

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.

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. Manufacturer 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

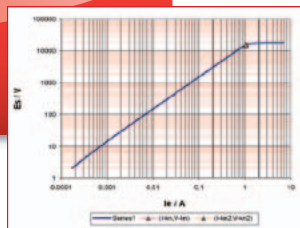
Automated testing procedure

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.

Step 1

Measurement of parameters

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



Step 2

Modeling

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

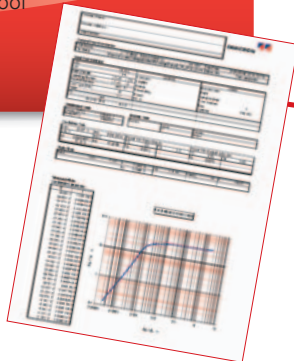
$$\Psi(t) = \Psi'_0 + \int_0^t (V_s(t) - R_{CT} I_{CT}(t)) dt - L_{CT} \frac{d}{dt} I_{CT}(t)$$

$$V_C(t) = V_s(t) - R_{CT} I_{CT}(t) - L_{CT} \frac{d}{dt} I_{CT}(t)$$

Step 4

Reporting

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



Step 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

VA	cos φ	Data type	Current ratio error in % at % of rated current							
			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

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 according to 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:

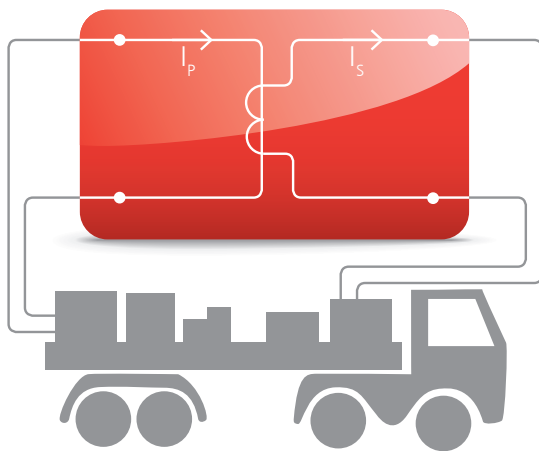
Mobility

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).

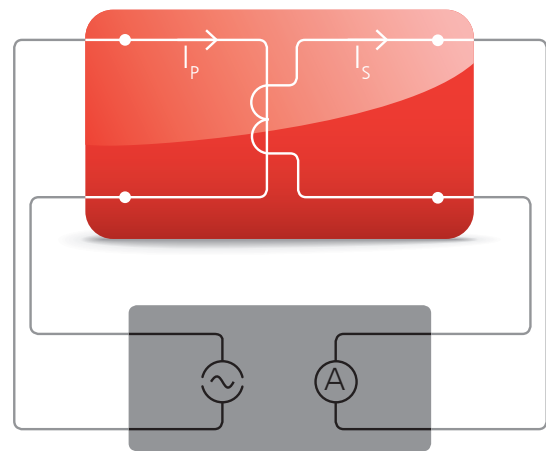
Accuracy

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.)

Accuracy

High accuracy, but complicated wiring makes testing error-prone

Safety

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

Handling

Requires several people to set-up and conduct the test

Mobility

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

Accuracy

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

Safety

Typical current levels of 500 A to 800 A are used

Handling

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

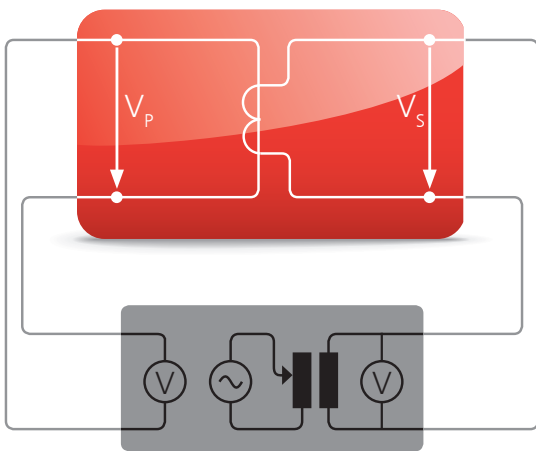
Safety

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.

