

# CT Analyzer

Revolution in current transformer testing and calibration



# Revolutionary way of CT testing

Current transformers are used for relaying and metering purposes in electrical power systems. They connect the high power primary side to the protection and metering equipment on the secondary side. Depending on the application they are used for, current transformers are designed differently.

## Protection current transformers

As it is used to feed protective relays, the CT must be accurate during normal and fault conditions. Failures in transformation could lead to misoperation of the relay along with unwanted and costly outages. To test CTs according to the requirements of modern protection systems, it is compulsory to consider transient components and auto-reclosure systems.

## Metering current transformers

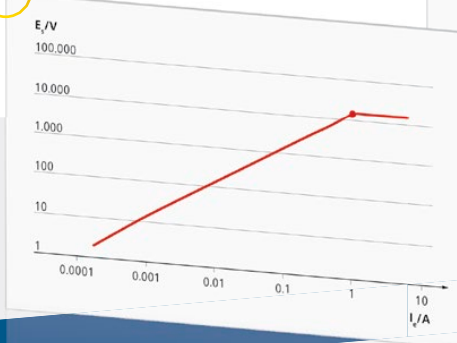
CTs for metering purposes must provide high accuracy up to class 0.1 to guarantee correct billing. It is therefore essential to test and calibrate the metering current transformer, as the entire metering chain is only as accurate as the instrument transformers feeding the meter.

In contrast to protection CTs, metering CTs must go into saturation directly above the nominal primary current level to protect the connected metering equipment.

## Automated testing procedure

### 1 Measurement of parameters

Measurement of CT parameters like excitation curve, eddy current, ratio, etc.



### 2 Modeling

Definition of CT model elements and calculation of CT parameters through embedded mathematical functions

$$\psi(t) = \psi'_0 + \int_0^t (U_s(t) - R_{CT} I_{CT}(t)) dt - L_{CT} \frac{d}{dt} I_{CT}(t)$$
$$U_C(t) = U_s(t) - R_{CT} I_{CT}(t) - L_{CT} \frac{d}{dt} I_{CT}(t)$$

### 3 Assessment according to IEEE or IEC standard

Automated comparison of test results with the defined values according to the selected IEEE or IEC standard

|       |              | Current ratio error in % at % of rated current |        |        |        |        |        |        |        |
|-------|--------------|--|--------|--------|--------|--------|--------|--------|--------|
| cos φ | Data type    | 1%   | 5%     | 10%    | 20%    | 50%    | 100%   | 120%   | 200%   |
| 0.8   | String value | -0.023   | -0.023 | -0.021 | -0.018 | -0.013 | -0.010 | -0.009 | -0.008 |
|       | Float value  | -0.023   | -0.023 | -0.021 | -0.018 | -0.013 | -0.010 | -0.009 | -0.008 |
| 0.8   | String value | -0.008   | -0.010 | -0.010 | -0.008 | -0.006 | -0.004 | -0.003 | -0.002 |
|       | Float value  | -0.008   | -0.010 | -0.010 | -0.008 | -0.006 | -0.004 | -0.003 | -0.002 |
| 1     | String value | 0.005  | 0.001  | 0.000  | -0.001 | 0.000  | 0.000  | 0.001  | 0.001  |
|       | Float value  | 0.005  | 0.001  | 0.000  | -0.001 | 0.000  | 0.000  | 0.001  | 0.001  |

The CT Analyzer is designed to accurately measure all relevant CT parameters and compare them to the requirements of the defined IEEE or IEC standard. Due to this automated assessment, testing engineers receive the 'pass or fail' decision within seconds.

## CT Analyzer – a new way of testing CTs

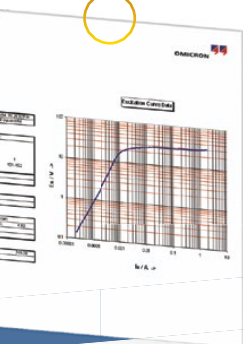
The CT Analyzer is the most complete testing system for protection and metering CTs according to IEEE and IEC standards. It allows all types of single and multi-ratio current transformers to be tested on-site in power system grids. Manufacturers of CTs, transformers or GIS use the CT Analyzer in their production facilities and test / development labs.

