

# VOTANO 100

Accurate and mobile voltage transformer testing and calibration system



# Sophisticated voltage transformer testing

## VOTANO 100: accuracy and portability

At only 15 kg/33 lbs and compact in size VOTANO 100 is the first portable device to also offer high accuracy. It can be used for testing protection and metering voltage/potential\* transformers (VTs) quickly. The measured results are automatically assessed in accordance with IEEE and IEC standards.

VOTANO 100 uses an electrical modeling method which is already well-established and can be compared to that used by OMICRON's CT Analyzer.

Its light-weight design makes it ideal for on-site tests and calibration tasks in power system grids. As a VT manufacturer you can use VOTANO 100 in your production facilities and test/development labs.

## VOTANO 100 and VBO2: a safe and reliable combination

VOTANO 100 is supplied with the separate voltage booster VBO2. This 4 kV amplifier provides the necessary test voltage during the ratio measurement. Its integrated switchbox automatically switches between the necessary test sequences. This facilitates fast and reliable tests as wiring only needs to be done once saving time and preventing failures.

VBO2 is positioned close to the transformer under test while VOTANO 100 is operated in the safe area outside of the high-voltage environment.

## Software-guided workflow

### 1 Measurement of parameters

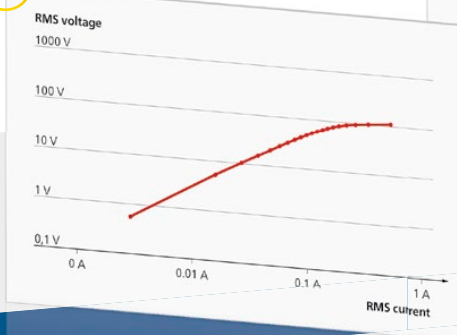
Software-guided and automated measurement of different VT parameters such as winding resistance, magnetization characteristics, etc.

### 2 Modeling

Determination of VT model elements and calculation of VT accuracy through embedded mathematical functions.

### 3 IEEE/IEC assessment

Automated comparison of test results with the defined values in accordance with the selected IEEE or IEC standard.



$$\Psi(t) = \Psi_0' + \int_0^t (V_s(t) - R_s \cdot I_{exc}(t)) dt - L_\sigma \cdot \frac{dI_{exc}(t)}{dt}$$

$$V_c(t) = V_s(t) - R_s \cdot I_{exc}(t) - L_\sigma \cdot \frac{dI_{exc}(t)}{dt}$$

Power		Voltage ratio error in % at % of rated voltage					
VA	cos Phi	Burden in %	2%	5%	80%	100%	120%
15	0.8	100	0.088%	0.123%	0.177%	0.177%	0.176%
3.75	0.8	25	0.033%	0.362%	0.415%	0.417%	0.415%
15	0.8	100	4.825 min.	4.287 min.	3.180 min.	3.185 min.	3.245 min.
3.75	0.8	25	2.802 min.	2.263 min.	1.155 min.	1.161 min.	1.220 min.
15	100	100	-0.57%	-0.54%	-0.482%	-0.481%	-0.483%
3.75	0.8	25	-0.33%	-0.30%	-0.246%	-0.245%	-0.246%
15	100	100	2.320 min.	1.783 min.	0.678 min.	0.683 min.	0.737 min.
3.75	0.8	25	0.302 min.	-0.235 min.	-1.340 min.	-1.339 min.	-1.300 min.

\* In some countries, voltage transformers (VTs) may also be referred to as potential transformers (PTs). This document will use the term voltage transformer.



Accuracy and portability: VOTANO 100 and VBO2

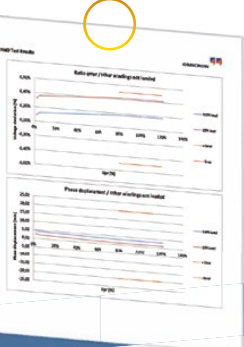
## What VOTANO 100 can do for you

- > Automated determination of VT ratio and phase angle accuracy for each single secondary winding
  - > considering different nominal voltage values
  - > considering different burden values
  - > under and without load (of the remaining secondary windings)
- > VT winding resistance measurement of secondary windings
- > Determination of magnetization characteristics
- > Leakage reactance measurement
- > Automatic assessment of results regarding class accuracy in compliance with pre-defined IEC and IEEE standards
- > Class verification of VTs with up to 5 secondary windings can be done within one measurement cycle (including open delta winding)
- > Burden measurements



### 4 Reporting

All data can be saved in Excel™ and XML format or can be printed as a test report.



