEE / ANSI standard). The CPC 100 also automatically demagnetizes the CT core after the test.

Your benefits
- Mulifunctional CT tests
- Primary injection up to 2 kA
- Simple wiring test with handheld polarity checker (CPOL2)
- Voltage withstand test up to 2 kV

+ CPOL2
The CPOL2 can check the correct polarity along the different connection points in the secondary wiring by analyzing the sawtooth signal injected into the CT’s primary side using the CPC 100.
**Winding resistance measurement**

Using the winding resistance measurement function also allows the user to calculate the accuracy limiting factor (ALF) for protection circuits and the instrument security factor (FS) for metering circuits.

**Power/dissipation factor (PF/DF) measurement**

When combined with the CP TD12/15, the CPC 100 is also capable of performing PF/DF measurements. This helps to assess the insulation condition of the CT.

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**Current transformer testing**

- CT ratio (with burden)
  - up to 800 A or 2000 A with CP CB2, 5 kVA output power
- CT burden
  - up to 6 A<sub>ac</sub> | secondary
- CT excitation curve
  - (knee point) up to 2 kV<sub>ac</sub>
- Polarity check with CPOL2
  - up to 800 A or up to 2000 A with CP CB2
- Accuracy limiting factor (ALF) test
- CT ratio with voltage
  - up to 130 V<sub>ac</sub> | bushing CTs
- CT winding resistance
  - up to 6 A<sub>ac</sub>
- CT demagnetisation and remanence
- CT voltage withstand test
  - up to 2 kV<sub>ac</sub>
- CT ratio Rogowski and CT ratio low power
  - up to 800 A or up to 2000 A with CP CB2, 5 kVA output power
- Power/dissipation factor test
  - up to 12kV/15 kV, 300 mA | with CP TD12/15
- IEC 61850 Sampled Values testing

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**+ CP CB2**

With the CP CB2 primary injection of current up to 2 kA can be realized for CT testing.

**+ CP TD12/15**

For high-voltage CTs, insulation material tests are very important and can be easily done with the CP TD12/15 accessory.
Voltage transformer (VT) / potential transformer testing

Why testing VTs?

The majority of VT failures occur due to electrical stresses or manufacturing and installation errors. Typically electrical stresses are caused by:

- Thunderstorms
- Ferro-resonances effects
- Over-voltages

Especially in high-voltage and extra high-voltage installations supervision of the VT insulation system is important to ensure that its dielectric characteristics have not degraded over time.

In case of (re-)commissioning of substations VT circuits should also be checked. Verifying the VT´s nameplate data helps to identify damages of the VT or wrong connections.

VT testing with the CPC 100

With a voltage output of up to $2000 \text{ V}_{\text{ac}}$, the CPC 100 can be used to test VT ratio, polarity and burden.

By injecting voltage into the primary side, ratio can be measured. Thereby the phase angles of high-voltage output and voltage measurement input are also measured. Thus the correct VT polarity can be verified.

Applying voltage to the secondary VT circuits and measuring the load current in amplitude and phase allows the actual burden to be measured, ensuring that it is within the VT´s specification data.

Your benefits

- Ratio testing from 15 Hz – 400 Hz
- Multi-functional VT testing
- Simple wiring check with handheld polarity checker (CPOL2)
Disturbance-free measurement

The VT’s secondary signal may be difficult to measure if it is small in amplitude – especially if neighboring parts of the substation are in operation. In case of strong disturbances, the user can select a frequency different to that of the power system and utilizes the “frequency selective measurement” function. Thus only the VT’s output signal with this particular frequency is measured while all other signals are filtered out.

Voltage/potential transformer testing

- VT ratio
  up to \(2 \text{kV}_{\text{AC}}\) | polarity and burden
- VT burden
  up to \(130 \text{V}_{\text{AC}}\) | secondary
- VT secondary voltage withstand test
  up to \(2 \text{kV}_{\text{AC}}\)
- Polarity check with CPOL2
  up to \(2 \text{kV}_{\text{AC}}\)
- VT electronics
  up to \(2 \text{kV}_{\text{AC}}\)
- IEC 61850 Sampled Values testing
- Power/dissipation factor test
  up to \(12 \text{kV}/15 \text{kV}, 300 \text{mA}\) | with CP TD12/15

+ CPOL2

The CPOL2 can check the correct polarity along the different connection points in the secondary wiring by analyzing the sawtooth signal injected into the VT’s primary side using the CPC 100.

+ CP TD12/15

For high-voltage VTs, insulation material tests are very important and can be easily done with the CP TD12/15 accessory.
Power transformer testing

Testing power transformers – Most common electrical tests with one device

Testing to assess the health of power transformers and to diagnose problems is of utmost importance to ensure the long-term and safe operation of these very expensive power assets.

With the CPC 100 power transformers and their ancillary components can be tested:

- Windings
- Tap changer
- Bushings
- Insulation
- Core
- Connection leads
- Surge arrestors

Winding resistance measurement

The CPC 100 provides an easy and accurate (4-wire connection) winding resistance measurement. Automatic measurement for tapped windings (by using CP SB1 with the on load tap changer) speeds up the measurement. The CPC 100 automatically discharges the inductive energy, which makes the measurement safe.

Demagnetisation

After switching off a transformer or after applying DC signals to a transformer, the core remains magnetized. This can cause problems for further diagnostic measurements or can lead to higher inrush currents. By using the CP SB1 switch box the integrated algorithm in the CPC 100 completely demagnetizes the transformer core.

Ratio & excitation current measurement

For measuring ratio and excitation current, the CPC 100 provides a 2 kV output, delivering 2500 VA. The test voltage is generated digitally and the current is automatically measured within the CPC 100. This makes the measurement highly accurate, easy to set up, fast and safe.

Your benefits

- Most common power transformer tests with one device
- Fully automated testing with switchbox CP SB1
- Advanced tap changer diagnostics using OLTC scan (DRM)
- Effective core demagnetization
Power/dissipation factor (PF/DF) measurement
For PF/DF measurement on power transformers and bushings, the CPC 100 is combined with the CP TD12/15. Measuring this factor over a broad frequency range – in addition to mains frequency – helps to better assess the insulation condition, for example detect whether the cellulose or the oil is contaminated by moisture.

Dynamic resistance measurement (DRM)
The DRM can be performed as a supplementary measurement in order to analyze the OLTC’s switching process. The CPC 100 + CP SB1 injects a DC current in the same way that it does for static winding resistance measurements with the addition of recording the dynamic behaviour of the diverter switch. Based on this non-invasive testing method, failures can be detected without opening the OLTC compartment.