The CT Analyzer offers a wide range of measurements, such as:

- > CT-ratio and phase-angle accuracy with consideration of nominal and operational burden for various currents
- > CT winding resistance
- > CT excitation / saturation (unsaturated and saturated)
- > ALF and FS (direct and indirect)
- > Burden impedance
- > CT residual magnetism

### 4 Reporting

All data is delivered in an XML file and can be displayed via the reporting tool



## Your benefits

- > Field verification of CTs up to the 0.1 accuracy class due to extremely high accuracy (0.02 % typical)
- > Compact and lightweight (< 8 kg / 17.4 lbs)
- > Automatic assessment in accordance with IEEE and IEC standards
- > Reduced testing time (typically < 1 min)
- > High noise immunity for on-site testing



# Highly accurate CT verification made mobile

## The ideal way of testing a current transformer

As energy is supplied by many different sources, power system grids for generation, transmission and distribution are expanded continuously. This makes the use of additional metering and protection CTs necessary. To test all of these CTs in a cost-effective and reliable way, the ideal CT test device fulfills the following requirements:

### Mobility

Test engineers often have to maintain several CTs within one utility. The ideal CT test device would therefore be an all-in-one solution, light enough to be carried by one person. It should be able to measure all parameters without the need for any further equipment (such as a burden box).

### Accuracy

Correct billing is only possible if metering CTs work within their specifications, for all secondary burdens and levels of primary current that are defined in the standards. To test and calibrate these metering CTs, measurement equipment delivering reliable results up to class 0.1 CTs is needed.

## Primary nominal current injection

## Primary current injection

### Mobility

- > Approx. 2 tons of equipment (high current source, huge cables, current booster, burden box etc.)

- > > 30 kg / 66.1 lbs (Not including additional equipment, e.g. external burden box)

### Accuracy

- > High accuracy, but complicated wiring makes testing error-prone

- > Not sufficient for high accuracy metering CTs
- > Sensitive to transient distortion from life signals (due to the use of 50 Hz test signals)

### Safety

- > Uses dangerously high voltages and currents (primary nominal current injection)

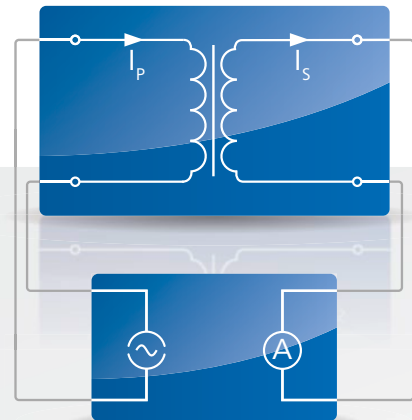
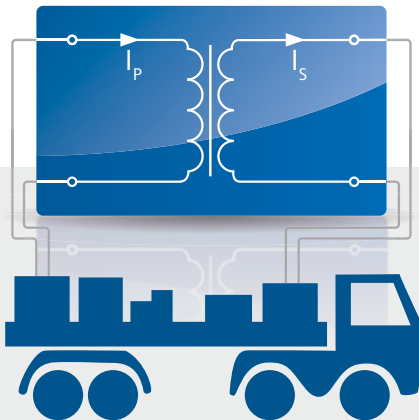
- > Typical current levels of 500 A to 800 A are used

### Handling

- > Requires several people to set-up and conduct the test

- > Re-wiring is required for each type of test (e.g. ratio, polarity, saturation, winding resistance)
- > Test results must be assessed manually

### Electrical model



## Safety

Equipment for testing CTs on-site must comply to applicable safety standards and regulations. However, the ideal test device avoids the use of high test currents and voltages and conducts tests with as low test voltages as possible to reduce the operator's health and safety risks.

