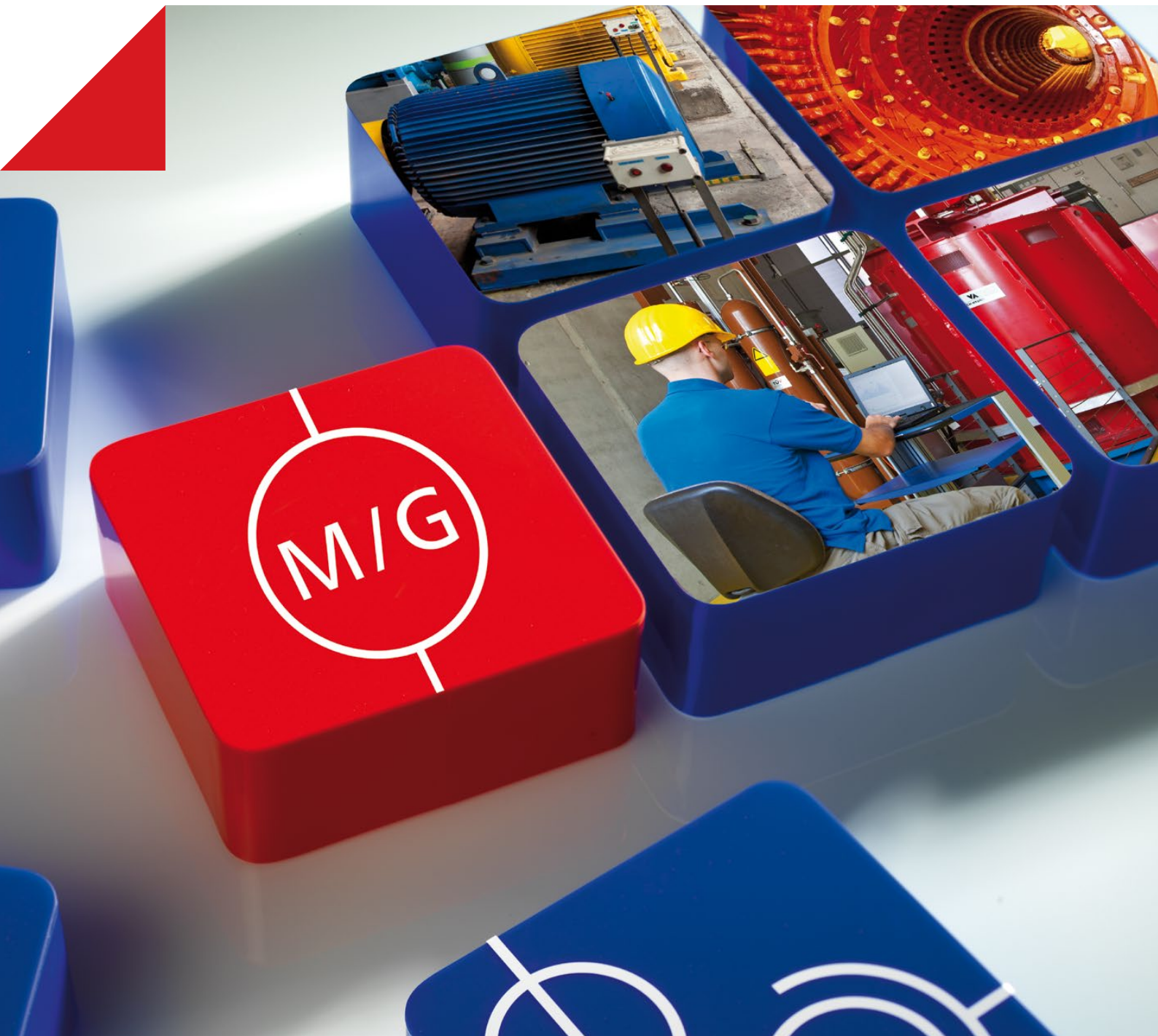


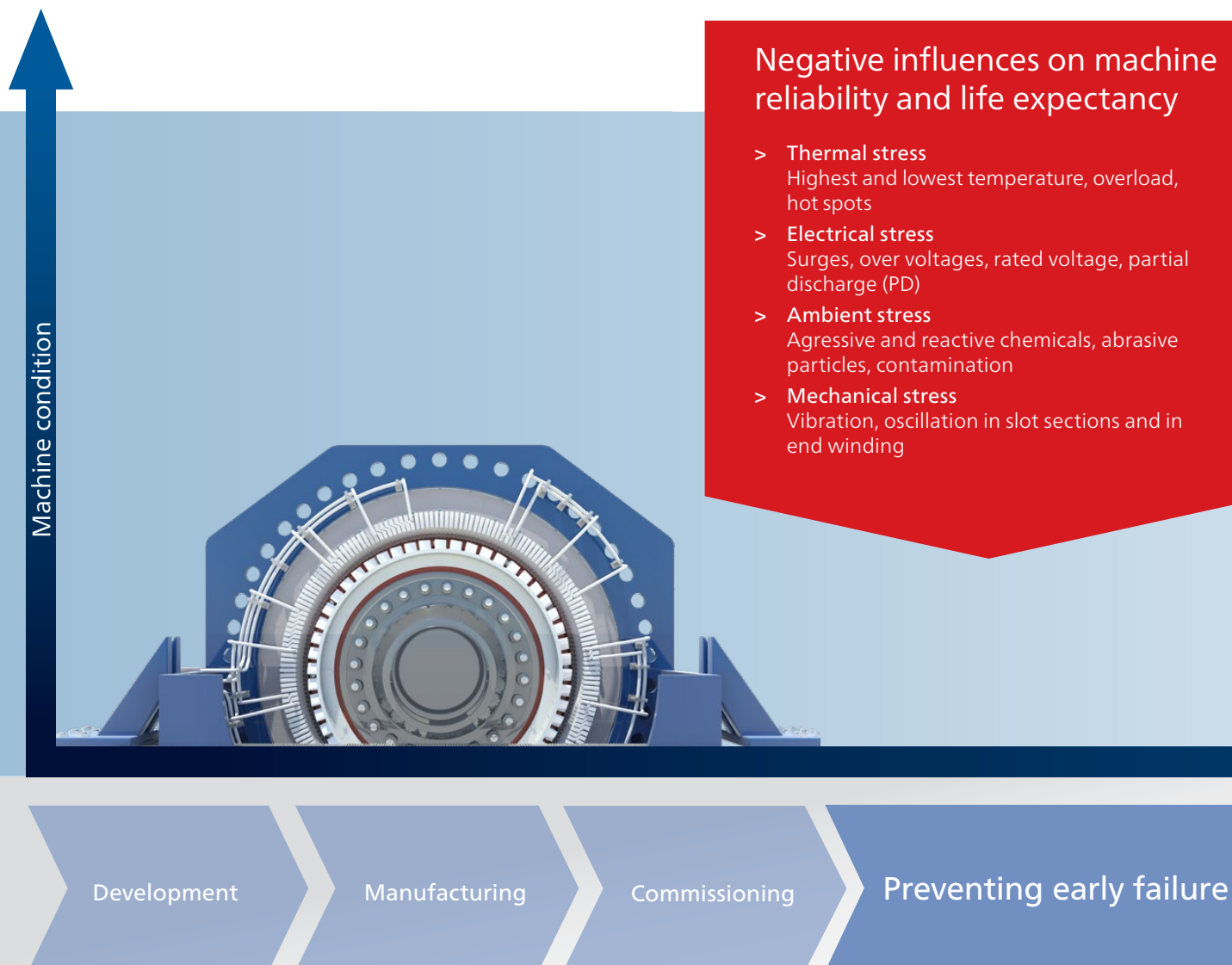
# Diagnostic testing and monitoring of rotating machines



# Know the condition of your machine for reliable operation

## Reducing the risk of failure in rotating machines

Rotating machines, such as motors and generators, are highly important components in power generation and industrial applications. Machine reliability and availability are therefore in high demand. Premature failure may lead to significant economical losses, due to unexpected outages and possible damage to the asset itself. To plan maintenance effectively, it is essential to have accurate condition information about when components need repairing or replacing.




A variety of electrical tests can be performed over the complete life cycle of your machines to increase their reliability, prevent premature failures and to extend reliable service life. Off-line diagnostic tests provide you with a snapshot of current condition and detect possible defects. Temporary and permanent on-line monitoring enable continuous condition assessment under normal operating conditions.

### Testing and corrective measures to ensure machine reliability and extend life expectancy

- > Regular or continuous condition assessments using various electrical diagnostic methods
- > Reverse the position of the starpoint
- > Partial rewinding of worn parts
- > Replace damaged components

Machine life expectancy



Normal life

Ensuring reliable operation



End of life

Extending lifetime



# Rotating machine parts and recommended electrical tests

## Detecting faults to prevent failure

Electrical diagnosis testing can tell you a lot about the condition of a motor or generator. Electrical tests are commonly done after the machine has been manufactured, installed on-site or during periodic maintenance checks.

The electrical tests listed here are diagnostic methods that allow the reliable condition assessment of insulation and other components in rotating machines.

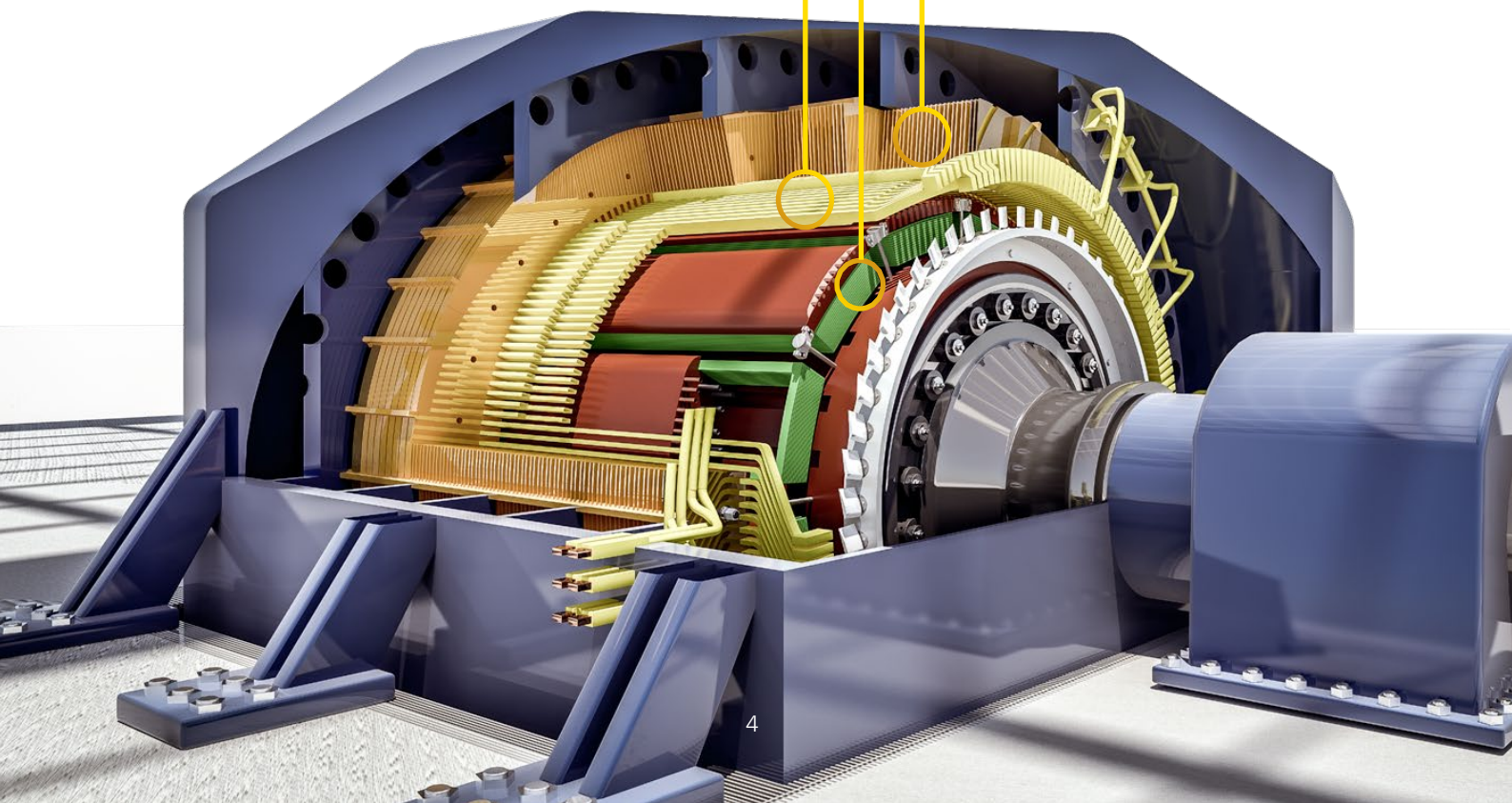
The results of these measurements give you an indication about when you should perform maintenance on affected parts.

