

For legal certainty
in wind energy

Megger[®]

All electrical tests
from a single
source



Reliably at your side in any situation

To meet the difficult challenges faced by our customers in the wind energy sector, we offer all electrical tests from a single source. This means you benefit from the only expertise of this kind in the world.

We offer a test system capable of performing all electrical tests in a wind farm. This tester can perform all tests according to DIN VDE 0100/DGUV regulation 3, or according to ONORM for your medium voltage switchgears and power cables, and also according to the appropriate seminars.

All test equipment needs to be as light, small and compact as possible, while maintaining safety standards, in order to be portable and able to perform the challenging tests that are needed in the field, such as in wind turbines, narrow nacelles and steel tubes.

Experts must be able to take their test equipment with them wherever they are in any situation. It must be compact, robust and intuitive to operate so that it can be used immediately without a long training period. It should support the user with useful convenience functions. And finally, it should feature internal data storage for clear, meaningful and legally compliant audit logs.

Through our range of seminars across Germany, we can provide you with information on every technical consideration, all legal and normative requirements and general conditions — **for your security of supply**





All electrical tests from a single source

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Megger is a world-leading premium manufacturer of measurement and test systems for the electrical industry. Our brand name derives from 'megohmmeter' and was registered in 1903 under trademark law, although the first portable insulation tester carried the Megger name as early as 1889. In the field of measuring and testing technology for the electrical industry, we are therefore the longest-running manufacturer in the world. This means that our megohmmeter is... **the original!**



Precision multi-functionality
at the highest level



Testing electric motors and generators

MTR105

Handy multi-functional tester

The MTR105 enables you to check every important parameter of generators and electric motors in the wind energy plant. With stable test voltages from 50 V to 1000 V, you can not only test for good/bad, but also evaluate the long-term quality of the insulation with time-controlled PI, DAR diagnostics. With the blue guard terminal (G), you can effectively avoid leakage currents on contaminated housings. This is a very useful function in, for example, older wind turbines located near coasts, where salt-containing crusts form on the enclosures.

The outer case is almost indestructible and is weatherproof according to IP54, including the battery and fuse compartments. It is suitable for virtually any application situation. Shock-absorbing rubber overmoulding provides protection and grip. The scope of delivery includes all required test leads as well as (Kelvin) terminals and test probes for the insulation tests.

- Three-phase insulation diagnostics with temperature correction and measurement
- Guard terminal ensures precise measurement results even in contaminated enclosures
- Voltage meter AC, DC, TrueRMS
- Four-wire low-ohm measurement (Kelvin)
- Continuity and diode test
- Motor rotation direction with phase sequence
- Distinguishes between capacitive, inductive and resistive charging states
- Detects live lines and immediately blocks the measurement for safety reasons



About the rotating machines in wind turbines

The nacelle of a wind turbine contains several rotating electrical machines. The powerful generator, for example, which generates 400 V AC voltage from the rotor rotation. The strong azimuth motor driving the large rolling bearing which rotates the entire turbine into or out of the wind. Or the electric pitch systems that change the angle of the blades.



Checking contact connections

MOM2

Handy micro-ohmmeter with up to 220 A test current

When it comes to choosing the right micro-ohmmeter, ease of handling is a key factor. For example, when working at higher altitudes (such as in the nacelle of a turbine), on load isolating switches, on busbars or when working in confined spaces. Compact in design and weighing just 1 kg, you can take MOM2 with you wherever you go. The 220 A test current means you will learn much more about the fault than with the 100 A required by the standard.

Thanks to the battery, you can work for a full day without having to connect to the mains. The measurement memory collects your results during the day, which you can then evaluate later comfortably and safely with MOM2 Win on a PC. Megger's Supercap technology in the MOM2 has enabled the development of the world's smallest and lightest micro-ohmmeter. A huge benefit when it comes to safety, efficiency and work ergonomics.

- **Weight approx. 1 kg** (without test leads)
- **Battery operation**
- **Measurement memory**
- **Up to 220 A test current**
- **MOM2 Win logging software**
- **Safe testing with DualGround**
- **Automatic range selection: 1 $\mu\Omega$ to 1000 m Ω**
- **Bluetooth® for PC communication**
- **Complies with all IEEE and IEC standards**
- **Extensive range of accessories**



About the contact connections in turbine machines in wind turbines

All contact connections within the turbine must be low-resistance enough to prevent devastating fires after heat formation. For this very important test, the standard requires at least 100 A. The handy MOM2 micro-ohmmeter is something really special — it offers 220 A of test current and weighs just under 1 kg! This makes it ideal for use at the very top of the nacelle.