Power transformer testing
> DC winding resistance up to 100 A\textsubscript{DC}
> Transformer demagnetization with CP SB1
> Dynamic load changer diagnostics (on load tap changer test) up to 100 A\textsubscript{DC} optionally with CP SB1
> Transformer turns ratio (TTR) per tap up to 2 kVAC | including polarity and excitation current | IEC 61387-1 support for transformer with unconventional vector groups
> Automatically determination of the transformer’s vector group with CP SB1
> Leakage reactance / short circuit impedance up to 6 A\textsubscript{AC}
> Transformer, bushing: power/dissipation factor + insulation capacitance up to 12 kV/15kV, 300 mA | frequency from 15 Hz to 400 Hz | with CP TD12/15
> Insulating fluids: power/dissipation factor up to 12 kV/15kV, 300 mA | with CP TD12/15 and CP TC12
> Excitation current per tap up to 12 kV/15kV, 300 mA | with CP TD12/15
> Frequency response of stray losses (FRSL)
> Surge arrestors: leakage current and watt losses up to 12 kV/15kV, 300 mA | with CP TD12/15
> HV source for voltage withstand test up to 15 kVA | with 3 CPCs + TRC1
> HV source for PD measurements up to 15 kVA | with 3 CPCs + TRC1

+ CP SB1
The switchbox CP SB1 reduces wiring work at power transformers. Thereby, the time needed for testing can be reduced and, at the same time, safety can be significantly increased.

+ TRC1
The triple remote control TRC1 allows three CPCs to be synchronized safely. This allows the CPC 100 to be used as a powerful HV source. Matching transformers are provided in order to match the rated voltage on the LV side.

+ CP TD12/15
Insulation condition assessment of transformers, bushings and insulation fluids (with the CP TC12).
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 \((k_L, R_L/R_L\) and \(X_L/X_L, k_0)\).

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.

**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.

**Your benefits**
- Accurate distance protection relay settings 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
Testing with the CPC 100

The main unit CPC 100 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.

Cable and transmission line diagnosis

- Line impedance and k-factor
  up to 100 A | with CP CU1

- Mutual coupling
  up to 100 A | with CP CU1

- Positive or zero sequence impedance

+ CP CU1

The CP CU1 allows the safe connection of the CPC 100 to a power line or HV cable. The impedance matching transformer within the CP CU1 ensures optimum power transfer from the CPC 100 to the power line.
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 in select areas.

Fall-of-potential measurement (3-point test)
The fall-of-potential measurement with the CPC 100 is performed according to EN 50522 or IEEE 81.

For the fall-of-potential measurement the voltage between the ground grid and ground electrodes in different distances to the ground grid is measured until reference ground is reached. Dedicated software transforms the test results into a voltage and impedance chart which allows the ground potential rise and the ground impedance to be determined.

Your benefits
- Determine true test values by power line injection
- Simple and accurate step and touch voltage measurements with handheld HGT1 device
- Reduction factor measurement on ground wires and cable shields
Step and touch voltage measurement

Step and touch voltage measurements according to EN 50522 and IEEE 81 are performed with the HGT1. This handheld device employs frequency selective measurements for effective noise suppression.

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

Dedicated test templates assess measured step and touch voltages according to EN 50522 and IEEE 80 automatically.

Ground system analysis

- Ground grid impedance for large systems up to 100 A | with CP CU1
- Step and touch voltage up to 100 A | with CP CU1 and HGT1
- Ground grid impedance for small systems up to 6 A<sub>AC</sub>
- Soil resistivity up to 6 A<sub>AC</sub>
- Integrity check of grounding connection up to 400 A<sub>AC</sub>
- Reduction factor / current split factor
- Measure multiple current paths with Rogowski coil

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.

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.
Rotating machines diagnosis

Why test rotating machines?
Rotating machines, such as motors and generators, are highly important components in power generation and industrial applications. Therefore, machine reliability and availability are in high demand. Motors and generators are exposed to high thermal, mechanical, and electrical stress that influences their reliability and life expectancy. Premature failure may lead to significant economic losses, due to unexpected outages and possible damage to the asset itself. In order to plan maintenance effectively, it is essential to have accurate condition information about when components need to be repaired or replaced.

A variety of electrical tests can be performed with the CPC 100 over the complete life cycle of machines to increase their reliability, prevent premature failures, and extend reliable service life.

PF/DF measurement and PF/DF tip-up test
The PF/DF measurement is used as a maintenance tool for entire windings. The portable solution CPC 100 + CP TD15 + CP CR600 allows PF/DF measurements to be carried out at nominal frequency.

The measurement results can be compared with previous measurements, factory acceptance tests, or a phase-to-phase comparison can be made. An acceptable PF/DF offers assurance that the insulation condition allows reliable operation.

Furthermore, a parallel partial discharge measurement allows for a more detailed diagnosis of the type of fault. The CPC 100 + CP TD15 can be used as HV source for the partial discharge measurement.

The measurement complies with international standards such as IEC 60894 and IEEE 286.

DC winding resistance measurement
A DC resistance measurement is performed to detect possible contact problems in the stator and rotor winding of a machine.

The CPC 100 offers an integrated micro ohmmeter with a maximum output of 400 A. The 4-wire method is used to detect connection problems in the stator winding (bad soldering contacts) as well as contact problems on the pole connectors of the rotor winding.

Both failures can be the root cause of a local hotspot and potentially damage the machine.

Your benefits
- Portable HV source
- High accurate PF/DF measurement with reference capacitance for maximum usability
- Defined voltage steps for a combined partial discharge and PF/DF measurement enable reproducible test conditions
Pole drop test
Mechanical stress in rotor windings cause inter turn faults (short circuits), which can lead to a magnetic imbalance. This causes higher shaft vibrations which puts more stress on the bearings and can potentially damage them. The CPC 100 provides the AC source and the accurate voltage inputs needed to perform the pole drop test.

Electromagnetic imperfection testing
This test (also known as stray flux measurement) is performed to detect stator core interlaminaton faults that can cause overheating and damage during machine operation. The stator core is energized with a small percentage of nominal flux and the stray flux on the surface is measured along the slots. Faults are indicated by an increase of stray flux in amplitude and/or a change in the phase.

Rotating machines diagnosis
- Power/dissipation factor tip-up test at 50 Hz / 60 Hz
  up to 15 kV | 5 A | with CP TD15 and CP CR600
- Power/dissipation factor test with variable frequency
  up to 15 kV | frequency from 15 Hz to 400 Hz | with CP TD15
- HV source for testing rotating machines
  up to 15 kV | max. 2 µF | with CP TD15 and CP CR600
- DC winding resistance measurement
  up to 400 A DC and 5 kVA down to the microohm range.
- Pole drop test
- Electromagnetic imperfection testing
- Stator core measurement
  Semi-automatic scanning of the stator core, measurement and excitation in one solution

+ CP CR600
The CP CR600 compensator reactor enables the CP TD15 to be used with test objects with large capacitance such as large motors and generators.