## Handling

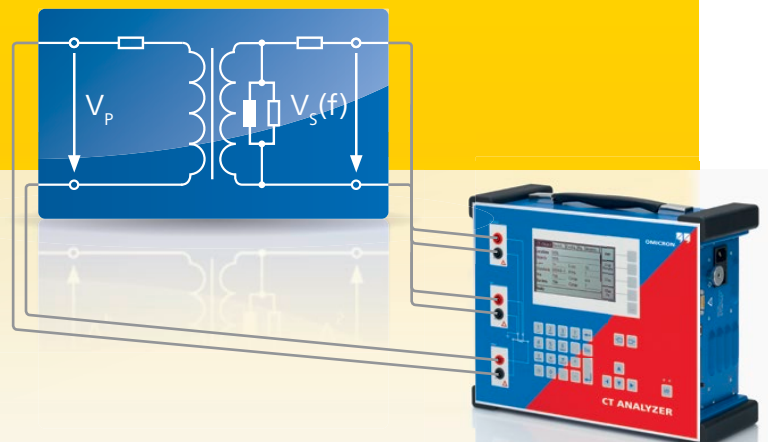
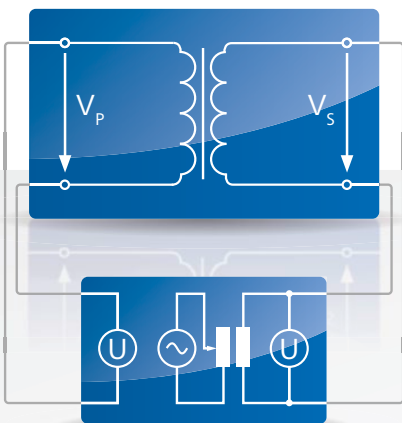
Short measurement times and an automated assessment to the respective IEC and IEEE standards characterize modern test equipment. All relevant parameters should be measured in one test cycle without the need for rewiring. Printable test reports, including all measured data and the assessment to the standard, are ideally created automatically by the test device.

### Secondary voltage injection

- > > 30 kg / 66.1 lbs (Not including additional equipment, e.g. external burden box)
- > Not sufficient for high accuracy metering CTs  
Sensitive to transient distortion from life signals (due to the use of 50 Hz test signals)
- > Voltages for saturation tests can be 2,000 V or more
- > Re-wiring is required for each type of test (e.g. ratio, polarity, saturation, winding resistance)
- > Test results must be assessed manually

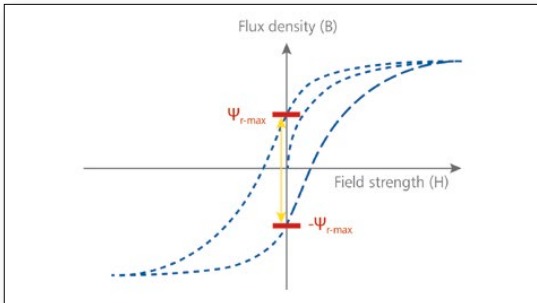
### CT as an electrical model

- > < 8 kg / 17.4 lbs; ideal for handling on site
- > Measurement of class 0.1 metering CTs Excellent noise suppression guarantees
- > Highly accurate on-site testing even if active lines are close to the test object
- > Maximum output voltage of 120 V
- > One-step test determining all parameters (< 1 min)
- > Automated assessment to standard and integrated report functionality





# Extraordinary features



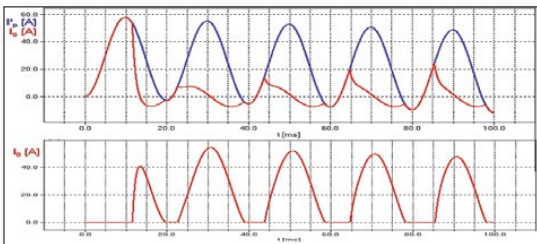
## RemAlyzer

- > Software-based tool to determine the residual magnetism in current transformers
- > Analysis of the remanence condition before putting into operation the CT to assure proper function
- > Simplifies power grid failure analysis after unwanted operation of protective relays
- > Demagnetizes the CT core after measurement

A screenshot of the 'Test Settings' software interface. It features a 'Location' section with fields for Station, Company, Feeder, Country, and Phase. An 'Object' section includes Serial No., Core, Tap, Manufacturer, Type, and Optional 1. Below these are various test parameters: I-prm (600 A), I-sec (5 A), Std (ANSI 45), P/M (M), Class (0.3), RF (1.5), f (60 Hz), Rated burden (7 VA), Op. burden (7 VA), cosp (7), and Op. cosp (7).

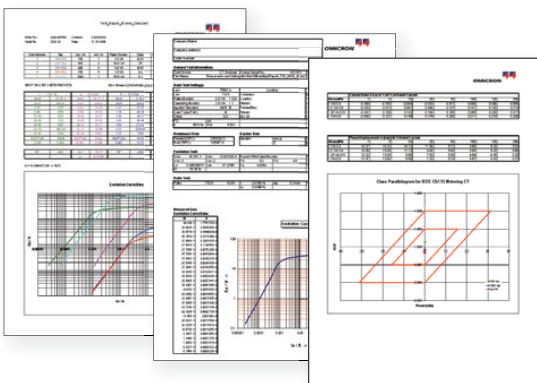
## Remote control

- > Full access to all functions of the CT Analyzer via a PC using the remote interface
- > Optimizes the integration into automated testing procedures in production lines
- > Data export into Excel™ and Word™
- > Customizable testing and reports