### Machine part tested

Stator winding

Rotor winding

Stator core



What should be checked	Recommended electrical tests										
Partial discharges (PD)	■	■	■								
Contamination	■	■	■		■					■	
Insulation degradation	■	■	■		■					■	
Voltage withstand				■							
Insulation integrity				■	■					■	
Connection problems						■					
Inter turn faults									■		
Inter turn faults							■	■			
High contact resistance						■					
Core imperfection											■

Capacitance, dissipation factor (tan δ)/ power factor measurements

Partial discharge (PD) measurement

On-line PD monitoring

Voltage withstand testing

Insulation resistance, polarization index and dielectric absorption ratio measurements

DC winding resistance measurement

Contact resistance measurement

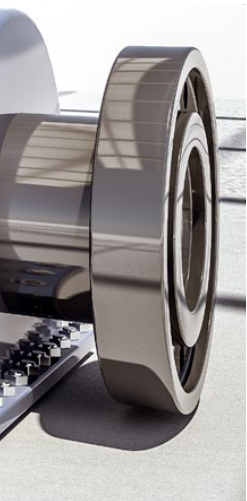
Sweep frequency measurement

Pole drop testing

Sweep frequency response analysis

Dielectric response analysis

Electromagnetic imperfection testing



# The ideal solution for your individual machine testing needs

## Recommended diagnostic tools

For common diagnostic methods on rotating machines, we offer the matching testing or monitoring solution. Together, these solutions allow you to perform a thorough condition assessment of electrical machines in order to quickly identify potential problems and risk of failure.

Electrical test	CPC 100	+ CP TD15 + CP CR600	TANDO 700	MPD 800
Capacitance, dissipation factor (tan δ)/ power factor measurements	■ <sup>2</sup>	■ <sup>2</sup>	■	
Partial discharge (PD) measurement	■ <sup>1,2</sup>	■ <sup>1,2</sup>		■
On-line PD monitoring				
Voltage withstand testing	■ <sup>1,2</sup>	■ <sup>1,2</sup>		
Insulation resistance, polarization index and dielectric absorption ratio measurements				
DC winding resistance measurement	■			
Contact resistance measurement	■			
Pole drop testing	■			
Sweep frequency response analysis				
Dielectric response analysis				
Electromagnetic imperfection testing	■			

<sup>1</sup> Used as a high-voltage source  
<sup>2</sup> Also possible with CPC 80 with CP TD1

Universal testing set for electrical diagnostics on high-voltage assets



Dielectric testing device with a compensating reactor



High-precision measurements of capacitance and dissipation factor/ power factor for use in test labs



Universal partial discharge (PD) measurement and analysis system



MONTESTO 200

MONGEMO

DIRANA

FRANEO 800

■

■

■

■

■

■

■

Portable on-line PD measurement and temporary monitoring system

Permanently-installed system for continuous on-line PD monitoring of generators and motors

Light-weight testing device for dielectric response analysis on high-voltage assets

Sweep frequency response analyzer



# Capacitance, dissipation factor ( $\tan \delta$ )/power factor measurements

## Which part can be tested?

- ✓ Stator winding
- Rotor winding

## Why measure?

Capacitance (C) and dissipation factor (DF/ $\tan \delta$ )/power factor (PF) measurements are conducted to identify defects, which affect the condition of the machine insulation. A healthy insulation is essential for safe operation.

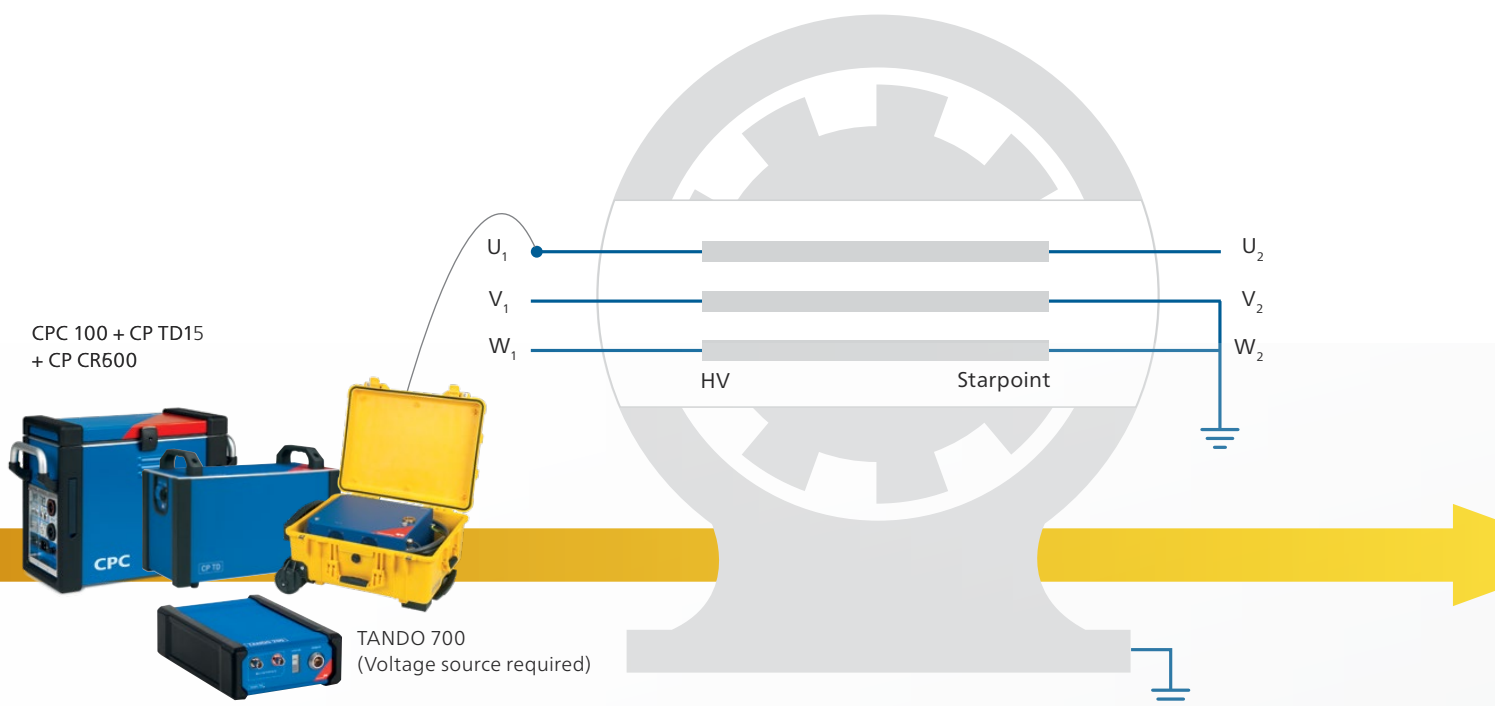
Variations in C and DF/PF over time are often signs of partial discharges (PD) or insulation degradation. The trend data assists in determining the speed of insulation aging and to identify critical changes that may require further inspection.

## How does it work?

In combination with a high-voltage source, the measurement instrument is connected to the machine's terminals for either phase-to-ground measurements or a combined three-phase measurement if the star point is not accessible. Phase-to-phase measurements can be performed as well in order to check the end winding capacitance.

The DF/PF is usually measured over a specific voltage ( $U/U_n$ ) range during a tip up test. A typical starting voltage and step increment is  $0.2 U_n$ . Other steps and starting points, such as  $0.1 U_n$  can be chosen. A comparison is made either phase-to-phase or with previous measurements.

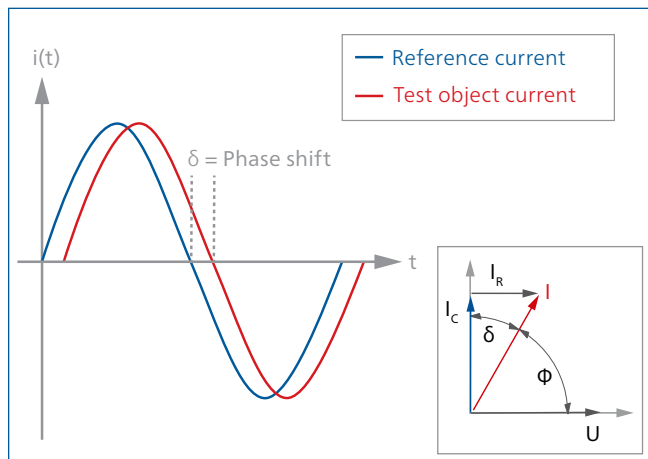
C and DF/PF measurements are defined by international standards, such as IEEE 286-2000 and IEC 60034-27-3.



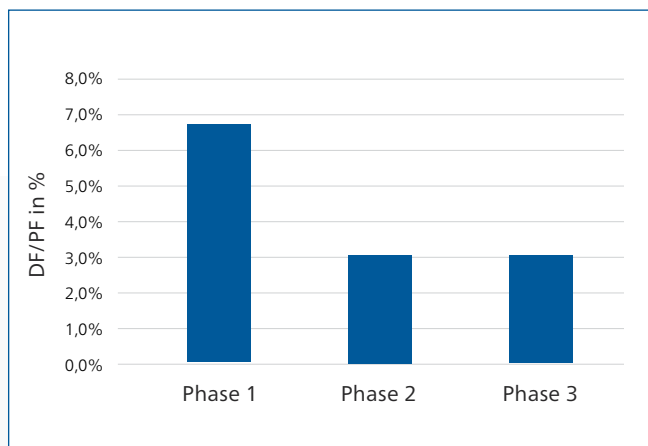


### Good to know ...

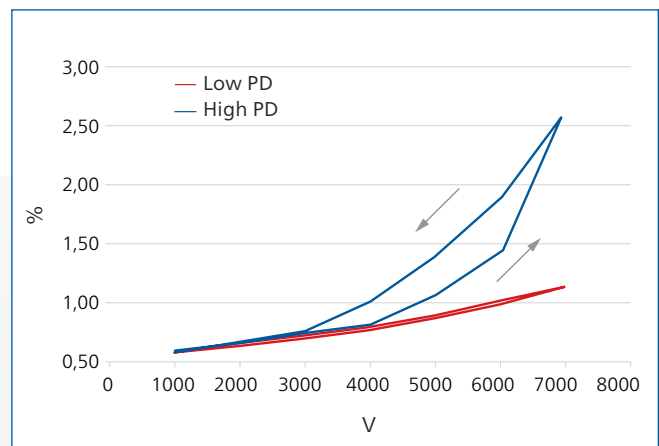
- > A progressive increase of the DF/PF in the curve during the tip up test can be an indication of ongoing PD activity. PD measurement is then recommended to determine the defect type and location.
- > OMICRON recommends to test in an upwards and downwards ramp to give an indication of PD activity (inception and extinction voltage).
- > DF/PF values can be compared to the manufacturer's published data or to prior tests to determine insulation condition changes.
- > Visual inspections can also identify damage caused by defects.