+ CP TD15
Insulation condition assessment of motors and generators. The CPC 100 + CP TD15 can provide up to 15 kV. It can be be used as HV source and PF/DF measurement system at the same time.
Gas-insulated switchgear testing

Testing gas-insulated switchgear to date

Gas-insulated switchgears (GIS) are compact and are, therefore, used in applications where space is limited. For commissioning of GIS a high-voltage (HV) withstand test is required in accordance with standards (IEC 62271-203).

To date the test voltage needed for a withstand test has been produced by a resonance circuit. This test system consists of an HV test transformer, a coupling capacitor and a power control unit. The HV test transformer and the coupling capacitor have to be connected directly to the GIS.

Weak points of this testing principle:

> The complete test system is difficult to transport, because it consists of very heavy and large components.
> It is difficult to use it at test sites with limited space, such as wind turbines.
> The HV test lead must be connected to, and disconnected from, the GIS system for testing. This normally includes a time-consuming venting and refilling process of the SF$_6$ gas.

Innovative GIS testing

With the CPC 100 + CP RC it is possible to perform GIS tests without the need of a big HV transformer. This is possible because the system directly makes use of a specially designed “Power VT” for testing.

This Power VT is an integral part of the GIS and generates the required test voltage. CPC 100 injects power at the LV side of the VT, producing the necessary voltage on the HV side. A direct connection of the measuring system to the integrated VT of the GIS system eliminates the need for draining and refilling any SF$_6$ gas.

The CPC 100 + CP RC system comprises several small and light-weight components (< 21 kg / 46 lbs) which can be transported by one person. With its modular design GIS tests can even be accomplished at test sites with limited space.

Your benefits

> Small and light-weight test system with high output power
> Testing without gas venting and refilling procedure
> Automatic frequency tuning for ideal load compensation
Powerful voltage withstand testing
When combined with the CP RC1, the CPC 100 allows withstand tests with a maximum test voltage of 200 kV to be carried out on GIS systems up to a rated voltage of 123 kV. The CPC 100 + CP RC2 is appropriate for testing GIS systems with a rated voltage of up to 145 kV and a maximum test voltage of 235 kV. This package is supplied with the additional CP AT1 auto-transformer to guarantee the necessary output power of the CPC 100 for higher loads.

HV source for partial discharge measurements
During production or maintenance, impurities can occur in GIS. These can cause major problems in operation. Therefore, it is recommended to perform a partial discharge measurement during commissioning (acceptance tests). While performing these measurements with our MPD series the CPC 100 + CP RC can be used as the HV source.

GIS testing
> Withstand test
   up to 235 kV | max 1.6 nF | with CP RC2
> HV source for partial discharge measurements
   up to 235 kV | max 1.6 nF | with CP RC2

+ CP CR
With the compensating reactor 4 mH CP CR4 or 6 mH CP CR6 the CP CR compensates the capacitance in a modular fashion.

+ CP TR
The isolation transformer CP TR provides a potential-free output signal and compensates the capacitive load.

+ CP AT1
The auto-transformer CP AT1 allows to connect the mains supply of the CPC 100 to a three-phase 16 A power outlet, and delivers the required power for the test setup.
Switchgear and circuit breaker testing

Why test switchgear and circuit breaker?
Switchgear consists of busbars, circuit breakers (CB), disconnectors and earthing switches. There are various connections and contacts within the switchgear. Poorly maintained or damaged contacts can cause arcing, single phasing or even fire which can lead to the total loss of the asset.

Therefore, it is common practice to conduct contact resistance measurements to ensure that the connections have been made with the appropriate contact pressure.

Additionally, the insulation of CBs within the switchgear has to be tested. These assets are frequently exposed to HV stresses, switching currents and very high fault currents, which heat up the circuit breakers and impact on the insulation material.

Contact resistance measurement
The CPC 100 can measure contact resistance by injecting a current of up to 400 A_{DC} into the contacts and measuring the voltage drop (using the 4-wire method). The resistance value can be compared to the value given by the manufacturer as well as to previous records.

Your benefits
- Contact resistance testing with up to 400 A_{DC}
- Power/dissipation factor measurement
- Testing of entire chain from the CT to the CB’s main contacts
Insulation testing of circuit breakers

For power/dissipation factor measurements on CBs, the CPC 100 is combined with the CP TD12/15. Measuring this factor over a wide frequency range – in addition to mains frequency – helps to better assess the insulation condition.

Switchgear / circuit breaker testing

> Contact resistance
  up to 400 A\textsubscript{dc}

> Bushing: power/dissipation factor (\tan \delta)
  + insulation capacitance
  12 kV/15kV, 300 mA | frequency from 15 Hz to 400 Hz | with CP TD12/15

> Circuit breaker: power/dissipation factor (\tan \delta)
  up to 12 kV/15kV, 300 mA | frequency from 15 Hz to 400 Hz | with CP TD12/15

> Insulating fluids: power/dissipation factor (\tan \delta)
  up to 12 kV, 300 mA | with CP TD12/15 and CP TC12

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**Switchgear / circuit breaker testing**

- Contact resistance
  up to 400 A\textsubscript{dc}
- Bushing: power/dissipation factor (\tan \delta)
  + insulation capacitance
  12 kV/15kV, 300 mA | frequency from 15 Hz to 400 Hz | with CP TD12/15
- Circuit breaker: power/dissipation factor (\tan \delta)
  up to 12 kV/15kV, 300 mA | frequency from 15 Hz to 400 Hz | with CP TD12/15
- Insulating fluids: power/dissipation factor (\tan \delta)
  up to 12 kV, 300 mA | with CP TD12/15 and CP TC12

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**CPC 100**

\( \mu \Omega \) measurement with the CPC 100’s 400 A\textsubscript{dc} capabilities enables accurate contact resistance measurements on circuit breakers.

**+ CP TD12/15**

Insulation condition assessment of circuit breakers and insulation fluids (with CP TC12).
Commissioning and trouble shooting of protection systems

Commissioning protection systems
In order to work properly, protection and control systems have to be correctly integrated into the substation or power plant. Quantities from the primary system are transformed at the VTs and CTs – using their different cores – and so the voltage and current signals must be correctly connected to the protection relays, automation units and meters.

From these protection and control units, the trip signals are routed back to the primary apparatus, for example, the circuit breakers. A fault in any part of this system may result in a system failure – false tripping or a failure to trip.

To prevent such a failure, the system’s functionality can be verified by injecting into the primary side of the CT or VT and checking the measured values at the relay or automation unit. Finally, injecting current at the magnitude of a fault should result in the tripping of the circuit breaker, which allows the verification of the complete chain.