## Your benefits

- > Very high accuracy allows field calibration of VTs up to the 0.1 accuracy class
- > Excellent portability through compact size and low total weight (15 kg / 33 lbs)
- > Automated measurements
- > Automatic result assessment as per IEEE and IEC standards directly after the test
- > Short testing time compared to conventional methods (< 15 min)

# Accuracy and mobility for on-site VT testing

## Characteristics for the ideal on-site VT testing device

- > **Safety:** The dangerous part of the test taking place under high voltages should be kept as short as possible.
- > **Accuracy:** Accuracy level should allow a calibration of metering VTs with up to class 0.1.
- > **Mobility:** It should be compact and lightweight enough to be carried by one person.
- > **Handling:** It should offer fast and automated tests and assessment to the respective IEC and IEEE standards. The setup and testing effort should be kept at a minimum in order to reduce time and costs. All relevant parameters should be measured in one test cycle and without the need for any further equipment (such as a burden box) and for rewiring.

### Primary nominal-voltage injection

### Primary high-voltage injection

#### Safety

- > Very high voltages of up to 1.9 times nominal voltage

- > Typically voltage levels of up to 10kV are used

#### Accuracy

- > Very high accuracy
- > Many testing components resulting in a lot of calibration work and wiring

- > Not sufficient for calibration
- > Sensitive to coupling from nearby live cables (typical measurement at mains frequency)

#### Mobility

- > Approximately half a ton of equipment (controlled voltage transformer, high-voltage transformer, heavy cables, booster, burden box, etc.)

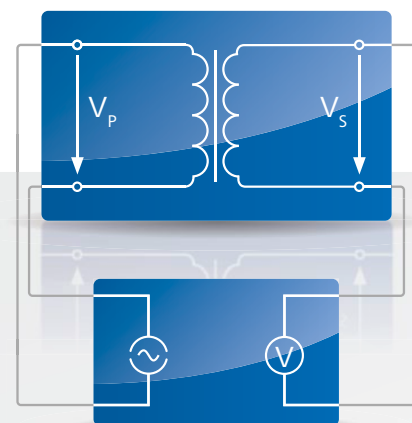
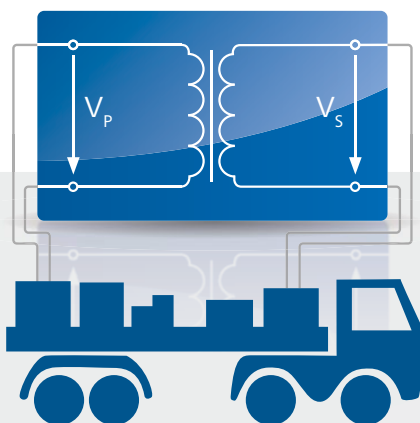
- > More than 30kg / 66lbs (not including additional equipment, e.g. external burden box)

#### Handling

- > A manual assessment of the results as per applicable standards is possible
- > Complex test setup: setup and testing requires several people

- > Class compliance of the transformers can only be estimated
- > For the single ratio test only a simplified test set-up and process is necessary