Dielectric losses cause a phase shift.



DF/PF with a fault in phase 1 compared to good results of phase 2 and 3.



The blue line represents a machine with high PD activity (large hysteresis). The red line represents a new machine with low PD activity.

### Why use CPC 100 + CP TD15 + CP CR600?

- > Portable high-voltage test source with C and DF/PF measurement capability up to 15 kV and 6A
- > Resonant circuit (CP CR600 and test capacitance) for testing at rated frequency
- > Fast measurement due to automated test procedures and reporting
- > Detailed analysis due to automated voltage and frequency sweeps

### Why use TANDO 700?

- > High-precision measurements for test labs
- > Maximum safety through complete electrical isolation between acquisition units and the control unit
- > Measuring of grounded and ungrounded test objects also on high-voltage potential
- > Wide measuring input range from 5 $\mu$ A to 1A, and up to 28 A by the use of external shunts
- > Customized reporting with selectable measurement parameters and trends

# Partial discharge measurement

## Which part can be tested?

- ✓ Stator winding
- Rotor winding

## Why measure?

Partial discharges (PD) occur in the insulation system of rotating machines, where the local electric field stress exceeds the local electrical strength. It causes a progressive erosion of insulation materials that can lead to their failure.

Compared with other dielectric tests on rotating machines, the differentiating character of PD measurements allows single weak points of the insulation system to be clearly identified.

PD in rotating machines (e.g. slot discharges or end winding discharges) causes recognizable patterns. Through the pattern analysis, specific root causes can be identified, such as contamination, voids, cracks, aging, or general deterioration of different insulation components.

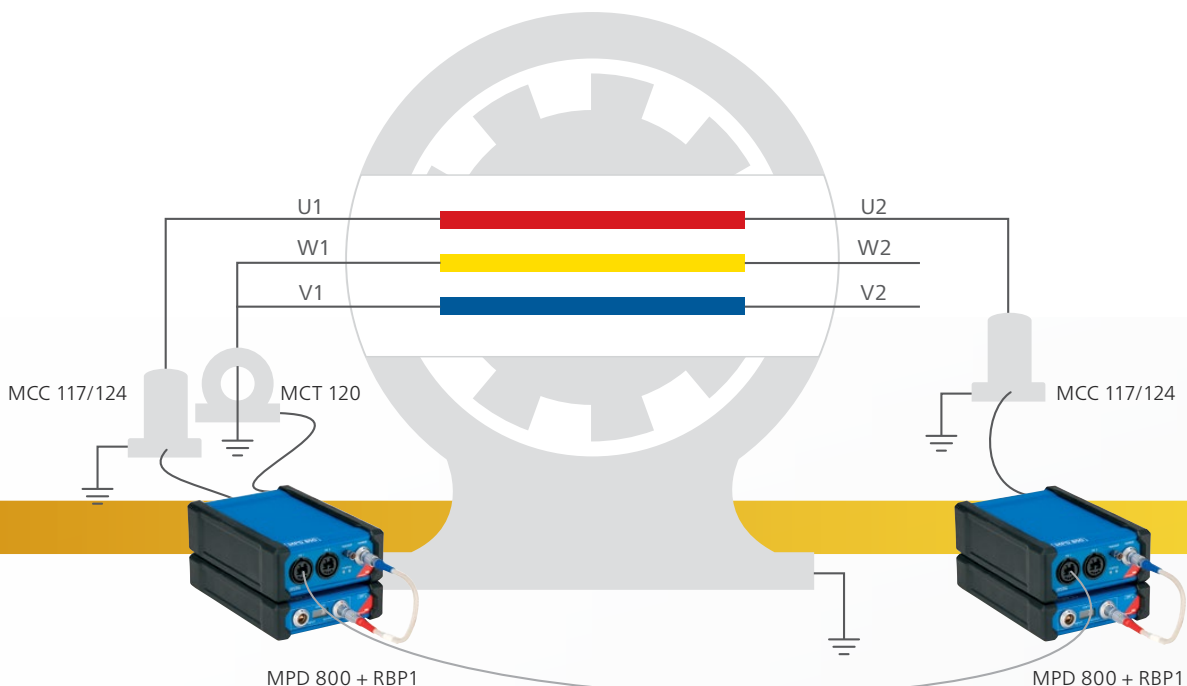
## How does it work?

Off-line PD measurements are performed when the machine is taken out of service and energized with a high-voltage source. A coupling capacitor is connected to the terminals of the machine, which is connected to the PD measurement device.

Depending on whether the star point is accessible, a single-phase measurement can be done. Otherwise a three-phase measurement in combination with source separation techniques enables you to identify PD activity in a specific phase.

Several measurements over time enable a trending of the insulation condition, which is the most powerful way to recognize a fault in its early stage.

There are a number of relevant international standards that specify how to make PD measurements on rotating machines, such as IEC 60034-27.



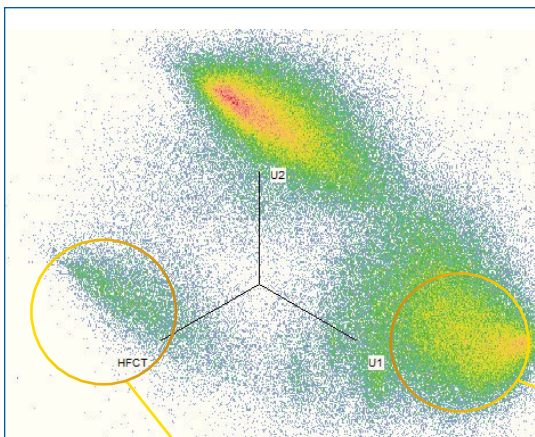
### Good to know ...

- > A combined measurement at the star point (when accessible) and at the terminals enables more detailed analysis.
- > Low filter frequency measurements enable a larger coverage of the windings.
- > Digital, frequency-selective PD measurement systems are robust against external noise and enable advanced diagnostic options.
- > Advanced diagnostic tools, such as 3PARD (three-phase amplitude relation diagram) and 3FREQ (synchronous multi-frequency measurements) are used to separate noise and multiple PD sources for more reliable interpretation.
- > OMICRON suggests the use of a high-frequency current transformer (HFCT) in the grounded, non-measured phases in order to measure cross-coupled signals and to enable the 3PARD option.

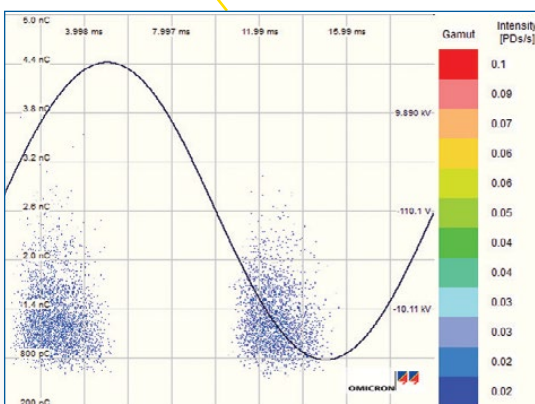
### Why use MPD 800?

- > IEC standard-compliant PD measurements on stator windings
- > Galvanic isolation via fiber optic cables ensures safe operation
- > Synchronous, multi-channel PD measurement and gating capabilities
- > PD data set recording and playback for later analysis
- > Advanced noise suppression and source separation techniques for reliable PD analysis
- > Customizable software allows users to select only the PD analysis tools they need

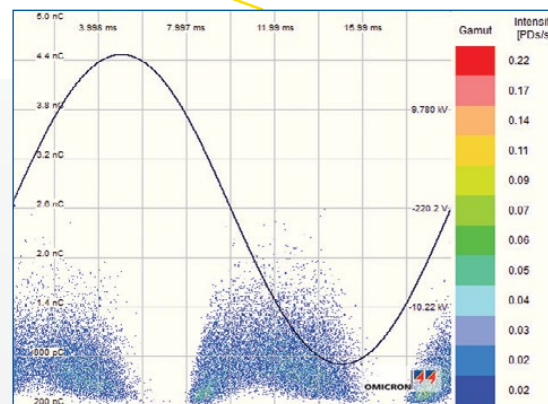
### Source separation with 3PARD



3PARD



PD source 1



PD source 2

# On-line partial discharge monitoring

## Which part can be tested?

- ✓ Stator winding
- Rotor winding

## Why measure?

Compared to routine off-line diagnostic tests, on-line partial discharge (PD) monitoring provides asset managers with continuous insulation condition status while motors and generators are in operation and under the influence of deteriorating forces.

Temporary PD monitoring is used to periodically observe changes in PD activity, whereas permanent PD monitoring continuously assesses PD activity over the entire service life of a machine. Based on the collected data, machine operators are able to decide if and when it is necessary to schedule downtime and perform maintenance.

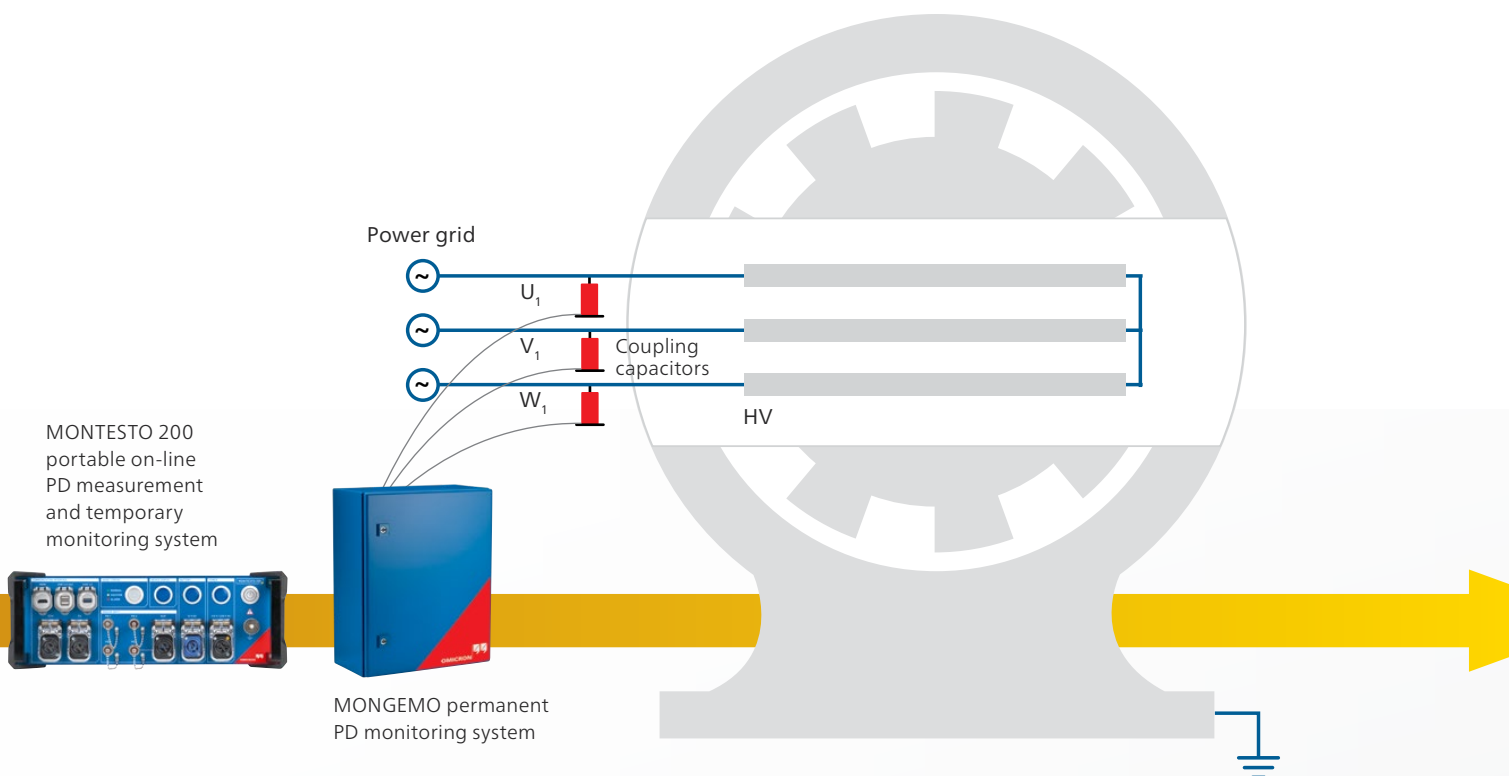
## How does it work?