CT & VT performance check
The CPC 100 allows the verification of the ratio and polarity of CTs and VTs – preventing wrong connections, especially in the case of tapped CTs. Injecting current or voltage into individual CTs / VTs and checking the reading at the relay ensures that phases are not mixed up and that the CT and VT ratio setting in the relay is correct.

The CPC 100 can also measure the burden on the CTs and VTs and, by determining the CT’s excitation curve, it ensures that the protection circuits are connected to the appropriate CT cores.

Wiring check
The CPC 100 can help to verify that the secondary wiring is correct. By injecting a sawtooth signal into the CT or VT, the operator verifies with a handheld device that the signal has the correct polarity at the connection points of the secondary systems.

Your benefits
> Testing of entire chain from the CT to the CB’s main contacts
> Versatile due to high-current and high-voltage outputs
> Wide range of applications covered

[Diagram of control room, CB, Busbar, Wiring terminal, Wires, Relay]
Timing of CBs with overcurrent elements
For testing of CBs or load breaker switches with integrated overcurrent elements, the CPC 100 can inject AC primary currents up to 800 A (or 2000 A together with the current booster CP CB2), and measure the time from the start of the injection to the interruption of the current.

Primary injection
With the CPC 100 primary faults can be simulated to check if overcurrent, differential or distance relays operate correctly. The total trip time including the CB operating time can also be measured in this test.

Protection installation testing
> CT ratio (with burden)
  up to 800 A or 2000 A with the CP CB2, 5 kVA output power
> CT burden
  up to 6 A | secondary
> CT excitation curve (knee point)
  up to 2 kV_ac
> VT ratio
  up to 2 kV_ac | polarity and burden
> VT burden
  up to 130 V | secondary
> Overcurrent relays with primary injection (MV)
  up to 800 A or 2000 A with the CP CB2, 5 kVA output power
> Polarity check with CPOL2
  up to 800 A or 2 kV_ac, 5 kVA output power
> Testing of the entire protection chain
  by primary fault current injection and live CB tripping

CPC 100
The CPC 100 can inject up to 800 A (2000 A with the CP CB2) or up to 2 kV as well as a sawtooth polarity check signal into CTs or VTs in the HV yard, hence performing testing on the whole system.

+ CPOL2
The CPOL2 can check the correct polarity along the different connection points in the secondary wiring by analyzing the sawtooth signal injected into the VT’s and CT’s primary side using the CPC 100.
IEC 61850-9-2 Sampled Values testing

IEC 61850
The standard for “Communication Networks and Systems for Power Utility Automation”, IEC 61850, utilizes network technologies for all types of information exchange. Within IEC 61850, protocols for the transmission of instantaneous voltage and current values are specified. The sensors used in the transmission process can be conventional CTs and VTs as well as unconventional current and voltage sensors.

Sampled Values
A merging unit (MU) collects the measured current and voltage values from the current and voltage sensors. Then it merges the digitized values, which are called “Sampled Values” (SV), into a data stream published to the substation network. Using this method, measured values (for example, the bus voltage for a busbar protection scheme) can easily be distributed to multiple bay devices.

Your benefits
> Ready for applications in digital substations
> Closed loop testing of merging units
> Primary injection works independently of the sensor technology used
Sampled Values testing with the CPC 100

The CPC 100 test system performs closed-loop testing whereby a test signal is injected on the primary side of the current / voltage sensors. The MU converts the sensor output into a SV stream which is published to the substation network. The CPC 100 then reads the data back from the network in order to perform a variety of different tests.

Automatic MU and channel detection is achieved by injecting a test signal with a specific wave form. An optimized and time-effective algorithm searches for the unique test pattern within all the available MUs on the network to identify the correct channel for testing.

The CPC 100’s SV test card operates according to the “Implementation Guideline for Digital Interface to Instrumental Transformers using IEC 61850-9-2” published by the UCA International User Group.

Sampled Values testing

- SV CT ratio test and polarity check up to 800 A or up to 2000 A , 5 kVA output power | with the CP CB2
- SV VT ratio test and polarity check up to 2 kVAC
- Automatic MU detection
- Automatic voltage / current channel detection
- Frequency selective voltage / current meter
- Noise level measurement
- Amplitude response of the signal processing chain up to 800 A or up to 2 kVAC | frequency from 15 Hz to 400 Hz

CPC 100

The CPC 100 injects a sinusoidal test signal to perform tests such as the ratio test. Additionally, the CPC 100 generates specific periodic wave shapes to identify the correct MU and corresponding test channel.
Operating from the front panel

Selecting test cards directly

Operating the CPC 100 manually provides the quickest results with minimal training and preparation – perfect for users who only operate the device occasionally. The user just selects the test card to be used, connects the CPC 100 to the asset and performs the test by pressing the start button.

Using pre-defined test templates

Additionally, pre-defined test templates help the user to perform frequently used tests conveniently and efficiently. A number of test cards (for example, power/dissipation factor, winding resistance, ratio measurement, etc.) are combined into one test template. An example is the template containing all the recommended measurements for testing a current transformer.

The test template can be seen as a test plan. It tells the user which measurements to make and provides the basis for the overall test report.

Test templates can be prepared in advance in the office on the PC – without the CPC 100 connected – and can then be executed on site, step by step. Users can also create their own test templates and define, which test cards they want to include.

The settings and results of all manual tests can be stored on a flash memory and transferred to a PC using a USB memory stick or ethernet connection.
Customized reporting: Microsoft Excel™

After transferring the test results to a PC, report templates in numerical and graphical form are available. The measurement data – including settings and results as well as administrative information such as date and time, filename, etc. – can also be imported to these templates for customized reporting, graphical result evaluation and further analyses.

Microsoft Excel™ reports provide the basis for client-specific reporting and allow test reports to be adapted to utility or manufacturer specific formats. Further content, such as company logos, can also be added.

Test reports can then be printed in a variety of languages.

Different ways to operate

The CPC 100 offers different operating modes, to meet the personal preferences of the user:

> From the front panel:
  Selecting test cards directly
> From the front panel:
  Using pre-defined test templates
> Fully automated:
  Using Primary Test Manager™ (see next page)
The Primary Test Manager™ (PTM) software solution makes it possible to perform a multitude of tests on power transformers, circuit breakers, and current transformers. It provides active guidance for the user during the process of testing with the CPC 100, making tests faster, easier, and safer.

Managing location, asset and test data
PTM provides a well-structured database for managing test results and getting a comprehensive overview of the asset’s condition. Locations, assets, jobs and reports can be defined and managed quickly and easily.