Tests according to VDE 0100/0105, DGUV regulation 3/ÖNORM OVE E 8001

MFT1845

Handy multi-functional tester

MFT1845 is future-proof and meets all requirements according to DIN VDE 0100 or ÖVE E 8001. The unit is ideal for single-phase and three-phase systems and it comes fully protected with a tough outer case. The measurement functions offer you a two- and three-wire loop resistance test without FI/RCD triggering for fast, repeatable results, and a comprehensive test of FI/RCD switches, including type B and the latest current probe measurement methods for stake-less earth testing.

MFT1845 provides you with an internal memory with Bluetooth communication for the simple creation of test reports. The device is designed for harsh environmental conditions and uncompromising reliability. This is ensured by the impact-resistant rubber protective cover. Additional protection is provided by the outer case, which is IP54 rated against dust and humidity. The unit itself provides electrical safety according to EN61010 CAT IV.

This device class features a unique input protection, cannot be damaged by unintentional operating errors and can even survive high voltage transients. The modern design enables safe operation in wind turbines and at high altitudes with the device strapped to the body, leaving your hands free.

About the tests according to VDE0100/DGUV regulation 3

Every operator of electrical systems (e.g. wind turbines) must carry out an initial test according to VDE 0100-600 and, after modifications according to VDE 0105-100, define the time limit and scope of the repeat test by means of a risk assessment. According to § 49 EnWG, VDE standards have legal status. The DGUV, on the other hand, is a set of rules for persons insured against accidents and members of professional associations. Violations will result in the loss of insurance benefits.

- Can be operated with safety gloves
- All functions are visible at a glance thanks to colour-coded rotary switches and large, illuminated display
- Two- and three-wire loop resistance testing without FI/RCD triggering for reproducible results
- Rotating field test
- Type B and B+ FI/RCD and two-pole FI/RCD tests without N or PE for industrial applications
- Earth resistance measurements, two- and three-pole, as well as with one or two current clamps
- Practical convenience functions and left/right operation support hands-free working
- Convenient logging software



Testing earthing systems

DET24C Handy earth clamps

DET14C and DET24C represent a new generation of earth clamps for measuring resistance in an earthing system. These current clamps induce a voltage into the loop and measure the current that flows in the earthing system. The resistance of the earth loop can be determined from this. This allows you to measure the resistance in earthing or lightning protection systems.

The novel, elliptical design of the jaw and the short jaw body allow you to safely cover round or even flat earth connections. The use of flat jaws prevents dirt build-up on the clamp and ensures measurement accuracy and reliability in practice. The advanced features, ease of use and CAT IV 600 V measurement category are further outstanding features. The DET24C earth clamps feature a measurement memory and a Bluetooth interface.

- **Measurement of the earth loop resistance from 0.05 Ω to 1500 Ω**
- **Leakage current measurement from 0.02 mA to 35 A**
- **Maintenance-free, flat jaw**
- **Elliptical jaw shape, opening 40 mm**
- **Measurement memory and interface for convenient logging**



About the earth resistance in turbine machines in turbines

Earth resistance measurement is a fundamental test in every wind turbine. It is the only way to prove the effectiveness of the foundation earth electrode. In most cases, the earth resistance measurement is not carried out, although it is generally required for all network forms by various regulations. For example, the earth resistance measurement must be carried out according to DIN 18014 directly after the foundation earth electrode has been manufactured, or according to the lightning protection standard DIN VDE 0185-305-3 when the lightning protection system is being built.



Lightning protection systems

DLRO10HD/DLRO10HDX micro-ohmmeter with 10 A test current

The DLRO10HD is a micro-ohmmeter with up to 10 A test current for the important measurement of lightning protection in wind turbines, for example. With a test current of just 10 A, specifically for low-resistance lightning conductors, and a test lead up to 100 m for long rotor blades, this micro-ohmmeter is unique and offers you everything for low-resistance testing of lightning protection systems.