Coupling capacitors are connected to each phase at the terminals when the machine is off-line. A data acquisition unit is then connected to the coupling capacitors.

A mobile workstation or central computer is connected via fiber optic cable to the acquisition unit for system setup, administration and data access using the software.

A continuous comparison of measured PD values on each phase is made with user-defined thresholds. Warnings and alarms indicate when such thresholds have been exceeded.

IEC 60034-27-2 is a relevant international standard that specifies how to monitor PD on rotating machines.



## Good to know ...

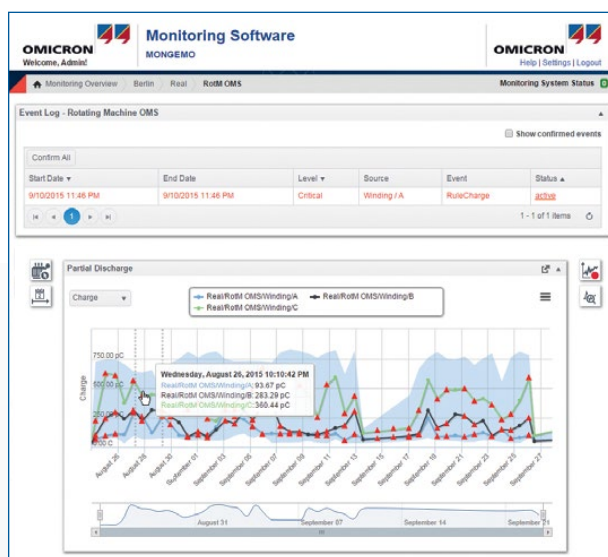
- > On-line PD monitoring does not expose insulation to higher voltage stresses than those encountered under normal operating conditions.
- > For frequent PD testing and monitoring, it is recommended that the coupling capacitors are permanently installed to avoid having to shut down the machine each time. The use of a terminal box enables convenient plug-and-play connections to the acquisition units.
- > Advanced diagnostic tools, such as 3PAR (three-phase amplitude relation diagram), are used to separate noise and multiple PD sources for reliable interpretation.
- > For older machines with increasing PD levels, a permanent continuous monitoring system is recommended to keep a constant eye on the insulation condition state.

## Why use MONTESTO 200?

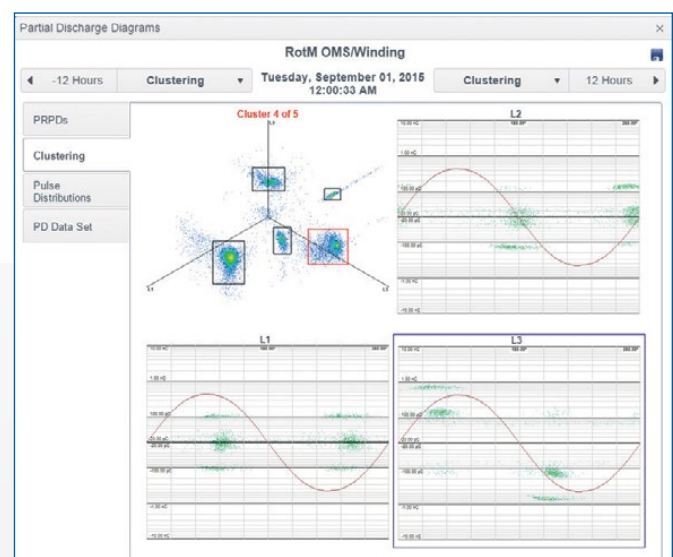
- > Two-in-one solution for on-line PD measurement and temporary monitoring
- > Compact and lightweight for easy transport
- > Designed for indoor and outdoor use
- > Built-in computer for continuous, long-term data collection and archival
- > Web-based interface for convenient remote data access
- > Automated software features for easy PD data analysis and reporting

## Why use MONGEMO?

- > Permanent on-line PD monitoring system for long-term use on single or multiple machines
- > Synchronous, multi-channel PD data acquisition for complete PD assessment
- > Advanced noise suppression and automatic PD cluster separation for convenient evaluation
- > Recording of raw PD data at selected intervals for in-depth post analysis
- > Seamless integration with third-party monitoring devices and SCADA systems



Real-time and historical PD data is displayed for each phase.



Advanced noise and multiple PD source separation techniques for reliable and convenient evaluation and defect identification.

# Voltage withstand testing

## Which part can be tested?

- ✓ Stator winding
- Rotor winding

## Why measure?

To ensure reliable operation, the voltage withstand testing can be used to detect single weak points in the insulation of motors and generators.

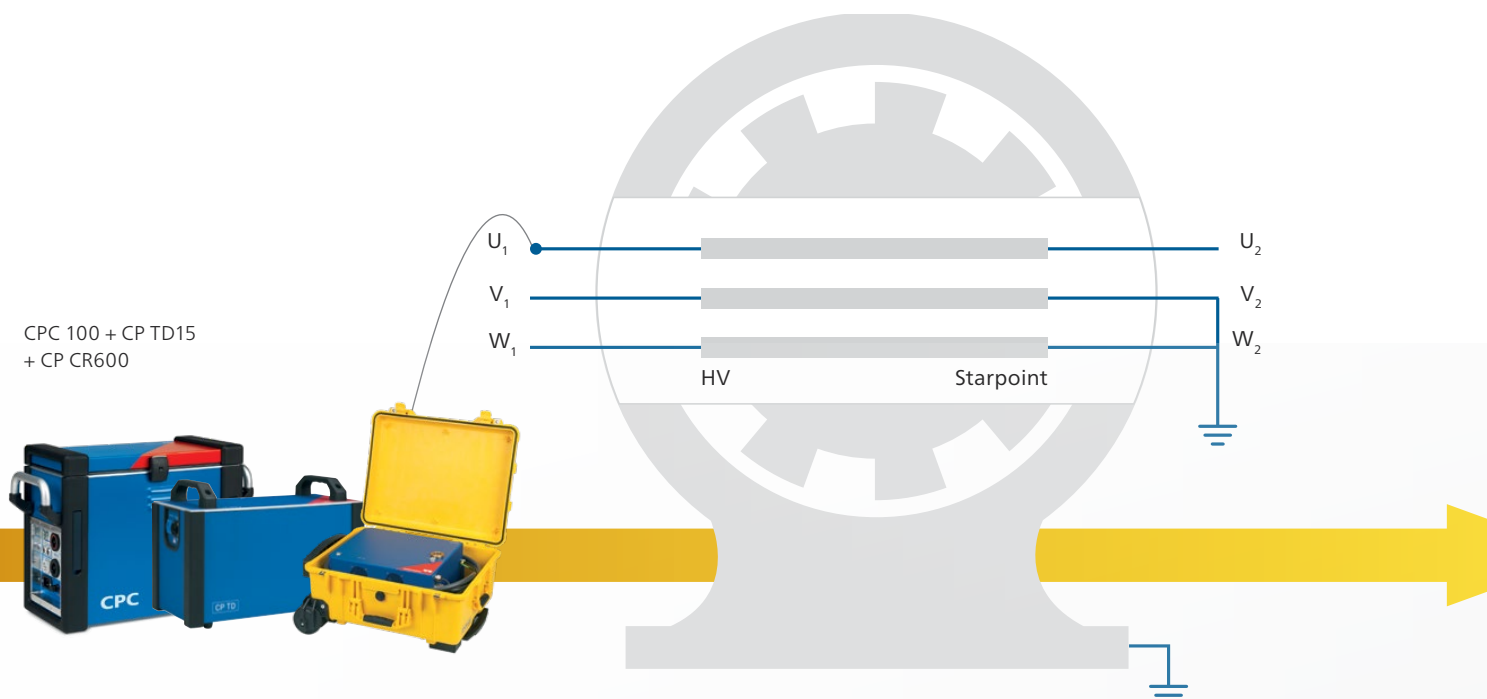
The voltage withstand test is a YES or NO investigation. The inherent withstand capability of healthy insulation is well above the usual proof test value. Failure during a test indicates that the insulation was unsuitable for service.

## How does it work?

An AC test source is applied to energize the windings with a potential much higher than the rated one in increased, ramped steps or steady increments.

The winding insulation passes the test when a certain overvoltage level is withstood without a breakdown.

Voltage withstand testing is defined by the standard IEC 60034-1. The test is performed only on new machines with the full test voltage according to the standard. For in-service machines, the test is performed at reduced voltage levels.

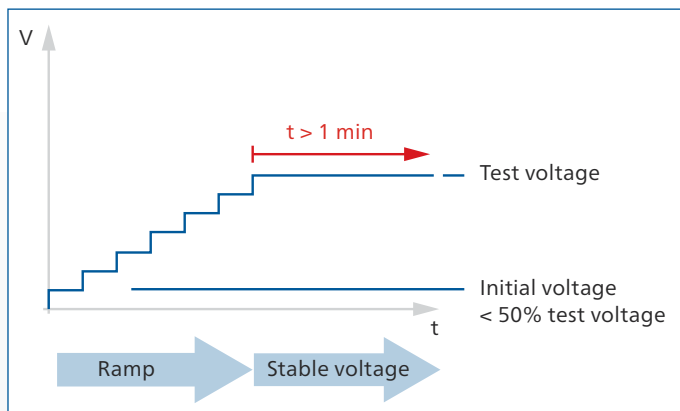


### Good to know ...

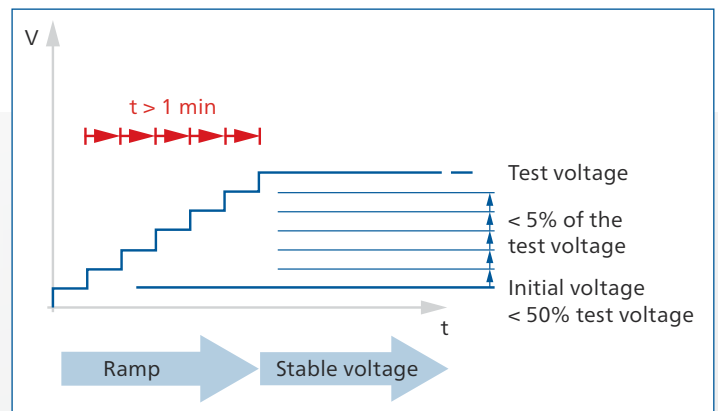
- > If no suitable AC source is available for testing at the rated frequency, a DC source can be used for testing. In this case, the amplitude of the DC voltage is higher than the RMS AC value according to the applicable standard.
- > The potential grading in the winding overhang and the breakdown mechanism are different when using DC instead of AC high voltage excitation.
- > An automatic high-voltage power supply (i.e., ramped voltage test set) can be used to linearly increase the applied voltage from zero up to some maximum value at a constant ramp rate, typically 1 to 2 kV per minute.
- > A good procedure is to check the polarization index (PI) first in order to see whether larger creepage paths already exist.