Import and export functionality
PTM supports data exchange between different test systems. Data can be imported easily in the PTM database. In addition, they can be filtered or exported in common formats such as XML, PDF, Microsoft Word™, Microsoft Excel™.

Data synchronization and back-up
During on-site testing, data is often generated by multiple testing teams. With the ‘PTM DataSync’ module all data can be synchronized to a central database hosted on premises or in the cloud. In doing so, data synchronization and storage becomes safer and more convenient. The relevant locations can be selected in order to keep the local database small.

Get the PTMate app free of charge in the App Store and Google Play Store!
Executing diagnostic tests
PTM helps to define the test asset with specific nameplate views. It indicates mandatory and recommended parameters, making data entry fast and easy.

Based on the nameplate values, PTM generates a customized test plan according to current standards and guidelines for each asset. This way PTM is able to provide you with a comprehensive test plan for assessing the condition of your asset thoroughly.

Result analysis and reporting
A real-time overview of the test results is given during the measurement and an instant “pass/fail” assessment of the test results is displayed based on specified limit values.

PTM automatically generates reports including all asset-related information and the tests that have been performed. This gives a comprehensive overview of the test object, test results and assessment.

Easy connection due to wiring diagrams
Pre-configured wiring diagrams based on selected assets help to set up the CPC 100 correctly. This minimizes the likelihood of measurement errors and speeds up the testing process.

Comparison tools for detailed analysis
For a detailed analysis, different test results can be compared side-by-side or trended over time. Users can choose between a time- and type-based comparison as well as a phase-based comparison.

PTMate app – your mobile companion
PTMate is our mobile companion for PTM. The app supports you on site and extends the PTM feature set to your smartphone, such as easy data entering, fast and safe wiring for tests as well as a stop button for ongoing measurements.

Customized, individual reports
User can adapt reports to their needs in PTM. Reports can be generated in Microsoft Word™, Microsoft Excel™ and as a PDF file.

They can be further adapted by e.g. compiling the included parts, providing comments or incorporating a company logo.

PTM supports you in the best possible way during execution of diagnostic tests via wiring diagrams and asset-specific test plans according to international standards.

For a comprehensive analysis, PTM offers automatic result assessment and comparison as well as customized reporting.
Front panel and connection possibilities

1. Grounding terminal
2. High AC voltage output 2 kV AC
3. External booster output
4. High DC current output 400 A DC
5. High AC current output 800 A AC
6. Mains power supply
7. Overcurrent protection
8. Power switch
9. 6 A or 130 V output
10. Current output 6 A DC
11. Current measuring input 10 A AC or DC
12. Voltage measuring input 300 V AC
13. Low level voltage measuring input 3 V AC
14. Voltage measuring input 10 V DC
15. Binary input for potential-free contacts or voltages up to 300 V DC
16. Safety key lock
17. Signal lights
18. Emergency stop button
19. Keys for the quick selection of applications
20. Keys for the quick selection of the desired view
21. LCD monitor
22. Soft-touch keys which change their function according to the selected application
23. Keys for selecting stacked test cards
24. Numerical keyboard
25. Advanced jog-dial hand wheel with “click” (Enter) function
26. Up / down keys for navigation and entering values
27. Test start / stop button
28. User manual

29. Serial interface for devices such as CP TD12/15
30. Plug to connect external safety functions (SAA1, SAA2, SAA3)
   Socket for the connection of the CPC 100 to a network or direct connection to a PC’s network connector
31. USB memory stick connection
## CPC 100

### Generator / Outputs

#### Current outputs

<table>
<thead>
<tr>
<th>Range</th>
<th>Amplitude</th>
<th>$t_{\text{max}}$</th>
<th>$V_{\text{max}}$</th>
<th>Power$_{\text{max}}$</th>
<th>$f$</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 A AC</td>
<td></td>
<td>25 s</td>
<td>6.0 V</td>
<td>4800 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>0 ... 400 A</td>
<td></td>
<td>8 min.</td>
<td>6.4 V</td>
<td>2560 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>0 ... 200 A</td>
<td></td>
<td>2 h</td>
<td>6.5 V</td>
<td>1300 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>6 A AC</td>
<td>0 ... 6 A</td>
<td>&gt; 2 h</td>
<td>55 V</td>
<td>330 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>3 A AC</td>
<td>0 ... 3 A</td>
<td>&gt; 2 h</td>
<td>110 V</td>
<td>330 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>400 A DC</td>
<td>0 ... 400 A</td>
<td>2 min.</td>
<td>6.5 V</td>
<td>2600 VA</td>
<td>DC</td>
</tr>
<tr>
<td>0 ... 300 A</td>
<td></td>
<td>3 min.</td>
<td>6.5 V</td>
<td>1950 VA</td>
<td>DC</td>
</tr>
<tr>
<td>0 ... 200 A</td>
<td></td>
<td>&gt; 2 h</td>
<td>6.5 V</td>
<td>1300 VA</td>
<td>DC</td>
</tr>
<tr>
<td>6 A DC</td>
<td>0 ... 6 A</td>
<td>&gt; 2 h</td>
<td>60 V</td>
<td>360 VA</td>
<td>DC</td>
</tr>
<tr>
<td>2000 A AC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Wth an optional current booster (CP CB2)

#### Inputs

<table>
<thead>
<tr>
<th>Measuring inputs (Accuracy$^a$)</th>
<th>Amplitude</th>
<th>Amplitude</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Imped.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full scale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Full scale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Voltage outputs

<table>
<thead>
<tr>
<th>Range</th>
<th>Amplitude</th>
<th>$t_{\text{max}}$</th>
<th>$I_{\text{max}}$</th>
<th>Power$_{\text{max}}$</th>
<th>$f$</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 kV AC</td>
<td></td>
<td>1 min.</td>
<td>1.25 A</td>
<td>2500 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>0 ... 2 kV</td>
<td></td>
<td>&gt; 2 h</td>
<td>0.5 A</td>
<td>1000 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>1 kV AC</td>
<td></td>
<td>1 min.</td>
<td>2.5 A</td>
<td>2500 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>0 ... 1 kV</td>
<td></td>
<td>&gt; 2 h</td>
<td>1.0 A</td>
<td>1000 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>500 V AC</td>
<td>0 ... 500 V</td>
<td>1 min.</td>
<td>5.0 A</td>
<td>2500 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>0 ... 500 V</td>
<td></td>
<td>&gt; 2 h</td>
<td>2.0 A</td>
<td>1000 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
<tr>
<td>130 V AC</td>
<td>0 ... 130 V</td>
<td>&gt; 2 h</td>
<td>3.0 A</td>
<td>390 VA</td>
<td>15 Hz ... 400 Hz</td>
</tr>
</tbody>
</table>