#### Electrical model

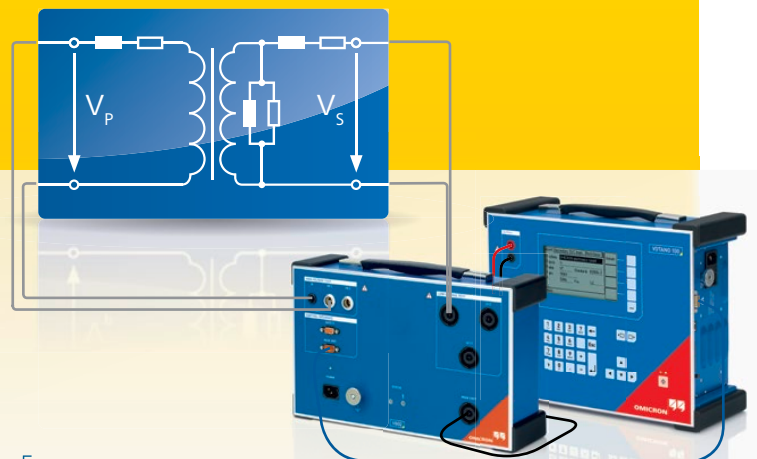
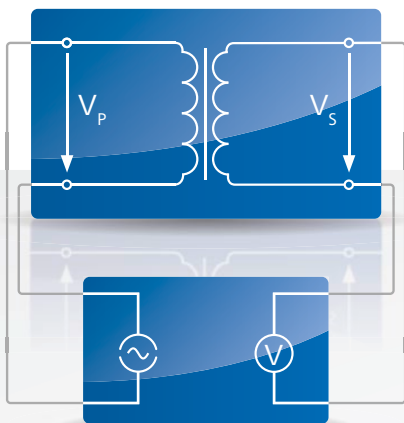


## Primary voltage injection

- > Typically voltage levels of up to 100V are used
- > Not suitable for calibration
- > Only sufficient for an estimation of the ratio
- > Typically less than 10kg / 22lbs
- > Ideal for handling on site
- > Class compliance of the transformer can only be roughly estimated
- > Comparatively simple and easy test setup

## Model-based VT testing

- > Measuring voltages of up to 4kV are used
- > Local isolation between high voltage and measuring equipment
- > Sufficient for measurement and calibration of class 0.1 metering VTs
- > Measuring signals away from the mains frequency guarantees excellent noise suppression
- > 15 kg / 33 lbs
- > Ideal for handling on site
- > Software-guided and automated test procedure (< 15 min)
- > Automated assessment (as per applicable standards) and reporting function
- > Enhanced simulation function eliminates the necessity to double-check measurements

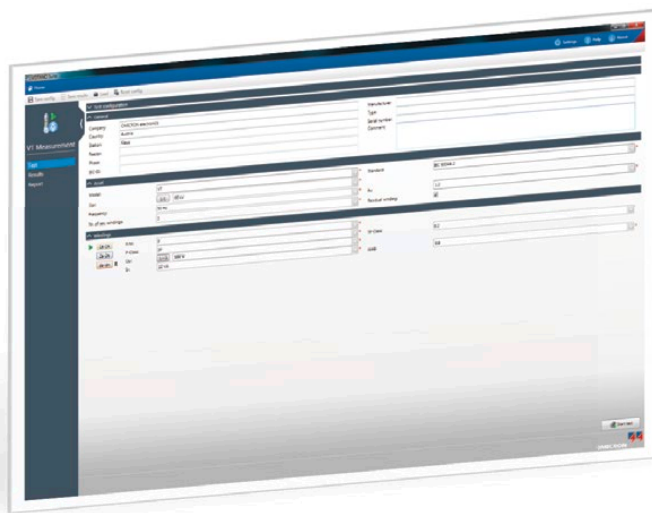


# VOTANO 100's features

	Power			Voltage ratio error in % at % of rated voltage				
	VA	cos Phi	Burden in %	2%	5%	80%	100%	120%
Ratio unloaded	15	0.8	100	0.088%	0.123%	0.177%	0.177%	0.176%
			25	0.033%	0.362%	0.415%	0.417%	0.415%
Phi, angle unloaded	15	0.8	100	4.825 min.	4.287 min.	3.180 min.	3.186 min.	3.245 min.
			25	2.802 min.	2.263 min.	1.155 min.	1.161 min.	1.220 min.
Ratio loaded	15	0.8	100	-0.57%	-0.54%	-0.482%	-0.481%	-0.483%
			25	-0.33%	-0.30%	-0.246%	-0.245%	-0.246%
Phi, angle loaded	15	0.8	100	2.320 min.	1.783 min.	0.678 min.	0.683 min.	0.737 min.
			25	0.302 min.	-0.235 min.	-1.340 min.	-1.335 min.	-1.300 min.