### Why use CPC 100 + CP TD15 + CP CR600?

- > Detailed analysis due to automated voltage and frequency sweeps
- > Maximum test voltage of 15 kV
- > Fast measurement due to automated test procedures and reporting
- > Modular and mobile system – heaviest component weighs 48 kg
- > Potable HV source for testing at rated frequency



The voltage is increased in a ramp or in steps to the intended test voltage, which is held for at least one minute.



If the voltage is increased in steps, it is recommended by IEC that the sets have to be lower than 5% of the test voltage.

# Insulation resistance, polarization index and dielectric absorption ratio

## Which part can be tested?

- ✓ Stator winding
- Rotor winding

## Why measure?

The insulation resistance (IR), polarization index (PI) and dielectric absorption ratio (DAR) measurements are useful for checking machine windings for contamination and insulation deterioration. They are also useful for evaluating insulation integrity to ensure safe operation, as well as to check for moisture in the stator windings after a long standstill period.

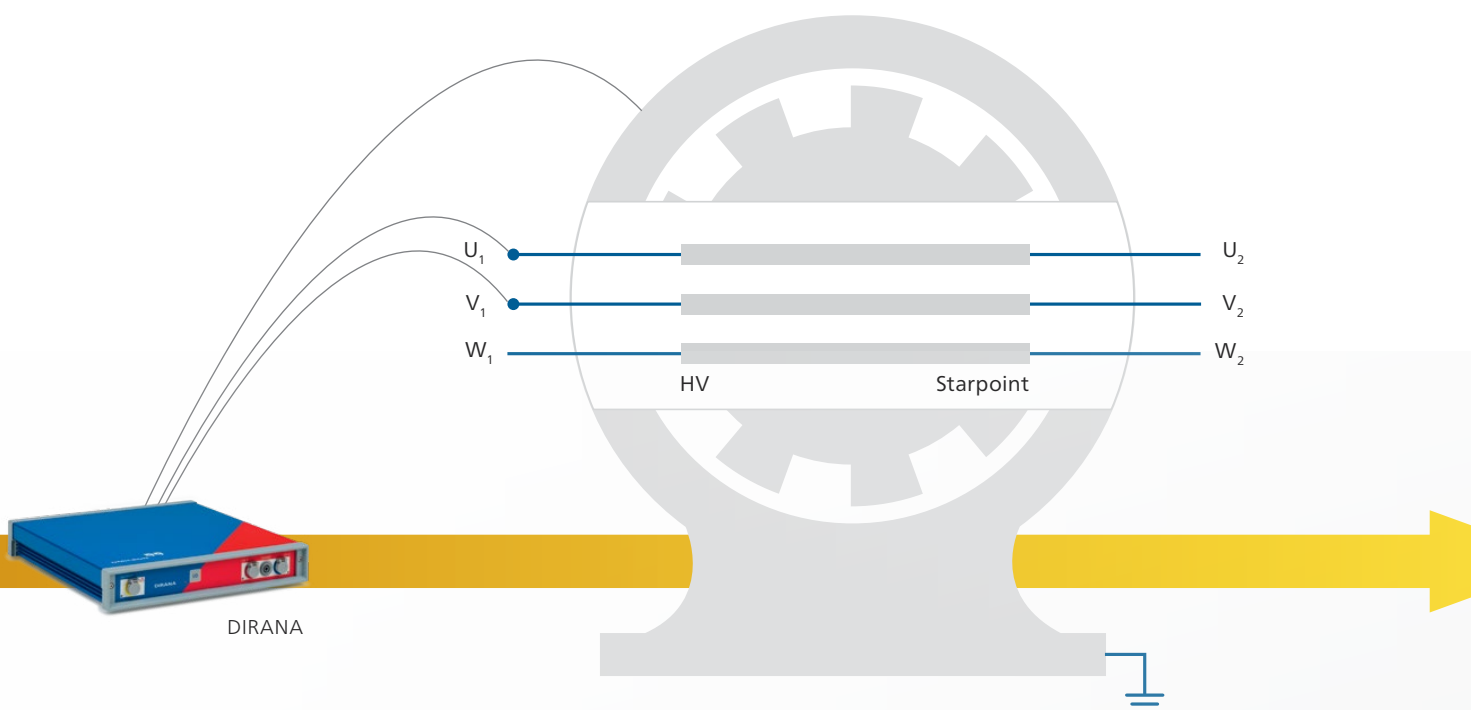
## How does it work?

For the insulation resistance measurement, a constant DC voltage is applied between the copper conductor and ground.

For determining the PI, the IR measurement is performed for 10 minutes. The PI is the ratio of the 10-minute reading divided by the 1 minute reading of the IR value. The DAR is also a ratio of two withstand values over time. Here one often uses the 60-second to 30-second value.

Compared to other phases or previous measurements, lower IR and PI (or DAR) values indicate possible weaknesses in the high-voltage insulation.

IEEE standard No. 43-2000 defines how these measurements should be performed and provides limits for the assessment of the results.





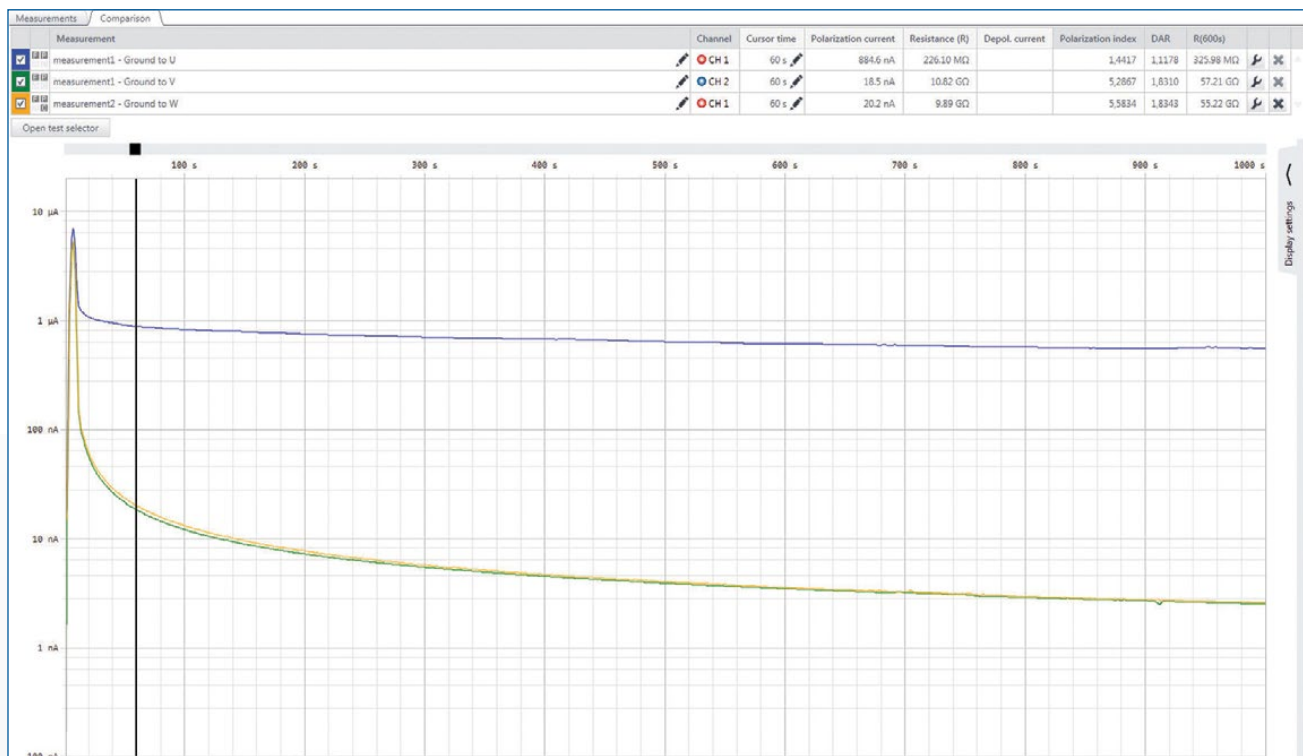
# o measurements

## Good to know ...

- > This is an integral measurement that delivers an overall statement about the insulation condition of the machine, but is no replacement for high potential AC tests (i.e. C, DF/PF or PD).
- > Pre-polarization, resulting for example from previous IR and PI measurements, may affect results. To prevent this, ensure a proper time interval (at least as long as the measurement itself) before subsequent measurements.
- > By measuring the dielectric response, the IR, PI and DAR are also determined.

## Why use DIRANA?

- > Automatic measurement of dielectric response, insulation resistance and polarization index
- > Simultaneous measurements on two phases
- > Connection diagrams help you find the optimal measurement configurations; show you the correct measurement scenarios
- > Pre-polarization check enables reliable measurements
- > High accuracy and safety by using low test voltages



IR resistance with a fault in phase U.

# DC resistance measurements

## Which part can be tested?

- ✓ Stator winding
- ✓ Rotor winding

## Why measure?

DC resistance measurements are performed, to detect possible contact problems in the stator and rotor windings of rotating electrical machines.

Connection problems can occur between single coils or bars of the winding or at the pole connectors in the rotor. They cause local hotspots, which can eventually damage the machine.