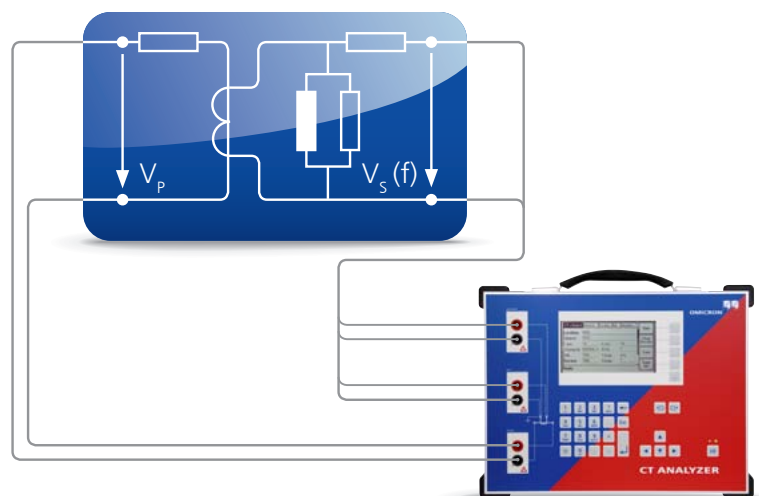
Handling

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



CT as an Electrical Model



Mobility

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

Accuracy

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

Safety

Voltages for saturation tests can be 2,000 V or more

Handling

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

Mobility

< 8 kg / 17.4 lbs; ideal for handling on site

Accuracy

- 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

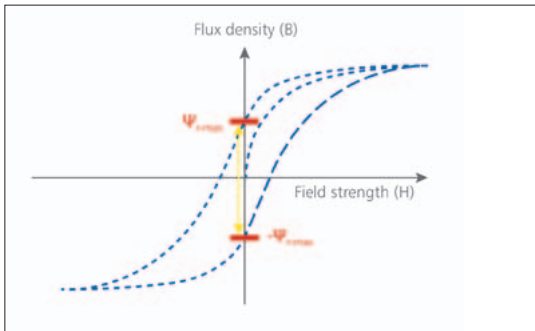
Safety

Maximum output voltage of 120 V

Handling

- One-step test determining all parameters (< 1 min)
- Automated assessment to standard and integrated report functionality

Extraordinary Features



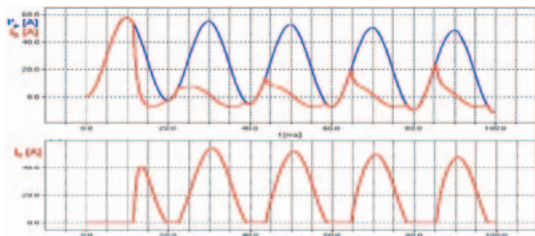
RemAlyzer

- > 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 'CT - Test Settings' software interface. The window title is 'Settings: 11-15 | Multi Ratio CT |'. It contains several input fields and dropdown menus organized into sections: 'Location' (Station, Company, Feeder, Country, Phase, BEC-ID), 'Object' (Serial No., Manufacturer, Core, Type, Tap, Optional 1), 'I-sec' (600 A), 'I-prim' (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.' (1), and 'Op. cosp.' (7).

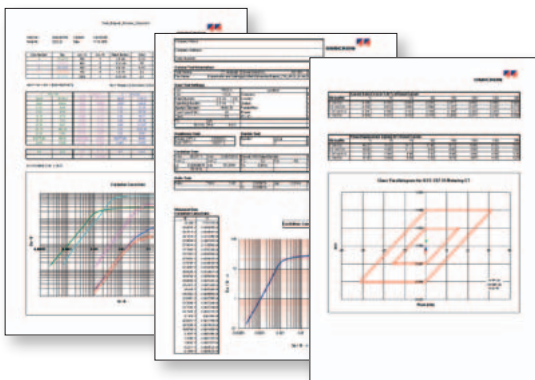
Remote Control

- > 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



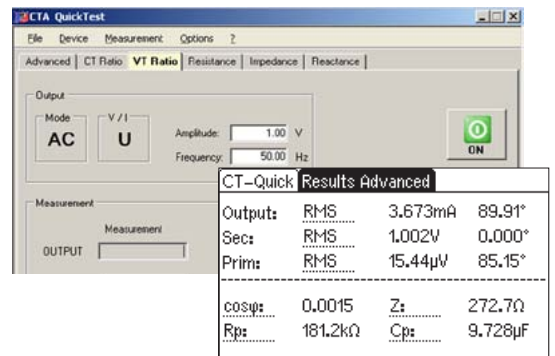
Verification for different burdens and currents

- > 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
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		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 Switchbox

- > 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
	Burden:	?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 features Standard Package

- > Excellent noise immunity to disturbances from energized power lines close to the measurement
- > Automatic assessment according to IEC 60044-1, or IEEE C57.13 up to accuracy class ≥ 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, $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ 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

- > 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
- > 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