#### Internal measurement of outputs (Accuracy$^a$)

<table>
<thead>
<tr>
<th>Output</th>
<th>Range</th>
<th>Error</th>
<th>Reading Error</th>
<th>Amplitude Error</th>
<th>Full scale Error</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>800 A AC</td>
<td>–</td>
<td>&lt; 0.10 %</td>
<td>&lt; 0.10 %</td>
<td>&lt; 0.10 %</td>
<td>&lt; 0.10 %</td>
<td></td>
</tr>
<tr>
<td>400 A DC</td>
<td>–</td>
<td>&lt; 0.20 %</td>
<td>&lt; 0.05 %</td>
<td>–</td>
<td>–</td>
<td></td>
</tr>
<tr>
<td>2 kV AC</td>
<td>2000 V</td>
<td>&lt; 0.05 %</td>
<td>&lt; 0.05 %</td>
<td>&lt; 0.10 %</td>
<td>&lt; 0.10 %</td>
<td></td>
</tr>
<tr>
<td>1000 V</td>
<td></td>
<td>&lt; 0.05 %</td>
<td>&lt; 0.05 %</td>
<td>&lt; 0.15 %</td>
<td>&lt; 0.15 %</td>
<td></td>
</tr>
<tr>
<td>500 V</td>
<td></td>
<td>&lt; 0.05 %</td>
<td>&lt; 0.05 %</td>
<td>&lt; 0.20 %</td>
<td>&lt; 0.20 %</td>
<td></td>
</tr>
<tr>
<td>5 A</td>
<td></td>
<td>&lt; 0.20 %</td>
<td>&lt; 0.05 %</td>
<td>&lt; 0.10 %</td>
<td>&lt; 0.10 %</td>
<td></td>
</tr>
<tr>
<td>500 mA</td>
<td></td>
<td>&lt; 0.05 %</td>
<td>&lt; 0.05 %</td>
<td>&lt; 0.10 %</td>
<td>&lt; 0.10 %</td>
<td></td>
</tr>
</tbody>
</table>

#### Additional features of the measuring inputs

Automatic range switching (except Amplifier test card)
Galvanically separated potential groups: I AC/DC ; V1 & V2 ; V DC
AC frequency range: 15 Hz to 400 Hz (except Amplifier test card)
Protection of I AC/DC input: 10 A very fast acting (FF) fuse$^a$

#### Binary input for dry contacts or voltages up to 300 V DC$^a$

- Trigger criteria: Toggling with potential-free contacts or voltages of up to 300 V
- Input impedance: > 100 kΩ
- Response time: 1 ms

#### Output to input synchronization

<table>
<thead>
<tr>
<th>Test cards Quick, Sequencer, Ramp</th>
<th>Amplifier test card</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency range</td>
<td>48 Hz ... 62 Hz</td>
</tr>
<tr>
<td>Synchronization inputs</td>
<td>V1 AC, V2 AC, I AC</td>
</tr>
<tr>
<td>Input magnitudes</td>
<td>10 % of input range full scale</td>
</tr>
<tr>
<td>Output magnitude</td>
<td>5 % of output range full scale</td>
</tr>
<tr>
<td>Settling time</td>
<td>100 ms after 5 % of output range full scale is reached</td>
</tr>
<tr>
<td>Signal changes</td>
<td>All quantities must be ramped within 20 signal periods</td>
</tr>
<tr>
<td>Phase tolerance</td>
<td>0.5 ° within the limits as specified above</td>
</tr>
</tbody>
</table>
Resistance measurement

4-wire measurement with 400 A DC output and 10 V DC input

<table>
<thead>
<tr>
<th>Current</th>
<th>Resistance</th>
<th>Voltage</th>
<th>Accuracy (full scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 A</td>
<td>10 μΩ</td>
<td>4 mV</td>
<td>Error &lt; 0.70 %</td>
</tr>
<tr>
<td>400 A</td>
<td>100 μΩ</td>
<td>40 mV</td>
<td>Error &lt; 0.55 %</td>
</tr>
<tr>
<td>400 A</td>
<td>1 mΩ</td>
<td>400 mV</td>
<td>Error &lt; 0.50 %</td>
</tr>
<tr>
<td>400 A</td>
<td>10 mΩ</td>
<td>4 V</td>
<td>Error &lt; 0.50 %</td>
</tr>
</tbody>
</table>

4-wire measurement with 6 A DC output and 10 V DVC input

<table>
<thead>
<tr>
<th>Current</th>
<th>Resistance</th>
<th>Voltage</th>
<th>Accuracy (full scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 A</td>
<td>100 mΩ</td>
<td>0.6 V</td>
<td>Error &lt; 0.35 %</td>
</tr>
<tr>
<td>6 A</td>
<td>1 Ω</td>
<td>6 V</td>
<td>Error &lt; 0.35 %</td>
</tr>
<tr>
<td>1 A</td>
<td>10 Ω</td>
<td>10 V</td>
<td>Error &lt; 0.25 %</td>
</tr>
</tbody>
</table>

2-wire measurement with 10 V DVC input

<table>
<thead>
<tr>
<th>Current</th>
<th>Resistance</th>
<th>Voltage</th>
<th>Accuracy (full scale)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 5 mA</td>
<td>100 Ω</td>
<td></td>
<td>Error &lt; 0.60 %</td>
</tr>
<tr>
<td>&gt; 5 mA</td>
<td>1 kΩ</td>
<td></td>
<td>Error &lt; 0.51 %</td>
</tr>
<tr>
<td>&gt; 5 mA</td>
<td>10 kΩ</td>
<td></td>
<td>Error &lt; 0.50 %</td>
</tr>
</tbody>
</table>

Power supply and mechanical data

Single-phase, nominal

100 V AC ... 240 V AC, 16 A

Single-phase, permissible

85 V AC ... 264 V AC (L-N or L-L)

Frequency, nominal

50 Hz / 60 Hz

Power consumption

< 3,500 VA (< 7,000 VA for a time < 10 s)

Connection

IEC 320 / C20

Weight

29 kg / 64 lbs (case without protection cover)

Dimensions

468 x 394 x 233 mm (18.4 x 15.5 x 9.2 in), cover, without handles.

Equipment reliability

Shock

IEC / EN 60068-2-27, 15 g / 11 ms, half-sinusoid, each axis

Vibration

IEC / EN 60068-2-6, frequency range from 10 Hz to 150 Hz, continuous acceleration 2 g (20 % / 65 %), 10 cycles per axis

Environmental conditions for CPC 100 and CPC 100 accessories

Operating temperature

-10 °C ... +55 °C / +14 °F ... +131 °F

Storage temperature

-20 °C ... +70 °C / -4 °F ... +158 °F

Humidity range

5 % ... 95 % relative humidity, no condensation
Technical data CPC 100 accessories

**CP TD12/15 – Tan-delta unit**

Combined with the CPC 100, the CP TD12/15 measures the capacitance and dissipation/power factor with laboratory precision.