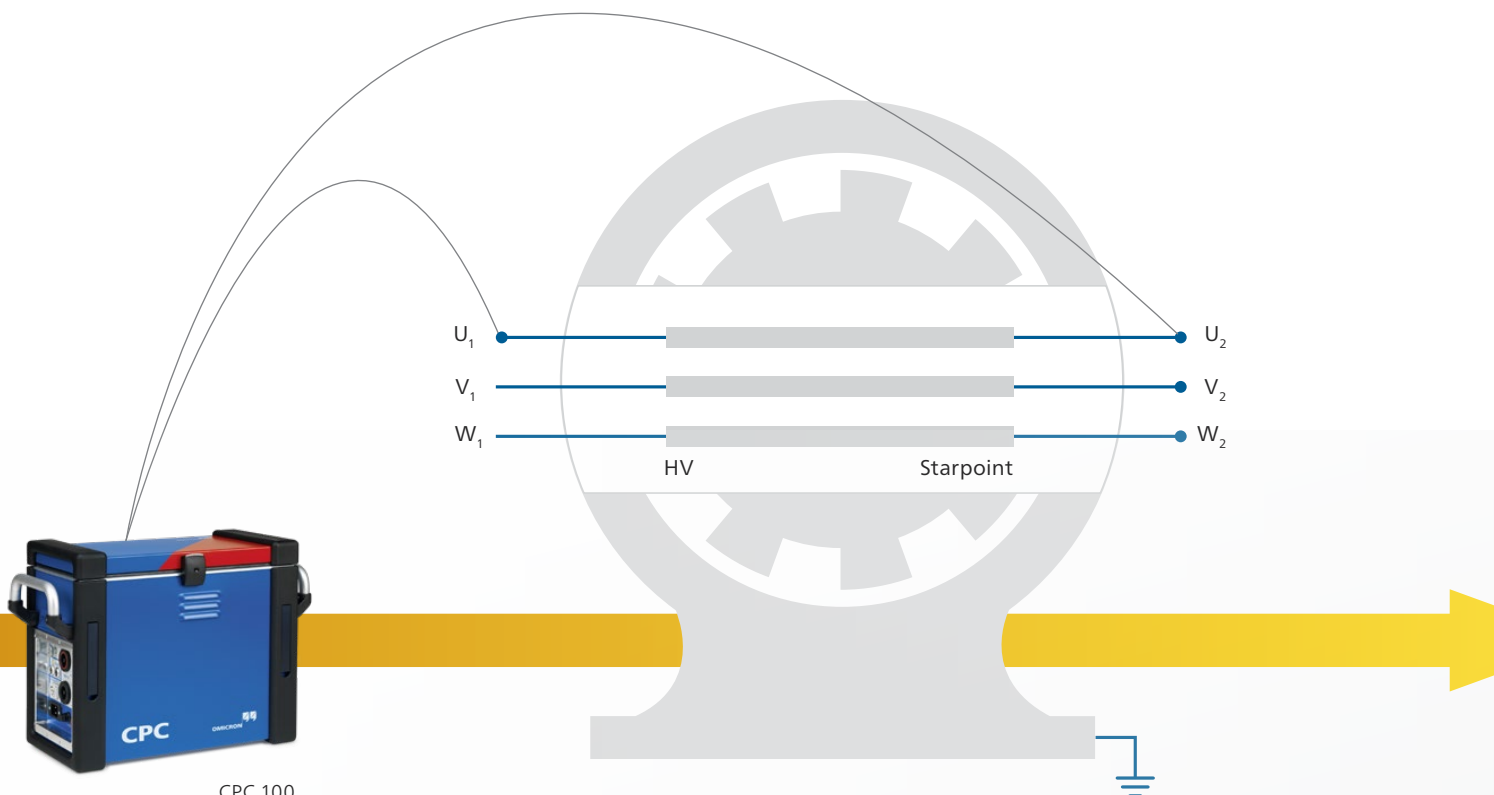
The typical origins of these faults include bad soldering contacts, which become weaker through operation, or loose connections as well as oxidized or damaged surfaces on machine pole connectors.

## How does it work?

To measure DC resistance, the measuring instrument is connected to the outputs of the machine. The DC current and DC voltage are measured at the same time for each phase and the resistance is calculated.

The data shows a comparison between the phases to previous measurements. A variation indicates a potential contact problem.

For measurement of the contact resistance, e.g. on pole connectors, a high DC current is injected between the contacts. Also in this case, the measurement is compared with other measurements or with previous data.



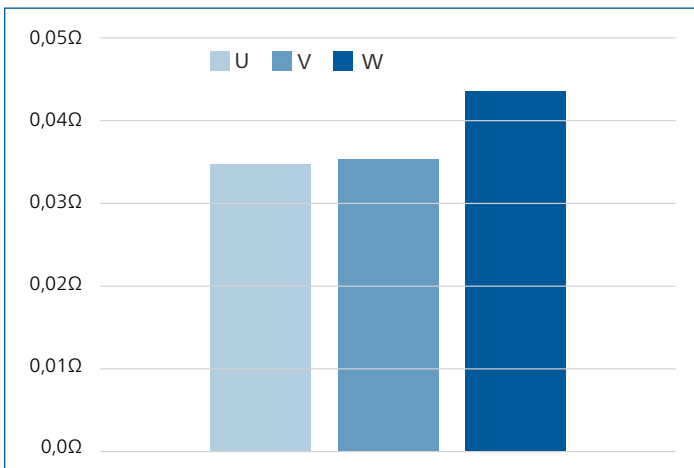
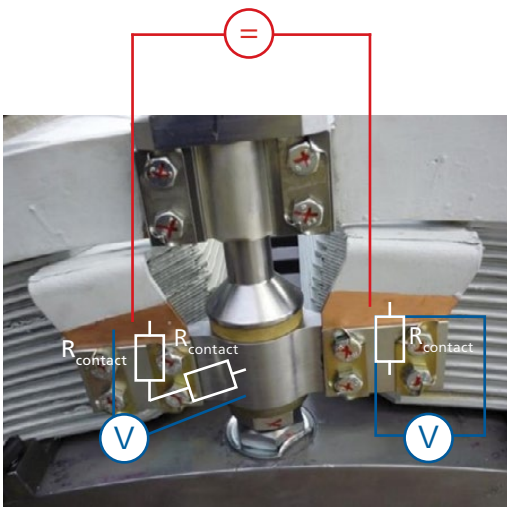
CPC 100

### Good to know ...

- > A four-wire measurement enables the most reliable results and minimizes the influence of the test setup.
- > As the measurement is a comparative method, the resistance values must be temperature corrected in order to compare the results.
- > Inspections with a thermal camera can be used to confirm the results. A high current is applied and a visual inspection with a thermographic camera reveals where the hot spots are located.

### Why use CPC 100?

- > Multifunctional device applicable for most routine electrical tests on rotating electrical machines
- > Up to 400 A DC and 5 kVA for resistance measurements down to the microhm range.
- > Easy to transport (29 kg) for on-site testing
- > Testing templates, automatically generated testing procedures and test reports



Winding resistance measurement with 100A (phase W with bad soldering contact).



Repair of defective soldering contact

# Pole drop testing

## Which part can be tested?

- Stator winding
- ✓ Rotor winding

## Why measure?

Mechanical stress in rotor windings cause inter turn faults (short circuits), which can lead to a magnetic imbalance. This causes higher shaft vibrations and, as a result, higher stress and damage to the bearings.

Similar to sweep frequency response analysis, the pole drop test is performed on single-pole rotor windings to detect inter turn faults.

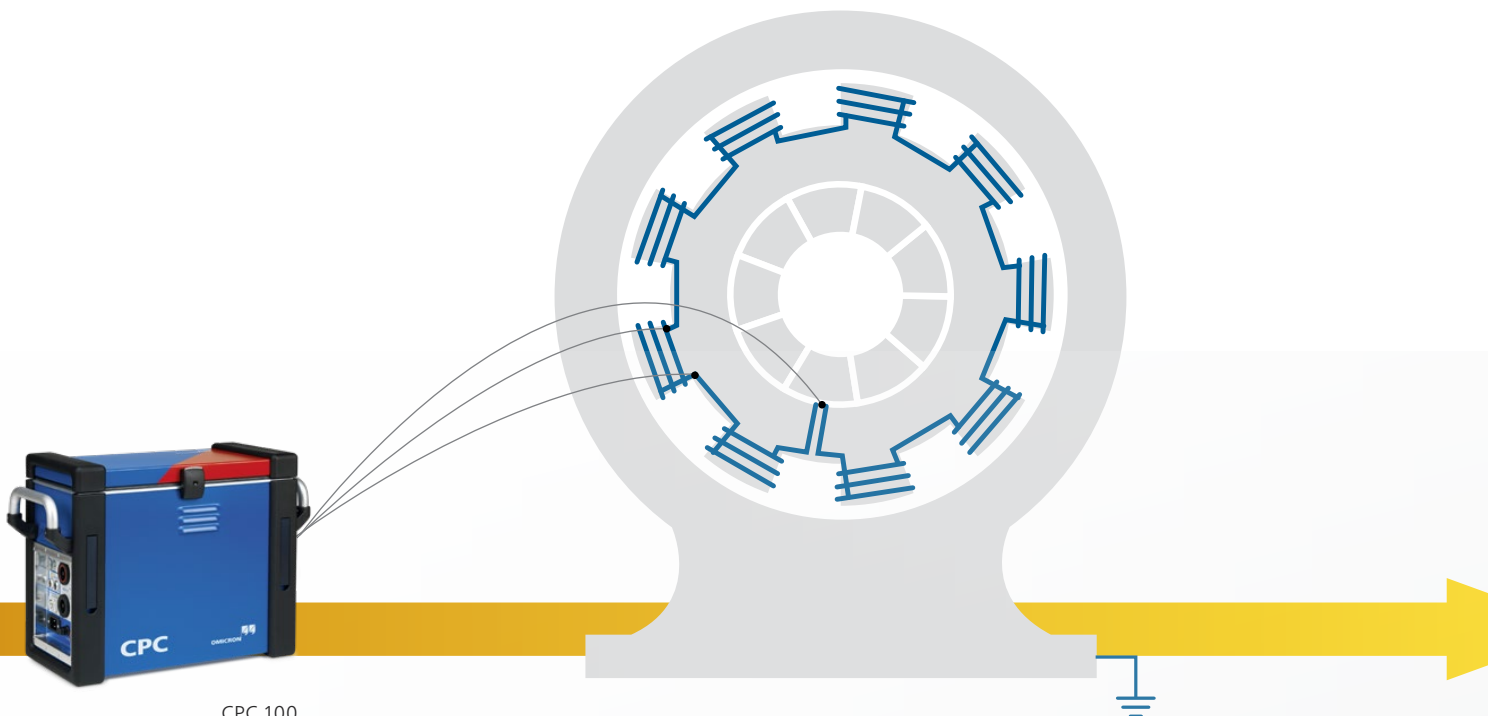
This is a simple comparative test performed during factory acceptance testing, routine maintenance inspections or during refurbishments of rotating machine pole winding.

## How does it work?

A pole drop test is performed when the generator is in a standstill condition. An AC current is injected into the slip rings to energize the pole windings.

By measuring the voltage drop of every pole between the pole winding connectors, the impedance can be determined. A comparison of the measurement results of each of the poles or with previous measurements identifies possible inter turn faults in the pole winding.

A pole with an inter turn fault shows a significant lower voltage drop (or lower impedance) than the average value of the healthy poles.



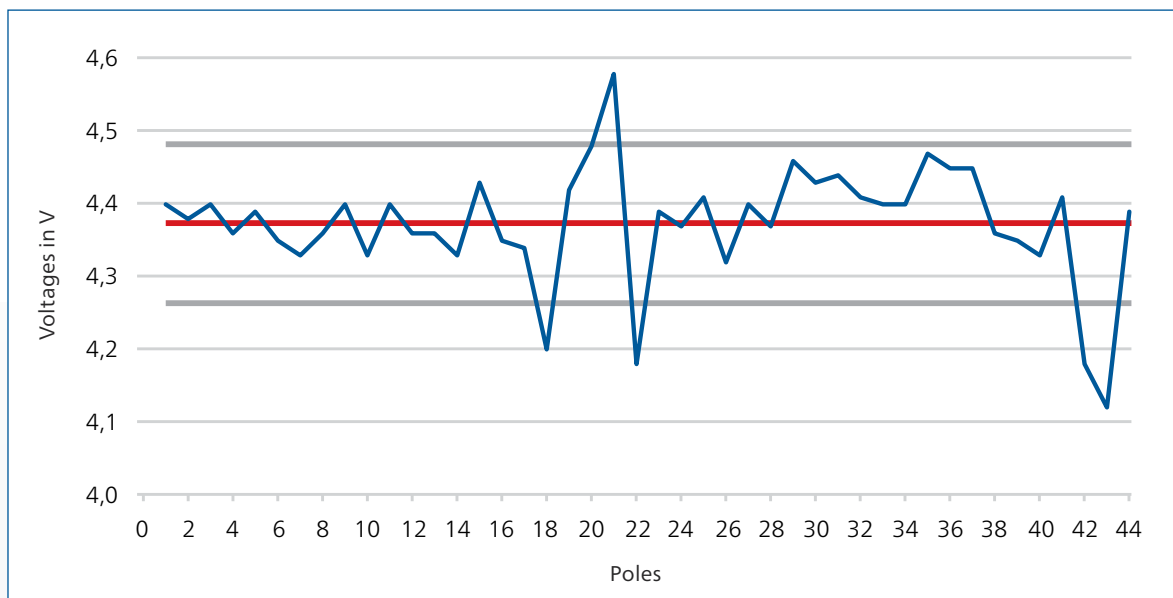
CPC 100

### Good to know ...

- > The impedances of each pole should be compared with one another. Also a comparison with previous measurement results is possible. Based on OMICRON experience, a  $\pm 2.5\%$  difference from the average is an indication of a fault and should be investigated.
- > The values can change especially for removed rotors depending on their position. This also applies to machines where the upper part of the stator is removed.
- > Potential inter turn faults resulting from centrifugal forces cannot be detected as the rotor winding is at standstill during testing.