Current Ratio Accuracy		Environment Conditions	
Ratio 1 - 2000	0.02 % (typical) / 0.05 % (guaranteed)	Operating Temperature	-10 °C up to + 50 °C / 14 °F up to 122 °F
Ratio 2000 - 5000	0.03 % (typical) / 0.1 % (guaranteed)	Storage Temperature	-25 °C up to + 70 °C / -13 °F up to 158 °F
Ratio 5000 - 10000	0.05 % (typical) / 0.2 % (guaranteed)	Humidity	Relative humidity 5% up to 95% not condensing
Phase Displacement		EMC	
Resolution	0.1 min	The product adheres to the electromagnetic compatibility (EMC) Directive 2004 / 108 / EC (CE conform)	
Accuracy	1 min (typical) / 3 min (guaranteed)		
Winding Resistance		EMC-Emission	
Resolution	1 mΩ	International	IEC 61326-1 Class A
Accuracy	0.05 % (typical) / 0.1 % + 1 mΩ (guaranteed)	Europe	EN 61326-1 Class A
Power Supply		USA	FCC Subpart B of Part 15 Class A
Input Voltage	100 Vac to 240 Vac	EMC-Immunity	
Permissible Input Voltage	85 Vac to 264 Vac	International	IEC 61326-1
Frequency	50 / 60 Hz	Europe	EN 61326-1
Permissible Frequency	45 Hz to 65 Hz	Safety	
Input Power	500 VA	The product adheres to the low voltage Directive 2006 / 95 / EC (CE conform)	
Connection	Standard AC socket 60320	International	IEC 61010-1
Output		Europe	EN 61010-1
Output Voltage	0 Vac to 120 Vac	USA	UL 61010-1
Output Current	0 A _{eff} to 5 A _{eff} (15 A _{peak})	Canada	CSA C22.2 No. 1010.1-92
Output Power	0 VA _{eff} to 400 VA _{eff} (1500 VA _{peak})	Certificates from Independent Test Institutes	
Physical Dimensions		KEMA Test Report	
Size (W x H x D)	360 x 285 x 145 mm 9.2 x 7.2 x 3.7 in	PTB Test Report	
Weight	8 kg / 17.4 lbs (without accessories)	Wuhan HV Research Test Report	

Ordering information

Name	Order No.	Description
Standard Package	VE000656	CT Analyzer Standard Package
Advanced Package	VE000654	CT Analyzer Advanced Package
Upgrade Standard - Advanced	VESM0653	Software upgrade from Standard to Advanced
CT SB2 Kit	VEHZ0696	Hardware extension to connect and test multi-ratio CTs
Primary Resistance Kit	VEHZ0684	4 pol cable and Kelvin clamps
Remalyzer	VESM0657	Software License

Accessories

Accessories (part of Standard and Advanced Package)

Coax cables

VEHK0651 - with banana plugs
2 x 3 m / 2 x 9.8 ft,
1 x 10 m / 1 x 32.8 ft



Battery clamps

VEHZ0652 - with 4 mm / 0.2 in banana sockets (primary side connection)



Crocodile clamps

VEHZ0656 - with 4 mm / 0.2 in banana sockets (secondary side connection)



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

Flexible terminal adapters

VEHS0009 - with 12 x 4 mm / 0.2 in banana socket



Compact Flash Card

VEHZ0654 - 128 MB
Memory space for at least 416 test reports



Compact Flash card reader

VEHZ0655 - USB 2.0 Compact Flash card reader



User manual

VESD0605 - User manual



Carry bag

VEHP0018 - CT Analyzer carry bag



Grounding (PE) cable

VEHK0615 - 1 x 6 m / 1 x 19.7 ft,
6 mm² / 0.01 sq in,
(protective earth connection)



USB - RS232 converter cable

VEHZ0014 - with Nullmodem cable



Training CT

VEHZ0643 - 300:5, class 0.5 FS 5



CT Analyzer PC software toolset

VEISM0800 - remote control software, QuickTest, Excel File Loader etc.

Power cord

depends - country-dependent

Additional accessories

Calibration CT

VEHZ0649 - 2000:1 / 2000:5,
class 0.02



Coax cable

VEHK0657 - with Kelvin clamps,
3 m / 9.8 ft



Pluggable winding

VEHK0658 - Pluggable 23 turns
winding



Coax cables

VEHK0654 - 3 m / 9.8 ft*
VEHK0652 - 6 m / 19.7 ft*
VEHK0653 - 10 m / 32.8 ft*
VEHK0655 - 15 m / 49.2 ft*
VEHK0656 - 100 m / 328.1 ft*



* with banana plugs

CT SB2 upgrade kit

VEHZ0696 - CT SB2 inclusive
accessories



Transport case

VEHP0068 - Transport case with
wheels



Primary resistance Kit

VEHZ0684 - 4 pole cable 15 m / 49.2 ft
(CT SB2 to CTprim),
2x Kelvin clamps



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. Broad application knowledge and extraordinary customer support provided by offices in North America, Europe, South and East Asia, Australia, and the Middle East, together with a worldwide network of distributors and representatives, make the company a market leader in its sector.

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



*Datasheet CT SB2
Switch Box*

For a complete list of available literature please visit our website.

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