This series is also perfectly suited to many other applications, such as testing welding connections or the winding resistance of large motors and transformers. The DLRO10HDX version also features a measurement memory. There are five test modes, a high resolution of up to 0.1 micro-ohms, a basic accuracy of up to 0.2 percent and a special mode for measurements on inductive test pieces. The robust outdoor housing is ideal for use in the field and has the IP65 degree of protection, IP54 in battery mode.

- **Five operating settings can be selected with a rotary switch**
- **Automatic start function**
- **Resolution to 0.1 $\mu\Omega$, measuring range up to 2500 Ω**
- **Test current 0.1 mA to 10 A**
- **Choice of high or low output power**
- **Input protection up to 600 V**
- **Battery or mains operation**
- **Extremely robust housing, IP54 protection when open, IP65 when closed**
- **50, 75, 100 m test lead for the rotor blades**

About the lightning protection system in wind turbines

Wind turbines stand high up on hills or in open spaces. Lightning strikes can completely destroy a wind turbine, but are not a problem if the resistance of the lightning protection system is low enough. The DLRO10HD micro-ohmmeter is specifically designed for this important test task. With a 10 A test current and up to 100 m test lead for long blades, it offers you everything for low-resistance testing, especially on the lightning conductor.



DC insulation resistance analysis

S1 series

High-end insulation resistance analysis

The S1-series DC insulation testers are the 'top end' DC insulation resistance measurement devices available on the market — ideal for energy suppliers and service companies. This class of devices offers you special properties that perform particularly well in environments with very high interference, such as substations and switchgears — in other words, anywhere where transformers are located.

The special feature: The S1 series has a very high short-circuit current of 6 mA, very high noise suppression up to 8 mA with four filter options as well as insulation resistance measurements up to 15 TΩ at 5 kV for S1-568 or up to 32 TΩ at 10 kV for S1-1068. The measurement accuracy at +23°C is ± 5% for measurements up to 1 TΩ at 5 kV and 2 TΩ at 10 kV. All S1 and MIT measuring devices share the robust and impact-resistant IP65 outdoor carrying case.

- High test voltage up to 15 kV
- Ideal in very noisy environments
- Fast charging of capacitive loads such as HV power cables
- Guard terminal ensures precise measurement results even in contaminated enclosures
- Additional safety thanks to remote control
- Fast charging with Li-ion battery or mains
- Measuring ranges up to 30 TΩ
- Measurement memory with time/date stamp, USB interface
- Impact-resistant IP65 outdoor case
- Lightweight and compact at only 4.5 kg



About the insulation in wind turbines

The insulation on each electrical conductor begins to age immediately after the system is installed. Heat, frost, saltwater or pests accelerate this process. The systematic testing and diagnosis of the insulation with direct current in the generator, in the transformer and, of course, in all electrical LV lines is therefore the most important test for every electrical component of a turbine.

For legal certainty in wind energy

SVERKER900

Multi-tester for converters, protection and switches

With more than 25 000 specimens built, the SVERKER is the most successful protection testing system in the world. With the SVERKER900, you can efficiently test the current transformer's functional unit, the protective relay and even the power switch in the switchgear systems of wind turbines as well as in substations. All this in just one operation! And that's single- and three-phase, and without any other devices such as a PC.

Today, a sophisticated protection test device must also be able to faithfully simulate a frequency change in the network. This is required by the new IEC 60255-181 2019 standard, which has been in force since 1st February 2019. So far only the SVERKER900 can do that. Standard test equipment only simulates the frequency change from the next zero crossing. However, the relay may not be able to detect the fault in this way.

- Single- and three-phase tests
- Secondary and primary testing
- Three currents and four voltages
- Stand-alone function
- 900 V AC/105 A AC single-phase
- Extensive range of accessories
- Frequency measurement according to IEC 60255-181
- SVERKER Viewer PC software

The right software for your logs must be as easy to use as the SVERKER900. This requirement was the guiding principle behind the development of the new 'SVERKER Viewer' PC software.



Your three SVERKER900 configurations

SVERKER900 Basic	■ Main instrument ■ Pre-fault/fault instrument
SVERKER900 Standard	■ Main instrument ■ Pre-fault/fault instrument + Current transformer magnetisation instrument + Ramp instrument + Sequence instrument
SVERKER900 Expert	■ Main instrument ■ Pre-fault/fault instrument ■ Current transformer magnetisation instrument ■ Ramp instrument ■ Sequence instrument + Impedance instrument



About testing protective relays in wind turbines

The requisite testing (as part of commissioning) is primarily intended to ensure that the protection devices are correctly parametrised. Repeat tests on digital protection devices are designed to discover faults that cannot be determined via the self-regulation process. In the case of analogue protection devices, it is also possible for changes to develop in their characteristics. The test devices simulate secondary variables for testing all protective functions in the protective relay.