### Why use CPC 100?

- > Multifunctional device applicable for most routine electrical tests on rotating electrical machines
- > Easy to transport (29 kg) for on-site testing
- > Testing templates, automatically generated testing procedures and test reports



The red line indicates average value. Not all measurement values are in the acceptable range within  $\pm 2.5\%$  of the average value. This indicates suspected inter turn faults.

# Sweep frequency response analysis

## Which part can be tested?

- ✓ Stator winding
- ✓ Rotor winding

## Why measure?

Sweep frequency response analysis (SFRA) is performed to detect inter turn faults caused by mechanical stress in the pole windings of machines during factory acceptance testing or during routine maintenance testing. It can also be used for detecting inter turn faults in the stator windings.

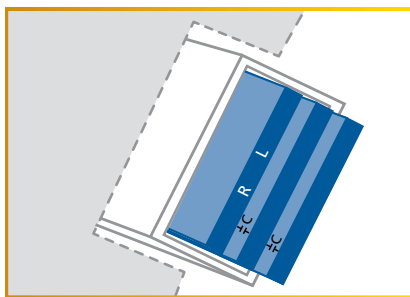
## How does it work?

The electrical circuit in the stator as well as the rotor can be assumed to be a complex electrical network of capacitance, inductances and resistors with its own frequency response. Any defects in the windings result in a change of the network and the corresponding frequency response. Measuring this frequency response enables the detection of the fault.

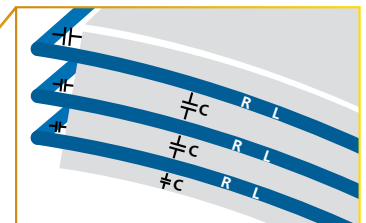
A sinusoidal signal is applied at the input of the electrical network.

Both the amplitude and the phase shift of the output signal are measured.

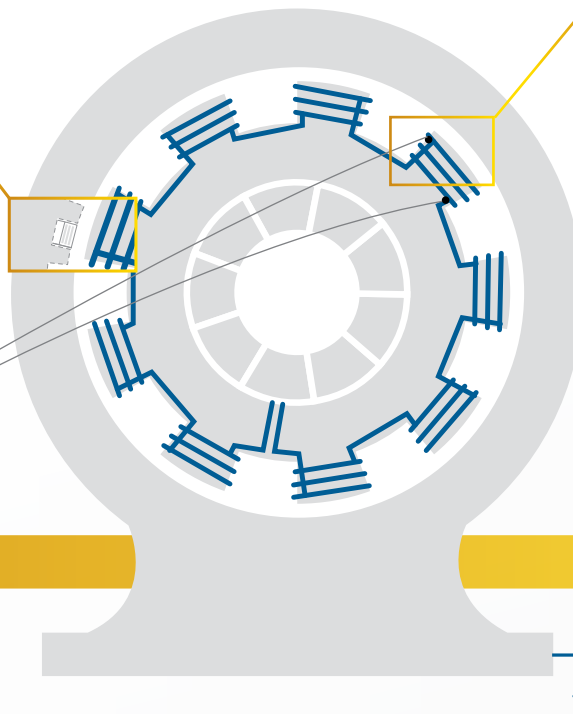
The frequency response is determined by comparing the amplitude and phase of the input and output signals. The values deviate between different poles or between previous measurements when inter turn faults change the behavior of the frequency response.



Sweep frequency response analysis (SFRA) enables inter turn fault detection in stator windings.



SFRA also allows reliable rotor winding diagnosis for rotating machines.



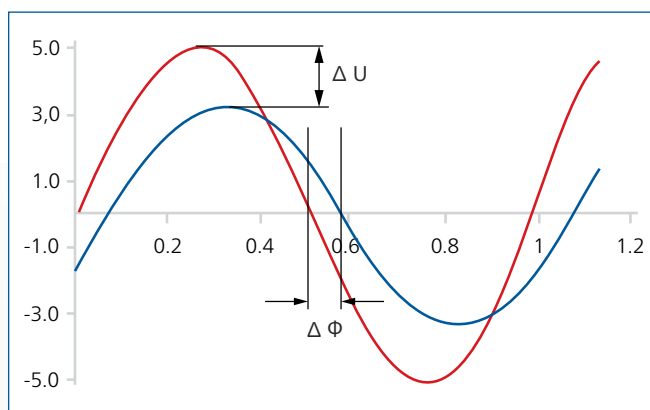
FRANEQ 800

### Good to know ...

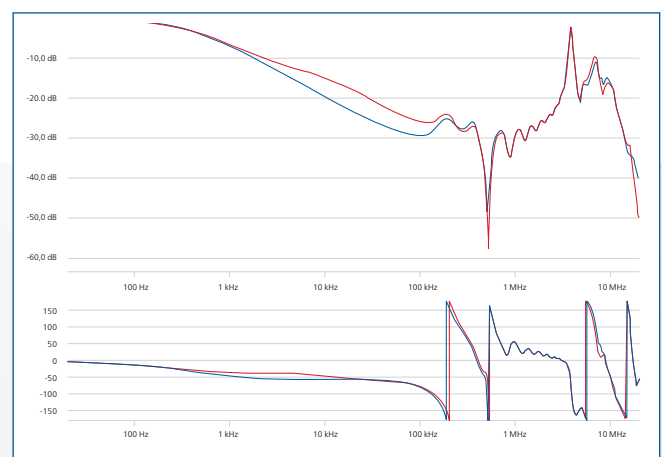
- > The SFRA method was developed to detect mechanical deformations of transformer windings and is also used for inter turn fault detection in the windings of rotating machines.
- > With surge testing, an injection may be required from both sides of the winding. This is not needed for the SFRA measurement.
- > For measurements on poles: As this is a comparative measurement, be aware that if the upper part of the machine is missing, there will be a difference between the upper and lower poles, depending on their position, as well as to previous measurements.

### Why use FRANEO 800?

- > Highest dynamic range in SFRA testing industry (> 150 dB)
- > Higher accuracy ( $\pm 0.5$  dB down to -100 dB)
- > High sensitivity enables reliable results with maximum safety at low voltage levels
- > Adjustable output voltage
- > Software support for automatic result analysis, comparisons and customized reporting



Measurement principle



The blue line references the healthy pole; the red line indicates pole with inter turn fault, where one turn is bridged.

# Dielectric response analysis

## Which part can be tested?

- ✓ Stator winding
- Rotor winding

## Why measure?

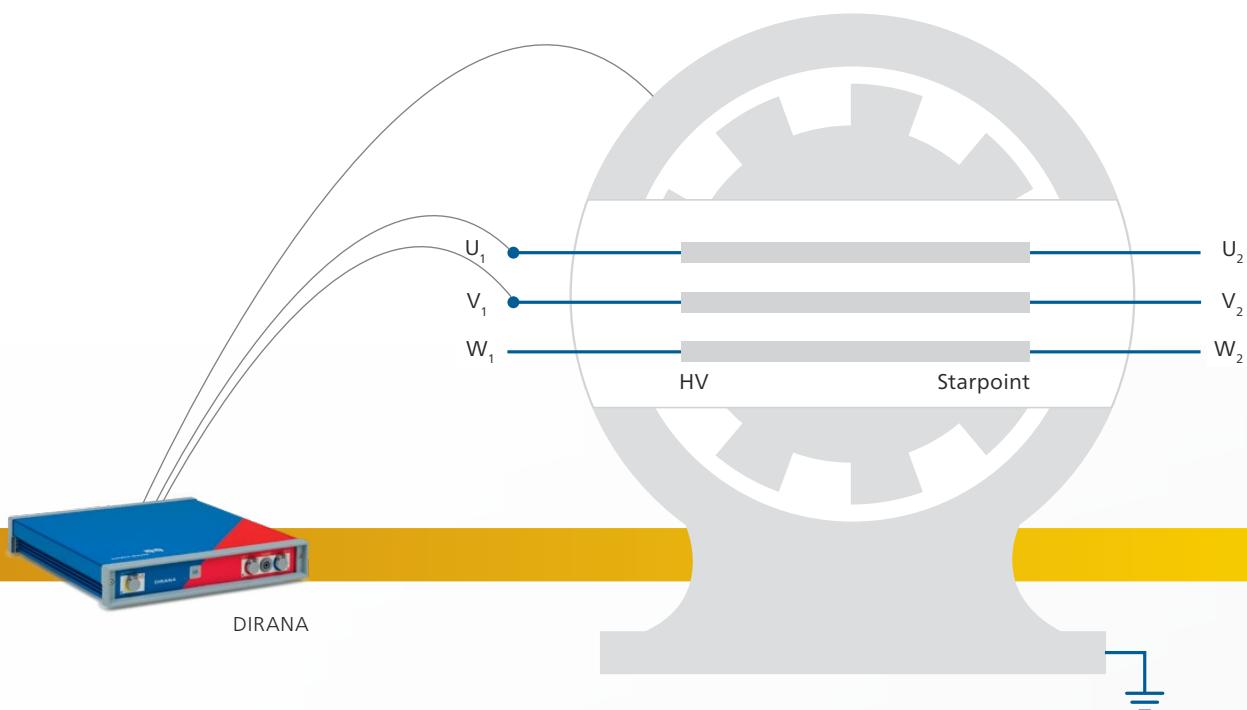
Dielectric response analysis of rotating machines assesses the condition of machine insulation, such as contamination, deterioration and insulation integrity. It also detects moisture after a long machine standstill.

## How does it work?

The dielectric response analysis determines the dielectric properties of an insulation in a very broad frequency range ( $\mu\text{Hz}$  to  $\text{kHz}$ ). This makes it very sensitive for detecting a variety of insulation defects.

Usually the phase-to-ground of the stator insulation is measured on rotating machines. The output voltage is applied to the ground, and one or two input channels are connected to the phase(s).

The assessment of the measurement can be performed by using absolute values, such as capacitance or dissipation factor/power factor (DF/PF), etc., or by comparing the dielectric response curves of different phases.