### High-voltage output

<table>
<thead>
<tr>
<th>U/f</th>
<th>THD</th>
<th>I</th>
<th>Smax</th>
<th>tmax</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ... 12 kV AC</td>
<td>&lt; 2 %</td>
<td>300 mA</td>
<td>3600 VA</td>
<td>&gt; 2 min</td>
</tr>
<tr>
<td>0 ... 15 kV AC</td>
<td>&lt; 2 %</td>
<td>300 mA</td>
<td>4500 VA</td>
<td>&gt; 2 min</td>
</tr>
</tbody>
</table>

### Capacitance Cp (equivalent parallel circuit)

<table>
<thead>
<tr>
<th>Range</th>
<th>Typical accuracy 2</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 pF ... 3 μF</td>
<td>Error &lt; 0.05 % of reading + 0.1 pF</td>
<td>I &lt; 8 mA, Vtest = 2 kV ... 10 kV</td>
</tr>
<tr>
<td>1 pF ... 3 μF</td>
<td>Error &lt; 0.2 % of reading</td>
<td>I &gt; 8 mA, Vtest = 2 kV ... 10 kV</td>
</tr>
</tbody>
</table>

### Power factor (cos φ) / Dissipation factor (tan δ)

<table>
<thead>
<tr>
<th>Range</th>
<th>Typical accuracy 2</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 ... 10 % (capacitive)</td>
<td>Error &lt; 0.1 % of reading + 0.005 %</td>
<td>f = 45 Hz ... 70 Hz, I &lt; 8 mA, Vtest = 2 kV ... 10 kV</td>
</tr>
<tr>
<td>0 ... 100 % (cos φ)</td>
<td>Error &lt; 0.5 % of reading + 0.02 %</td>
<td>Vtest = 2 kV ... 10 kV</td>
</tr>
<tr>
<td>0 ... 10000 % (tan δ)</td>
<td>Error &lt; 0.5 % of reading + 0.02 %</td>
<td>Vtest = 2 kV ... 10 kV</td>
</tr>
</tbody>
</table>

### Mechanical data

- Dimensions (W × H × D): 460 x 317 x 223 mm / 18.1 x 12.5 x 8.8 in
- Weight CP TD12: 23 kg / 51 lbs
- Weight CP TD15: 24 kg / 53 lbs

1. Depending on control device and power supply
2. Means “typical accuracy” at typical temperatures of 23 °C ± 5 K; 98 % of all units have an accuracy which is better than specified

**CP SB1 – Switch box**

The CP SB1 switch box enables fully automatic testing of three-phase power transformers.

- AC input / V1 AC output: Max. 300 V rms
- DC input: Max. 6 A DC
- Transformer high and low voltage connections: Max. 300 V rms between all connectors and ground
- Supply: Via serial interface from CPC 100 (+15 V)
- Dimensions (W × H × D): 357 x 235 x 111 mm / 14.1 x 9.2 x 4.4 in
- Weight: 3.5 kg / 7.7 lbs

**CP TC12 – 12 kV oil test cell**

The CP TC12 oil test cell precisely determines the dielectric constant, the dissipation factor (tan delta) and the power factor of insulating liquids such as transformer oil.

- Cell type: Three-electrode design with guard
- Test gap: 11 mm / 0.43 in
- Capacitance of empty cell (air): Approx. 65 pF ± 10 %
- Sample volume: 1.2 liters ... 2 liters / 41 ... 68 fl.oz.
- Max. RMS test voltage: 12 kV
- Inner dimensions (diameter × height): 172 mm × 180.8 mm / 6.8 × 7.1 in
- Outer dimensions (W × H × D): 220 x 235.5 x 220 mm / 8.7 × 9.3 × 8.7 in
- Weight: Approx. 9.2 kg / 20 lbs

**CP DB1 – Discharge box**

The CP DB1 transformer discharge box facilitates fast discharging of power transformers during the test process.

- 6 A path
  - Switch closed
    - 6 A continuous
  - Switch open
    - The discharge process is faster by a factor of 4 compared to the CPC 100, 6 Apeak
    - Overtemperature protection: 85 °C / 185 °F
    - Overvoltage protection: 150 V / 5 kA between connectors

- 100 A path
  - Switch closed
    - 100 A continuous
  - Switch open
    - The discharge process is faster by a factor of 10 compared to the CPC 100, 100 Apeak, 2500 Jmax
    - Overvoltage protection: 200 V / 30 kA between connectors

### Mechanical data

- Dimensions (W × H × D): 357 x 235 x 147 mm / 14.0 x 9.2 x 5.8 in
- Weight: 4 kg / 8.8 lbs
**CP CU1 – Coupling unit**

In combination with the CPC 100 the CP CU1 is used for line parameter measurements and ground testing.

### Output ranges

<table>
<thead>
<tr>
<th>Range</th>
<th>Current</th>
<th>Compliance voltage at &gt; 45 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 A</td>
<td>0 ... 10 A rms</td>
<td>500 V rms</td>
</tr>
<tr>
<td>20 A</td>
<td>0 ... 20 A rms</td>
<td>250 V rms</td>
</tr>
<tr>
<td>50 A</td>
<td>0 ... 50 A rms</td>
<td>100 V rms</td>
</tr>
<tr>
<td>100 A</td>
<td>0 ... 100 A rms</td>
<td>50 V rms</td>
</tr>
</tbody>
</table>

### Output power

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum power</td>
<td>5 000 VA (45 Hz ... 70 Hz), cos $\varphi$ &lt; 1.0 for 8 s at 230 V AC</td>
</tr>
<tr>
<td>Continuous power</td>
<td>0 ... 1 600 VA</td>
</tr>
</tbody>
</table>

### Measuring transformers

<table>
<thead>
<tr>
<th>Transformer</th>
<th>Ratio</th>
<th>Accuracy at 50 Hz / 60 Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>VT</td>
<td>600 V : 30 V</td>
<td>Class 0.1</td>
</tr>
<tr>
<td>CT</td>
<td>100 A : 2.5 A</td>
<td>Class 0.1</td>
</tr>
</tbody>
</table>