## Network simulation

- > NetSim is a software tool for network simulation (part of the Test Universe software suite for relay testing)
- > Easy transfer of CT Analyzer measurement data to NetSim
- > Accurate modeling of power systems for network studies and fault simulation testing of protection relays
- > Behavior analysis of protective relays in case of CT saturation



## Data handling and reporting

- > Test reports can be saved on the Compact Flash Card and transferred to a PC
- > Data and protocols can be shown on a PC via the Excel™ file loader program
- > Customizable report templates are available, for example:
  - > Different standards, classes and applications
  - > Single, multi-core and multi-tap CTs
  - > Three-phase testing
  - > Core testing

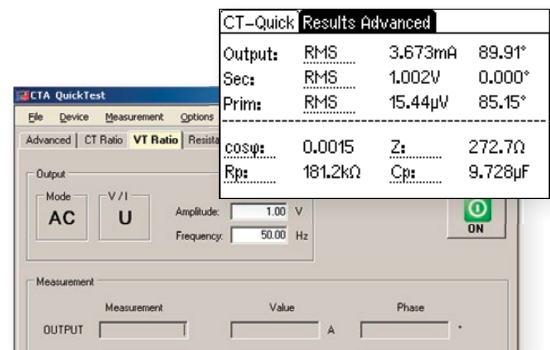
## Verification for different burdens and currents

- > Existing measurement data can be loaded to the CT Analyzer at any time
- > Recalculation of the CT parameters for different burdens and primary currents
- > No further on-site measurements are necessary to verify whether a change in the burden will influence the accuracy of a CT

| POWER |         | Current ratio error in % at % of rated current |        |        |        |        |        |        |        |        |
|-------|---------|--|--------|--------|--------|--------|--------|--------|--------|--------|
| VA    | cos Phi | Data type                                      | 1%     | 5%     | 10%    | 20%    | 50%    | 100%   | 120%   | 200%   |
| 15    | 0.8     | String value                                   | -0.023 | -0.023 | -0.021 | -0.018 | -0.013 | -0.010 | -0.009 | -0.008 |
|       |         | Float value                                    | -0.023 | -0.023 | -0.021 | -0.018 | -0.013 | -0.010 | -0.009 | -0.008 |
| 7.5   | 0.8     | String value                                   | -0.008 | -0.010 | -0.010 | -0.008 | -0.006 | -0.004 | -0.003 | -0.002 |
|       |         | Float value                                    | -0.008 | -0.010 | -0.010 | -0.008 | -0.006 | -0.004 | -0.003 | -0.002 |
| 3.75  | 1       | String value                                   | 0.005  | 0.001  | 0.000  | -0.001 | 0.000  | 0.000  | 0.001  | 0.001  |
|       |         | Float value                                    | 0.005  | 0.001  | 0.000  | -0.001 | -0.000 | 0.000  | 0.001  | 0.001  |
| 0     | 1       | String value                                   | 0.007  | 0.005  | 0.004  | 0.003  | 0.003  | 0.003  | 0.004  | 0.004  |
|       |         | Float value                                    | 0.007  | 0.005  | 0.004  | 0.003  | 0.003  | 0.003  | 0.004  | 0.004  |

## Manual testing: QuickTest

- > Use of the CT Analyzer as a multimeter with an integrated current and voltage source
- > Perform manual tests (L, Z, R, ratio, polarity, burden etc.) for trouble-shooting and quick verification on site
- > VT ratio check



## CT SB2 switch box

- > Automated testing of multi-tap CTs without the need for rewiring
- > Includes terminals for burden and primary resistance tests
- > CTs with up to six taps can be tested
- > Automatic wiring check before measuring
- > Use attached to the CT Analyzer or as a standalone unit



## „Guessing“ nameplates

- > Determination of unknown CT data
- > Older CTs can be classified and put into service without contacting the manufacturer
- > Determinable parameters include:
  - > CT type
  - > Class
  - > Ratio
  - > Knee point
  - > Power Factor
  - > Nominal and operating burden
  - > Winding resistance (primary and secondary)

|             | CT-Object | Resistan... | Excitati... | Ratio |
|-------------|-----------|-------------|-------------|-------|
| before test | Location: | ????        |             |       |
|             | Object:   | ????        |             |       |
|             | I-pr:     | ?A          | I-sn:       | ?A    |
|             | Standard: | ANSI 45     | P/M:        | ?     |
|             | VA:       | ?VA         | Cosφ:       | n/a   |
|             | Burdens:  | ?VA         | Cosφ:       | ?     |
| after test  | Location: | ????        |             |       |
|             | Object:   | ????        |             |       |
|             | I-pr:     | 2000.0A     | I-sn:       | 5.0A  |
|             | Standard: | ANSI 45     | P/M:        | M     |
|             | Class:    | 0.3         | RF:         | 2     |
|             | VA:       | 22.5VA      | Cosφ:       | 0.9   |