Circuit breakers

EGIL

Compact base unit for circuit breaker testing

With EGIL you can measure circuit breakers in wind turbines in a way that is more compact, simple and yet more versatile — plus its price makes it attractive for small energy producers. In addition, it is the ideal additional tool for operations departments at large energy suppliers.

EGIL is designed to test medium-voltage circuit breakers that have only one main contact per phase. Its three time measurement channels are interconnected on one side. Signals from parallel contacts equipped with pre-switching resistors are recorded and displayed simultaneously. There are two separate time measurement channels for the measurement of auxiliary contacts. In order to make the connection on site as simple as possible, EGIL is supplied with ready-made multi-cable sets for both main and auxiliary contacts.

- For testing switching times and strokes on all circuit breakers with one breaker per phase
- Reliable and easy to use
- Two separate time measurement channels for the measurement of auxiliary contacts
- Analogue measurement channels for displacement transducers or general voltage/current measurements
- Static and dynamic resistance measurements together with optional accessory SDRM201
- High-performance analysis software CABA Win
- Extensive range of accessories



About testing circuit breakers in wind turbines

Circuit breakers connect or disconnect the electrical energy across all voltage levels. Their designs are highly complex. In addition to the normal current, circuit breakers also need to be able to disconnect the much higher short-circuit current. Circuit breakers always consist of a switching chamber with an insulating medium and a drive. The most important tests are the switching time measurement, the dynamic resistance measurement and the distance-time measurement.



Power transformers

MWA330A

Compact test device for winding resistance and turns ratio

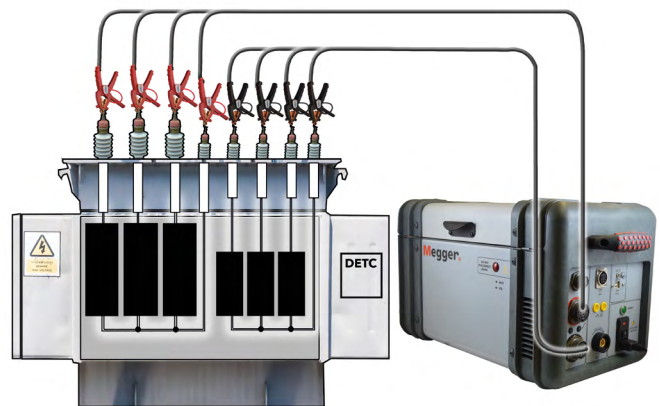
MWA330A is a three-phase test device for winding resistance measurements and turns ratio tests. With a single connection to three phases, you can carry out primary and secondary testing and test the two most important measurements on the transformer both economically and efficiently.

The transformer is only terminated once and has a three-phase connection to the 6 x 9 lead set. You work with just one operating system and receive a combined test log. You can immediately verify any abnormalities in the winding resistance test by performing the turns ratio test.

Automatic three-phase switching is usually much more economical than feeding in three phases. But, it is just as convenient. The device is lighter, more compact, more affordable...ideal for frequent use in wind turbines or smaller local power transformers — and comparably good for large transformers.

The quick test is the fastest possible way to identify faults in the turns ratio or winding resistance. The values of all phases are displayed and evaluated in tabular form on the large touch screen. And with the built-in printer, you can print the test logs on site.

- The two basic measurements on the transformer in just one operation
- All measurements with just one controller
- Only one test connection required
- Combined test protocol for resistance and ratio measurement
- 50% less effort and material transport



About the testing of power transformers

The winding resistance measurement is the most important measurement for the functionality of the transformer. You can detect short circuits or interruptions due to winding, connection or contact problems. The turns ratio measurement ensures that the transmission ratio corresponds to the manufacturer's specifications. It also confirms abnormalities in the winding resistance measurement. Faults caused by short-circuit windings are detected. This is particularly important in wind turbines.