### Inputs

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

### Accuracy

<table>
<thead>
<tr>
<th>Range</th>
<th>Accuracy of absolute value</th>
<th>Accuracy of phase angle</th>
<th>V SENSE voltage</th>
<th>I OUT current</th>
<th>Current range</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05 ... 0.2 Ω</td>
<td>1.0 ... 0.5 %</td>
<td>1.5 ... 0.8°</td>
<td>5 ... 20 V</td>
<td>100 A</td>
<td>100 A</td>
</tr>
<tr>
<td>0.2 ... 2 Ω</td>
<td>0.5 ... 0.3 %</td>
<td>0.8 ... 0.5°</td>
<td>20 ... 50 V</td>
<td>100 ... 25 A</td>
<td>100 A</td>
</tr>
<tr>
<td>2 ... 5 Ω</td>
<td>0.3 %</td>
<td>0.5°</td>
<td>100 V</td>
<td>50 ... 20 A</td>
<td>50 A</td>
</tr>
<tr>
<td>5 ... 25 Ω</td>
<td>0.3 %</td>
<td>0.5°</td>
<td>100 ... 250 V</td>
<td>20 ... 10 A</td>
<td>20 A</td>
</tr>
<tr>
<td>25 ... 300 Ω</td>
<td>0.3 ... 1.0 %</td>
<td>0.5 ... 1.5°</td>
<td>250 ... 500 V</td>
<td>10 ... 1.5 A</td>
<td>10 A</td>
</tr>
</tbody>
</table>

### Mechanical data

| Dimension (W x H x D) | 450 x 220 x 220 mm / 17.7 x 8.7 x 8.7 in |
| Weight | 28.5 kg / 62.78 lbs |

---

**CP GB1 – Grounding box**

The CP GB1 grounding box features high current surge arrestors to protect the CP CU1 and the CPC 100 from unexpected overvoltages on the line under test.

- **Nominal ac spark-over voltage**: $< 1 000$ V rms
- **Impulse spark-over voltage**: $< 2 000$ V peak
- **Short circuit proof with**: 16 mm cylindrical or 20 mm ball studs: 26.5 kA ($< 100$ ms) / 67 kA peak, 25 mm ball studs: 30 kA ($< 100$ ms) / 75 kA peak, Torsional moment for changing arrestors: $> 15$ Nm

| Dimension (Ø x H) | 200 x 190 mm / 7.9 x 7.5 in |
| Weight (including grounding cable) | 6.8 kg / 13.2 lbs |

**HGT1 – Handheld grounding tester**

The HGT1 handheld grounding tester can be combined with the CPC 100 and CP CU1 to measure step and touch voltages.

- **Voltage input**: Max. 25 V rms
- **Power supply**: 1 × 3.7 V lithium polymer (Li-Po) battery
- **Dimensions (W x H x D)**: 90 x 180 x 45 mm / 3.5 x 7.1 x 1.8 in
- **Weight (including battery)**: 0.48 kg / 1 lb
Technical data CPC 100 accessories

**CP CR600 – Compensation reactor**

The CP CR600 compensating reactor allows to test the insulation quality of generators, motors and other systems with large capacitance up to 1 µF.

- **Maximum test voltage**: 15 kV\text{rms} (≥ 50 Hz)
- **Inductors**
  - Capacitance compensation (possible combination)
  - 50 Hz / 15 kV
  - 100 H, 50 H, 25 H
  - 60 nF ... 160 nF:
    - 100 H
    - 50 H
    - 25 H
  - 130 nF ... 260 nF:
    - 100 H
    - 50 H
  - 230 nF ... 350 nF:
    - 100 H
  - 330 nF ... 450 nF:
    - 100 H
  - 420 nF ... 550 nF:
    - 100 H
  - 520 nF ... 640 nF:
    - 100 H
  - 620 nF ... 740 nF:
    - 100 H

- **60 Hz / 15 kV**
  - 100 H, 50 H, 25 H
  - 60 nF ... 120 nF:
    - 100 H
  - 85 nF ... 190 nF:
    - 100 H
  - 150 nF ... 250 nF:
    - 100 H
  - 220 nF ... 320 nF:
    - 100 H
  - 350 nF ... 460 nF:
    - 100 H
  - 420 nF ... 520 nF:
    - 100 H

- **Mechanical data**
  - Dimensions (W x H x D): 455 x 275 x 220 mm / 17.9 x 10.8 x 8.7 in
  - Weight: 48 kg / 105.8 lbs

**CP CB2 – Current booster**

The CP CB2 is an current booster for applications requiring currents up to 2000 A.

- **Output current**: up to 2000 A
- **Output power at 2000 A**: 5 kVA
- **Accuracy of current at 50 Hz / 60 Hz**: Error < ± 0.13 % (rd) ± 0.13 % (fs)
- **Phase tolerance at full scale**: Error < ± 0.25 %
- **Dimensions (W x H x D)**: 186 x 166 x 220 mm / 7.3 x 6.5 x 8.7 in
- **Weight**: 16.0 kg / 35.3 lbs

**CP RC – Compensating reactor**

The CP RC resonance circuit units in combination with the CPC 100 can be used for voltage withstand testing of gas-insulated switchgears (GIS).

- **Voltage output**: CP TR7 / CP TR8
  - 180 V / 220 V
  - CP CR4 / CP CR6
  - 220 V
  - CP AT1
  - 254 V - 278 V
- **Current output**: CP TR7 / CP TR8
  - 60 A
  - CP CR4 / CP CR6
  - 150 A
  - CP AT1
  - 16 A
- **Apparent power on secondary side**: CP TR7 / CP TR8
  - 13.2 kVA,
  - CP CR4 / CP CR6
  - 33 kVA,
  - CP AT1
  - 4.4 kVA,
- **Frequency**: CP TR7 / CP TR8
  - 80 Hz ... 120 Hz
  - CP CR4 / CP CR6
  - 80 Hz ... 120 Hz
  - CP AT1
  - 50 Hz / 60 Hz
- **Insulation class**: F
- **Weight**: CP TR7 / CP TR8
  - 19 kg / 42 lbs
  - CP CR4 / CP CR6
  - 20.5 kg / 45 lbs
  - CP AT1
  - 15.5 kg / 34 lbs
- **Dimensions (W x H x D)**: CP TR7 / CP TR8
  - 262 x 277.5 x 220 mm / 10.3 x 10.9 x 8.7 in

**CPOL2 – Polarity checker**

The CPOL2 can check the correct polarity along the different connection points in an instrument transformer’s secondary wiring.

- **Measuring range**: 250 µV\text{rms} ... 300 V\text{rms}
- **Evaluated signal form**: Polarity test signal with slope ratio ≥ 3:1
- **Nominal frequency**: 52.6 Hz
- **Power consumption**
  - Measurement active: < 100mW
  - Standby: < 50 µW
- **Input impedance**: > 300 kΩ
- **Batteries**
  - Type and number: 2 x 1.5 V Mignon LR6 AA AM4 MN1500
- **Dimensions (W x H x D)**: 180 x 55 x 35 mm / 7.1 x 2.2 x 1.4 in
- **Weight**: 150 g / 0.33 lb
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