# Technical data

## Technical features Standard Package

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- > Excellent noise immunity to disturbances from energized power lines close to the measurement
- > Automatic assessment according to IEC 60044-1, IEC 61869-2, or IEEE C57.13 up to accuracy class  $\geq 0.3$
- > Determination of ALF/ALFi and FS/FSi, Ts, and composite error for nominal and connected burden
- > CT ratio and phase measurement with consideration of nominal and connected secondary burden
  - > Currents from 1% up to 400 % of the rated value
  - > Different burdens (full, 1/2, 1/4, 1/8 burden)
- > CT winding resistance measurement (primary and secondary)
- > CT excitation curve (unsaturated and saturated)
  - > Saturation characteristic recording
  - > Direct comparison of excitation curve to a reference curve
- > CT phase and polarity check
- > Secondary burden measurement
- > Automatic demagnetization of the CT after the test
- > Small and lightweight (< 8 kg / 17.4 lbs)
- > Short testing time due to fully automatic testing
- > High level of safety using patented variable frequency method (max. 120 V)
- > „Nameplate guesser“ function for CTs with unknown data
- > Remote control interface
- > QuickTest: Manual testing interface
- > Display readable in bright sunlight
- > Simulation of measured data with different burdens and currents
- > Easily adaptable reports (customizable)
- > Knee-point voltage from 1 V up to 4 kV can be measured



## Additional features Advanced Package

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- > Automatic assessment for accuracy class  $> 0.1$  (inclusive classes defined in the IEEE C57.13.6 standard)
- > Measurement of transient behavior of TPS, TPX, TPY and TPZ type CTs
- > Automatic assessment according to IEC 60044-6 and IEC 61869-2
- > Determination of the transient dimensioning factor (Ktd)
- > Knee-point voltage from 1 V up to 30 kV can be measured
- > Considering Duty (C-O / C-O-C-O) e.g. auto-reclosure system



## Technical data CT Analyzer

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### Current ratio accuracy

|                      |  |
|----------------------|--|
| Ratio 1 ... 2000     | 0.02 % (typical) / 0.05 % (guaranteed) |
| Ratio 2000 ... 5000  | 0.03 % (typical) / 0.1 % (guaranteed)  |
| Ratio 5000 ... 10000 | 0.05 % (typical) / 0.2 % (guaranteed)  |

### Phase displacement

|            |                                      |
|------------|--------------------------------------|
| Resolution | 0.1 min                              |
| Accuracy   | 1 min (typical) / 3 min (guaranteed) |

### Winding resistance

|            |   |
|------------|---|
| Resolution | 1 mΩ  |
| Accuracy   | 0.05 % (typical) /<br>0.1 % + 1 mΩ (guaranteed) |

### Power supply

|                           |   |
|---------------------------|---|
| Input voltage             | 100 V <sub>AC</sub> ... 240 V <sub>AC</sub> |
| Permissible input voltage | 85 V <sub>AC</sub> ... 264 V <sub>AC</sub>  |
| Frequency                 | 50 / 60 Hz                                  |
| Permissible frequency     | 45 Hz ... 65 Hz                             |
| Input power               | 500 VA                                      |
| Connection                | Standard AC Socket IEC 60320                |

### Output

|                |  |
|----------------|--|
| Output voltage | 0 ... 120 V <sub>AC</sub>                              |
| Output current | 0 ... 5 A <sub>eff</sub> (15 A <sub>peak</sub> )       |
| Output power   | 0 ... 400 VA <sub>eff</sub> (1500 VA <sub>peak</sub> ) |

### Physical dimensions

|                  |  |
|------------------|--|
| Size (W × H × D) | 360 × 285 × 145 mm /<br>9.2 × 7.2 × 3.7 in |
| Weight           | 8 kg / 17.4 lbs (without accessories)      |