## Automated assessment of measurement results in compliance with the standards

- > Limit values for automated assessment are set in compliance with the applicable standards (IEC or IEEE)
- > Automatic assessment is completed within seconds after the measurement
- > Complete transformer assessment considering;
  - > different burdens of secondary windings under test
  - > different primary voltage values
  - > each secondary winding under load and no-load conditions (while the others are either under load or without load)



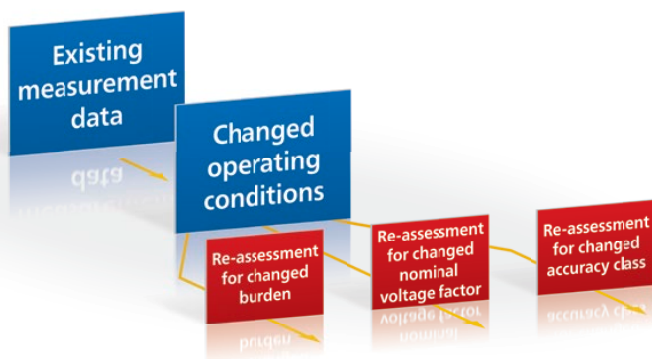
## Remote control

- > With the PC software you can easily control the whole measuring procedure
- > Allows the integration of VOTANO 100 into the automated testing procedures of a production line
- > You can export data into Excel™ or XML format

## Simulation and re-assessment

Using the measured data of previous tests you can save time and money by;

- > reloading existing measurement data into VOTANO 100 at any time for simulation
- > doing later simulations and re-assessment of transformers when the following parameters have changed:
  - > Burdens (individually for each winding)
  - > Nominal voltage factor
  - > Accuracy class of transformer
  - > Primary voltage
- > avoiding further on-site measurements to verify whether a change in the burden will influence the transformers' accuracy