Medium voltage cables

VLF Sinus 62 TD

Test system for medium-voltage cables up to 36 kV, specifically for wind farms

The VLF Sinus 62 test and diagnostic system was designed for commissioning tests and for status analyses of medium-voltage cables aged by operation up to 36 kV. It is the most compact and lightweight device with integrated tan delta measurement in its class. Any trained electrician can operate it intuitively and safely. This enables you to manage faults economically and at the same time increases your security of supply.

Commissioning test with VLF Sinus 62

A visual inspection allows you to make an initial assessment of the installation and assembly quality. Further measurements are necessary for an accurate assessment: The cable jacket test checks the quality of the cable routing. A VLF test reveals major assembly errors. With a PD measurement, you can detect and locate even the smallest assembly errors that can lead to failure during operation. A tan delta measurement provides information about the actual state of aged cable insulation. This guarantees operators a high level of reliability and availability for their cable runs.

- **The world's lightest and most compact test and diagnostic tool in its class**
- **The unit becomes a fully-fledged diagnostic system with the addition of the PD coupler PDS 62-Sin. This PD coupler is also the lightest coupler on the market**
- **Ideal for quality control of newly laid-medium voltage cables**
- **Internal tan delta loss factor measurement for determining the ageing state**
- **Standard-compliant jacket test according to IEC 60552**

About the testing of medium-voltage cables

Even when building a new turbine, shortcuts are often taken when it comes to laying medium-voltage cables. And this greatly affects and shortens the life of these cables. Usually, only the essential tests are carried out, so a VLF test and a cable jacket test according to DIN VDE 0276. However, this is far from enough to properly assess the actual quality of the installation. In order to maintain the assembly quality and a high degree of reliability, a PD measurement is essential and is recommended in many standards.



Battery storage

TORKE900 series

Regulated battery load simulation

TORKE930 and TORKE950 are ideal for your battery systems in the range of 7.5 to 300 V or 7.5 to 500 V. These are typically found in switchgears and also in facilities with UPS backup power systems, such as data centres and hospitals, where the safe supply of power is vital. The TORKE910 is a low-cost, simpler unit that can be used, for example, if you do not need to export logs.

The capacity of a battery decreases continuously over time, so it cannot continue to supply the same amount of power for as long as was originally planned. Age and temperature play an important role. Insufficient charging, uneven charging levels, corroded clamping bolts, internal connections or an unfavourable ambient temperature can shorten the life of a battery cell significantly.

Under favourable conditions, a battery can have a service life of decades, but this is the exception rather than the rule. Under unfavourable conditions, the capacity of battery cells decreases much faster than originally planned. A battery installation is only as strong as its weakest cell.

About the testing of battery storage

Your battery systems must be capable of constantly supplying electricity over a specified period of time. This defines their capacity. The capacity is the multiplication of the current by the time specified in hours — the ampere hour (Ah). The manufacturer's specifications are decisive; they specify the nominal value of the battery capacity. Only the capacity test allows an overall assessment of your battery systems. Therefore, the capacity test is the most important of all.

- **Testing of batteries, including during operation**
- **Dynamic discharge technology — full power at all voltages**
- **Safety by means of warning systems and automatic shut-off, for example in the event of blocked air flow**
- **Expandable load resistors with TXL units**
- **Reverse polarity protection**
- **Single cell measurement with BVM system**
- **TORKE Win analysis software**
- **Extensive range of accessories**



Qualify your employees — even further

A reliable energy supply is based on efficient maintenance strategies. However, these strategies should be adapted to the continuous development of electrical switchgear. This not only increases the demands on the test technician, but also increases their responsibility.

However, better test equipment is only one tool that will help technicians fulfil this greater responsibility. Just as important is a test technician who can master both the test equipment and the general conditions for its use. Only in this way can technicians make more economic use of the new technical possibilities available to them for the benefit of both themselves and their companies. With our training programme, your work will become safer, more reliable, more flexible, faster and ultimately more profitable.