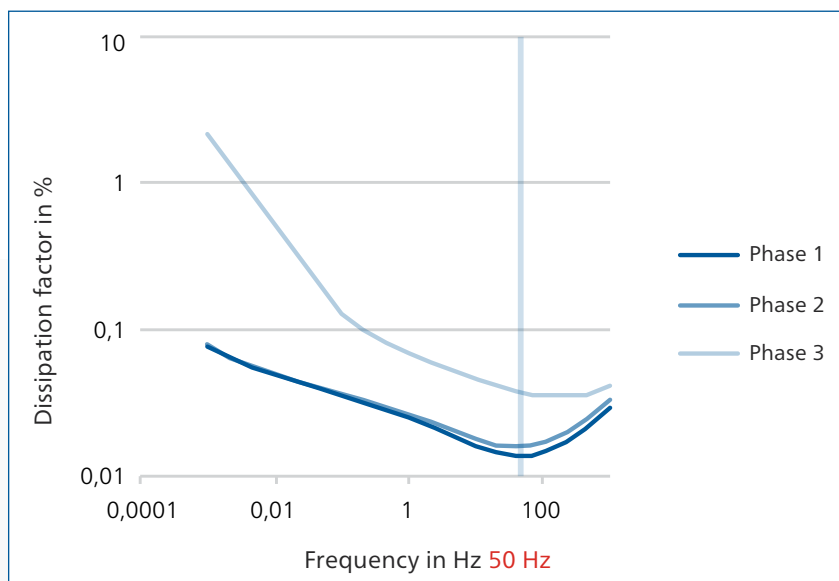


### Good to know ...

- > Dielectric response analysis is performed at relatively low voltages. This allows fast on-site testing. On the other hand, dielectric response analysis does not replace PD measurement. It simply detects certain damages resulting from PD, but it cannot detect PD on its own.
- > Creepage paths are easier to detect at lower frequencies. Therefore dielectric response analysis is more sensitive to detect creepage paths compared to DF/PF measurements at line frequency.
- > By measuring the dielectric response, the polarization index (PI) and insulation resistance (IR) is also determined.
- > Before starting the measurement, it is recommended to check the insulation for pre-polarization as this could influence the measurement results. Pre-polarization can be caused by prior DC tests (like insulation resistance, etc.) or by a previous PDC measurements on other phases.

### Why use DIRANA?

- > Dielectric response is measured within a wide frequency range
- > Automatic measurement of dielectric response, insulation resistance and polarization index
- > Simultaneous measurements on two phases
- > Connection diagrams help you to find the optimal measurement configurations; show you the correct measurement scenarios
- > Pre-polarization check enables reliable measurements
- > High accuracy and safety by using low test voltages



Dielectric response analysis with a fault in phase 3.

# Electromagnetic imperfection testing

## Which part can be tested?

- Stator winding
- Rotor winding
- ✓ Stator core

## Why measure?

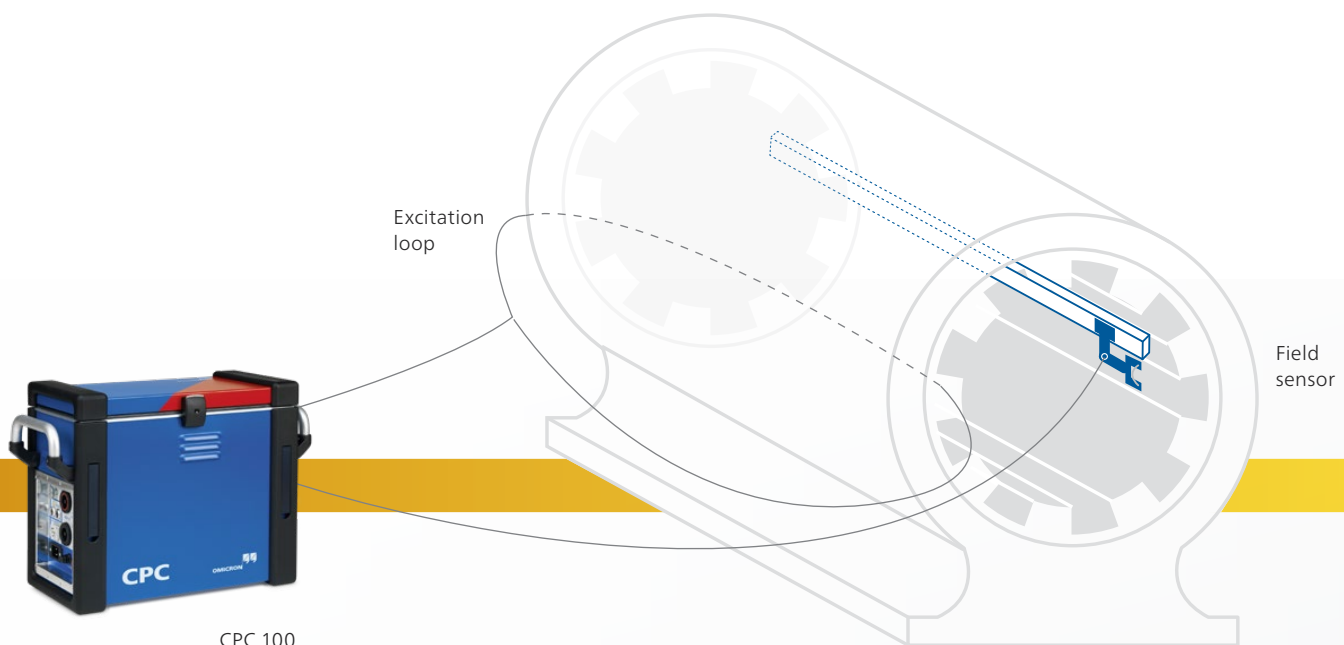
Stator cores are made of thin stacked laminated steel segments, insulated against each other by a layer of varnish to minimize losses. If lamination shorts occur, a loop current causes local hot spots, which can cause a partial melt down in the machine.

The electromagnetic imperfection test is performed to test for stator core inter-lamination imperfections that cause heating and damage during machine operation.

## How does it work?

The electromagnetic imperfection test is conducted offline during bigger maintenance shutdowns. To perform this test, the rotor is pulled out completely. The core is energized with a small percentage of nominal flux and the stray flux on the surface is measured along the slots with the measurement device.

Differences in the measurement results can indicate hot spots. Since the fault is creating imperfections in the magnetic circuit of the core, these can be determined by an increase of the stray flux in amplitude and a change in the phase.



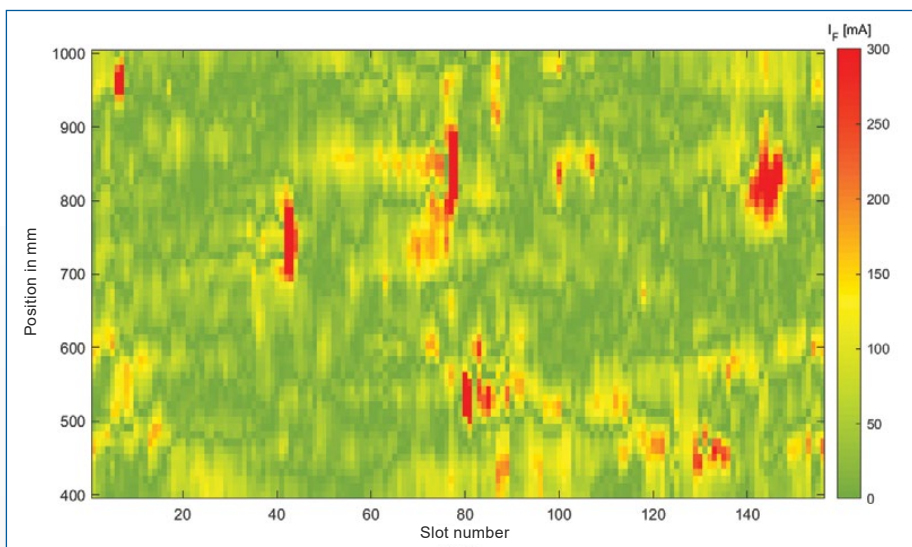
CPC 100

### Good to know ...

- > This test is recommended to investigate the core after previous problems and as a routine test to evaluate the integrity of the insulation between the core layers.
- > Compared to conventional thermographic tests, this test requires a very small amount of energy, which makes it less of an effort to perform.
- > The electromagnetic imperfection test offers the possibility to visualize potential inter core faults at the slot wall or at the slot base.
- > A reference measurement can be done to give the tester an idea about the amount of injected flux in order to reproduce the measurement in the future.

### Why use CPC 100?

- > Semi-automatic scanning of the stator core
- > Measurement and excitation in one solution
- > Frequency-variable injection from 15 to 400 Hz
- > User-friendly work flow using Primary Test Manager (PTM) software
- > Automated reporting including results, graphs and heat map
- > Easily extendable excitation cable to meet specific measurement requirements
- > Multi-functional CPC 100 meets additional testing needs



A heat map with adjustable limits provides you with a visual overview of hot spots in the stator.

We create customer value through ...

## Quality

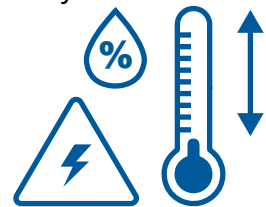
We always want you to be able to rely on our testing solutions. This is why our products have been developed with experience, passion and care and are continually setting groundbreaking standards in our industry sector.



You can rely on the highest safety and security standards

Superior reliability with up to

72



hours burn-in tests before delivery

100%

routine testing for all test set components



ISO 9001  
TÜV & EMAS  
ISO 14001  
OHSAS 18001



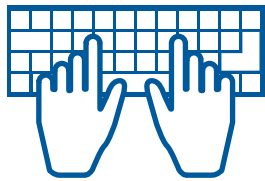
Compliance with international standards

## Innovation

Thinking and acting innovatively is something that's deeply rooted in our genes. Our comprehensive product care concept also guarantees that your investment will pay off in the long run – e.g. with free software updates.

More than

200



developers keep our solutions up-to-date

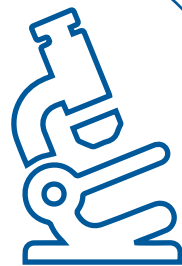
I need...



... a product portfolio tailored to my needs

More than

15%



of our annual sales is reinvested in research and development

Save up to

70%



testing time through templates, and automation

We create customer value through ...

## Support

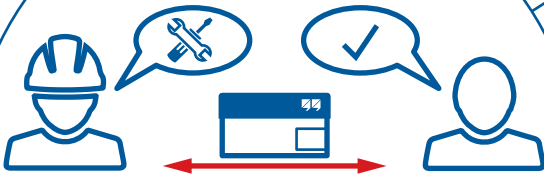
When rapid assistance is required, we're always right at your side. Our highly-qualified technicians are always reachable. Furthermore, we help you minimize downtimes by lending you testing equipment from one of our service centers.



Professional technical support  
at any time



Loaner devices help to  
reduce downtime



Cost-effective and straight-  
forward repair and calibration



25

offices worldwide for local  
contact and support

## Knowledge

We maintain a continuous dialogue with users and experts. Customers can benefit from our expertise with free access to application notes and professional articles. Additionally, the OMICRON Academy offers a wide spectrum of training courses and webinars.



Frequently OMICRON hosted user meetings, seminars and conferences

More than

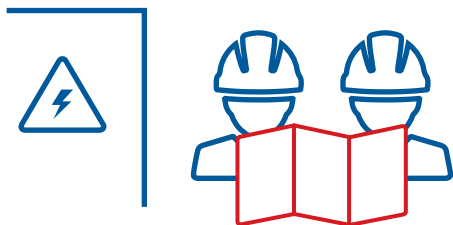
300



Academy and numerous hands-on trainings per year



to thousands of technical papers and application notes



Extensive expertise in consulting, testing and diagnostics

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

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

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

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