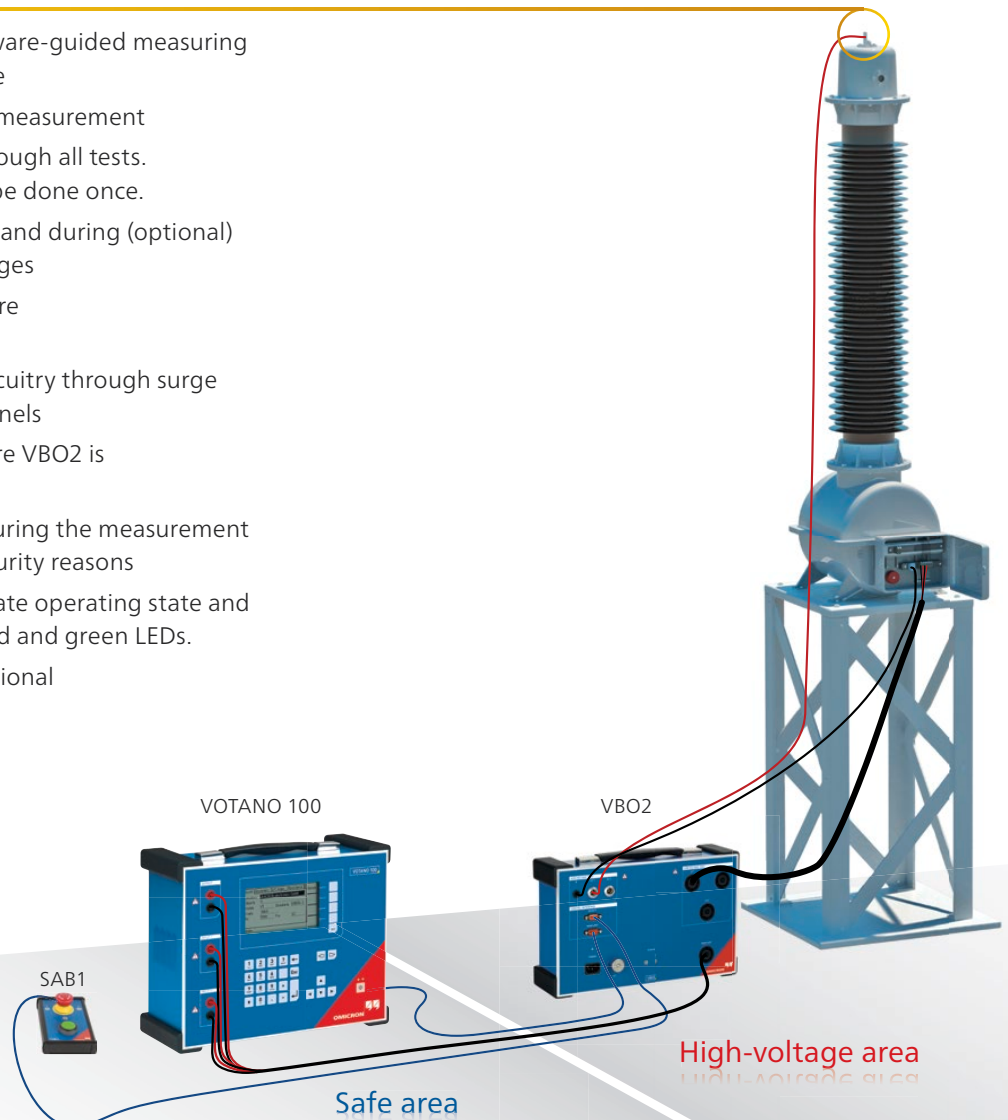
## Data processing and test reports

- > You can save the test results directly on the Compact Flash Card
- > With your PC you can easily generate reports using the Report Function
- > The content and layout of reports can be customized in Excel™



## Safe testing

- > Enhanced security through software-guided measuring procedure via GUI or PC software
- > Wiring diagrams for each single measurement
- > VBO2 automatically switches through all tests. HV and LV wiring only needs to be done once.
- > Acoustic warnings sound before and during (optional) measurements with higher voltages
- > Automatic plausibility check before critical measurements
- > VBO2 offers additional safety circuitry through surge arrestors for the measuring channels
- > Integrated system check to ensure VBO2 is correctly grounded
- > If reconnections are necessary during the measurement the system can be locked for security reasons
- > Safety box SAB1 and VBO2 indicate operating state and safe state of the test setup via red and green LEDs.
- > Emergency stop button for additional safety interruptions



# Specifications and software packages



## Technical specifications of VOTANO 100

### Inductive voltage transformers

#### Ratio measurement

Voltage ratio	Voltage level*	Typical accuracy
1 ... 350	0.6 kV ... 35 kV	0.05 %
> 350 ... 2450	> 35 kV ... 245 kV	0.07 %

#### Phase displacement measurement

Voltage ratio	Voltage level*	Typical accuracy
1 ... 350	0.6 kV ... 35 kV	1 min
> 350 ... 2450	> 35 kV ... 245 kV	2 min

#### Winding resistance measurement

Resolution	Guaranteed accuracy	Typical accuracy
1 mΩ	0.1 % + 1 mΩ	0.05 %

### Capacitive coupled voltage transformers

#### Ratio measurement

Voltage ratio	Voltage level*	Typical accuracy
300 ... 8000	> 30 kV ... 800 kV	0.07 %

#### Phase displacement measurement

Voltage ratio	Voltage level*	Typical accuracy
300 ... 8000	> 30 kV ... 800 kV	2 min

#### Winding resistance measurement

Resolution	Guaranteed accuracy	Typical accuracy
1 mΩ	0.1 % + 1 mΩ	0.05 %

### 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 Hz / 60 Hz
Permissible frequency	45 Hz ... 65 Hz
Input power	500 VA
Connection	Standard AC socket as per IEC 60320

### Output

Output voltage	0 ... 120 V <sub>DC</sub> , 0 ... 40 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 9.2 × 7.2 × 3.7 in
Weight	7.8 kg / 17.2 lbs (without accessories)

### Environmental conditions

Operating temperature	-10 °C ... +50 °C / +14 °F ... +122 °F
Storage temperature	-25 °C ... +70 °C / -13 °F ... +158 °F
Relative humidity	5 % ... 95 %, non-condensing

### PC Requirements

Operating system	Windows 8.1™ 64 bit Windows 8™ 64 bit Windows 7™ 32 bit and 64 bit Windows Vista™ with SP 1 32 bit Windows XP™ with SP 3
Necessary Microsoft® software	Microsoft Office® 2013 or 2010, Office® 2007 SP2, or Office® 2003 SP3

## Technical specifications of VBO2 voltage booster



### Physical dimensions

Size (W × H × D)	358 × 230 × 114 mm 14.1 × 9.1 × 4.4 in
Weight	7.3 kg / 16.1 lbs (without accessories)

### Environmental conditions

Please see VOTANO 100 parameters.