- **Test according to DIN VDE 0100, DGUV regulation 3 (ÖNORM E 8001)**
- **Test according to DIN VDE 0701-0702 (ÖNORM E 8701)**
- **Earthing measurement**
- **Insulation test**
- **Protective relay test**
- **Transformer test**
- **Circuit breaker analysis**
- **Cable fault detection**
- **Cable fault diagnostics**
- **Transformer test**
- **Battery test**

Details of seminar dates, locations and prices can be found in our seminar catalogue at:
www.megger.de/veranstaltungen



Seminar overview

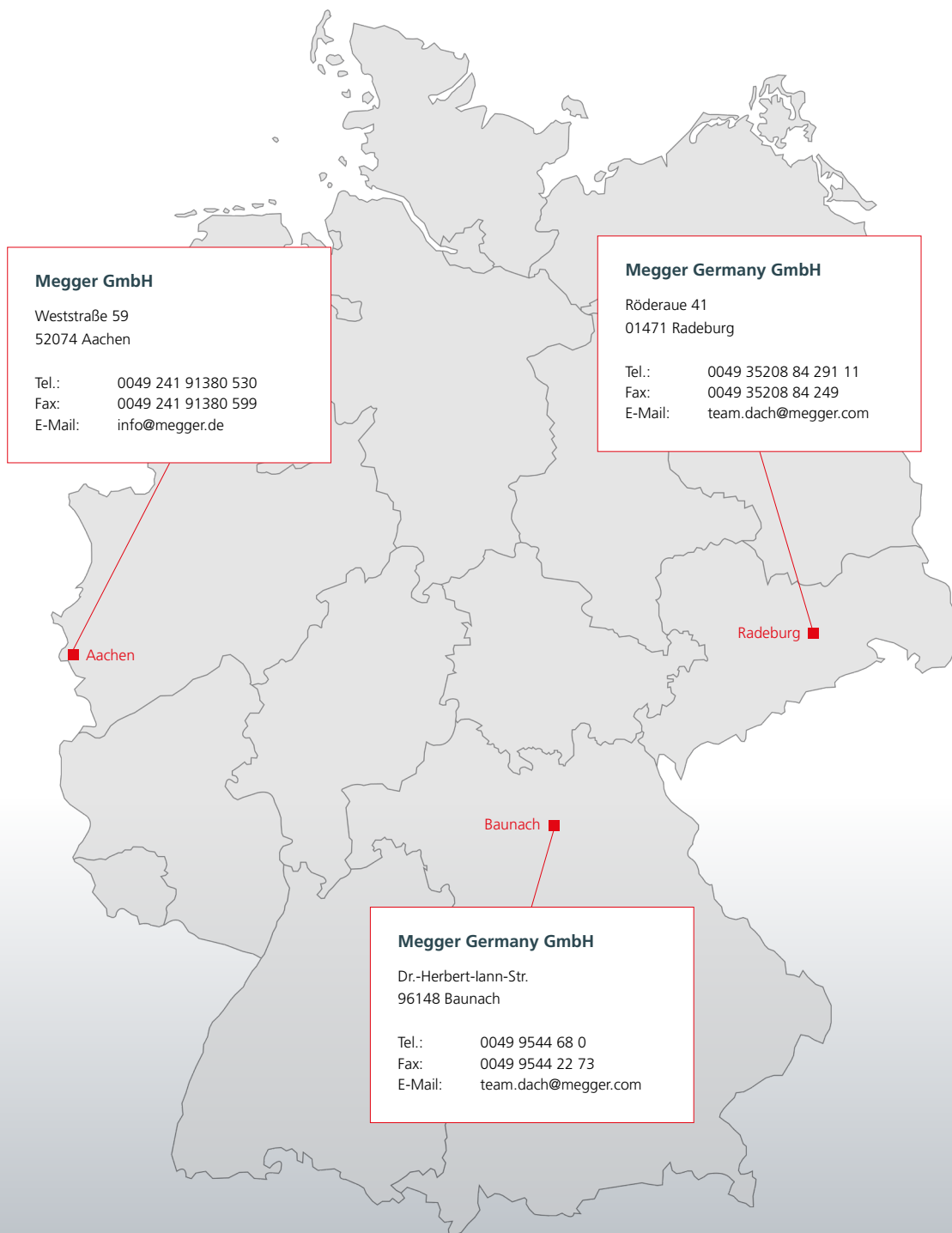
Megger offers detailed and very in-depth practical seminars. We prefer to work with small groups. Consequently, the number of participants is limited. Please think ahead if you are planning seminars for yourself or your employees. A good decision! We have more than 60 years' experience in training. To date, we have already introduced more than 50 000 experts to the latest methods of measuring and testing technology.

In order to ensure that you are well prepared for any event, we practise using your test equipment on different test objects, in different situations and under different conditions. Our training centres have seminar rooms with state-of-the-art equipment. In addition to basic theoretical knowledge, you will receive practical training on our test systems.



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