### Environment conditions

|                       |   |
|-----------------------|---|
| Operating temperature | -10 °C ... + 50 °C / 14 °F ... 122 °F         |
| Storage temperature   | -25 °C ... + 70 °C / -13 °F ... 158 °F        |
| Humidity              | Relative humidity 5 % ... 95 % not condensing |

### CE conformity

(EMC) Directive 2004/108/EC and low-voltage Directive 2006/95/EC

|        |  |
|--------|--|
| EMC    | EN 61326-1 Class A, IEC 61326-1 Class A,<br>FCC Subpart B of Part 15 Class A |
| Safety | EN 61010-1<br>IEC 61010-1<br>UL 61010-1<br>CSA C22.2 No. 1010.1-92           |

### Certificates from independent test institutes

KEMA Test Report  
PTB Test Report  
Wuhan HV Research Test Report

## Ordering information

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| Description                 | Order No. |
|-----------------------------|-----------|
| Standard Package            | VE000656  |
| Advanced Package            | VE000654  |
| Upgrade Standard – Advanced | VESM0653  |

# Accessories

## Accessories and software (part of Standard and Advanced Package)



### Coax cables

with banana plugs  
2 × 3 m / 2 × 9.8 ft,  
1 × 10 m / 1 × 32.8 ft

### Order No.

VEHK0651



### Battery clamps

with 4 mm / 0.2 in banana sockets  
(primary side connection)

### Order No.

VEHZ0652



### Crocodile clamps

with 4 mm / 0.2 in banana  
sockets (secondary side  
connection)

20 mm / 0.8 in opening width,  
2 × red, 2 × black

### Order No.

VEHZ0656



### Flexible terminal adapters

1 with 12 × 4 mm /  
0.2 in banana socket

### Order No.

VEHS0009



### Compact Flash Card

128 MB Memory space for at  
least 416 test reports

### Order No.

VEHZ0654



### Compact Flash card reader

USB 2.0 Compact Flash card reader

### Order No.

VEHZ0655



### User manual

User manual

### Order No.

VESD0605



### Carry bag

CT Analyzer carry bag

### Order No.

VEHP0018



### Grounding (PE) cable

1 × 6 m / 1 × 19.7 ft,  
6 mm<sup>2</sup> / 0.01 sq in,  
(protective earth connection)

### Order No.

VEHK0615



### Training CT

300:5, class 0.5 FS 5

### Order No.

VEHZ0643

### CT Analyzer PC software toolset

remote control software, QuickTest,  
Excel™ File Loader etc.

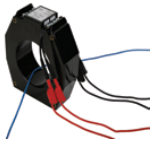
### Order No.

VESM0800



Power cord  
depends – country-specific

## Additional accessories and software



### Calibration CT

2000:1 / 2000:5,  
class 0.02

### Order No.

VEHZ0649



### Coax cables

3 m / 9.8 ft\*  
6 m / 19.7 ft\*  
10 m / 32.8 ft\*  
15 m / 49.2 ft\*  
100 m / 328.1 ft\*

\* with banana plugs

### Order No.

VEHK0654  
VEHK0652  
VEHK0653  
VEHK0655  
VEHK0656



### Pluggable winding

Pluggable 23 turns winding

### Order No.

VEHK0658



### Transport case

Transport case with wheels

### Order No.

VEHP0068



### CT SB2 upgrade kit

CT SB2, accessories included

### Order No.

VEHZ0696



### USB - RS232 converter cable

with Nullmodem cable

### Order No.

VEHZ0014



### Primary resistance Kit

4 pole cable 15 m / 49.2 ft  
(CT SB2 to CTprim),  
2 x Kelvin clamps

### Order No.

VEHZ0684



### Set of two Kelvin clamp adapters

Kelvin clamp adapter can be used together with the standard measurement cable

### Order No.

VEHZ0628

### RemAlyzer

Software License for the CT Analyzer to determine the residual magnetism in current transformers

### Order No.

VEISM0657

OMICRON is an international company serving the electrical power industry with innovative testing and diagnostic solutions. The application of OMICRON products allows users to assess the condition of the primary and secondary equipment on their systems with complete confidence. Services offered in the area of consulting, commissioning, testing, diagnosis and training make the product range complete.

Customers in more than 140 countries rely on the company's ability to supply leading-edge technology of excellent quality. Service centers on all continents provide a broad base of knowledge and extraordinary customer support. All of this together with our strong network of sales partners is what has made our company a market leader in the electrical power industry.

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



Datasheet CT SB2  
Switch Box

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