\* network voltage level (line-to-line voltage)



## Features of VOTANO 100 software packages

	Standard Package	Advanced Package	Capacitive VT Upgrade
Complete measurements for inductive VTs with up to 5 secondary windings	■	■	
Complete measurements for capacitive VTs with up to 5 secondary windings	–	–	■
Complete measurements for VTs as part of combined VT/CT units with up to 5 secondary windings	■	■	
Automatic assessment as per applicable standards up to accuracy class > 0.3			
> IEC 60044-2 for inductive VTs	■	■	
> IEC 60044-5 for capacitive VTs	–	–	■
> IEC 61869-3 additional requirements for inductive VTs	■	■	
> IEC 61869-5 additional requirements for capacitive VTs	–	–	■
> IEEE C57.13 standard requirements for conventional transformers	■	■	
> ANSI C93.1 requirements for capacitive VTs	–	–	■
Automatic assessment as per applicable standards up to accuracy class ≥ 0.1	–	■	
Ground fault winding (open delta) definition is included in the test specifications e.g. $V_{sr}/3$	■	■	
VT ratio and phase error measurement in accordance with the standard	■	■	
> Primary voltage levels between 5 % and 190 % of the nominal primary voltage			
> Nominal burden and burden values below (0 VA, 25 % and 100 % burden)			
> Other windings under load and without load			
> Customized burden			
Ratio and phase error measurements considering the Total Simultaneous Burden (TSB)	■	■	
VT polarity check	■	■	
Direct comparison of VT excitation curve to a reference curve	■	■	
Secondary winding resistance	■	■	
Short-circuit impedance	■	■	
Remote interface	■	■	
Easy generation of customizable reports	■	■	
Subsequent simulation and re-assessment of the VTs after modification of parameters	–	■	
> Burden (individually for every winding)			
> Nominal voltage factor / rated voltage factor			
> Accuracy class of VT			
> Primary voltage			
Saved measuring data can be reloaded into VOTANO 100 for simulation at any time	–	■	
Burden measurement	–	■	

■ included    – not included

# Ordering information VOTANO 100

## Packages

	Description	Ordering No.
VOTANO 100 Standard Package incl. accessories	Package for complete measurements of inductive VTs with up to 5 secondary windings and automatic assessment as per applicable standards up to accuracy class > 0.3	VE000802
VOTANO 100 Advanced Package incl. accessories	Package which expands the automatic VT assessment function up to accuracy class > 0.1 and offers the burden measurement function	VE000803

## VOTANO 100 Package



## Upgrade Options

	Description	Ordering No.
VOTANO 100 Capacitive VT Upgrade Option	Upgrade option for Standard and Advanced Package which expands the possible measurements to capacitive VTs with up to 5 secondary windings	VESM0801
VOTANO 100 Standard to Advanced Upgrade Option	Software upgrade option which upgrades VOTANO 100 from the Standard to the Advanced Package	VESM0802

## Accessories

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	Description	Ordering No.
Calibration VT	High-precision calibration IVT (0.05% accuracy) for calibration of VOTANO 100 and VBO2 (calibration certificate ISO / IEC 17025 included)	VEHZ0801

Calibration VT



## Services

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	Description	Ordering No.
Recalibration of Calibration VT	Recommended recalibration of calibration VT every 1-2 years (return shipment included)	VEDK9057
Calibration of new VOTANO 100 devices	Optional calibration of new VOTANO 100 devices according to IEC17025. Certifies accuracy for VT accuracy class determination and verifies accuracy of low- and high-voltage in- and outputs	VEDK0017
Recalibration of VOTANO 100 devices in service	Recommended annual recalibration of VOTANO 100 devices in service according to IEC17025. Certifies accuracy for VT accuracy class determination and verifies accuracy of low- and high-voltage in- and outputs (return shipment included)	VEDK9058

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.

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