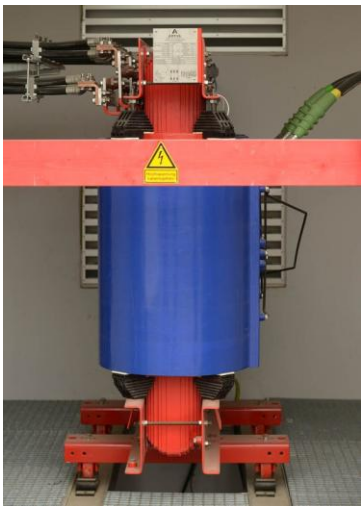
PROMET L10 | SMO
APPLICATION

PROMET High-Precision Ohm Meters
Measurements on inductive loads

Dipl.-Ing. Jürgen Dreier, Product Manager

When carrying out diagnosis, maintenance and servicing on inductive loads such as motors, transformers, transducers, etc. the ohmic resistance of windings, electrical connections and breakers has to be measured. Our PROMET L10 and PROMET SMO ohm meters meet the special requirements which this involves.

Induction
Electromagnetic induction is the interaction between magnetism and electricity which was discovered by Faraday in 1831. If the magnetic flux through an area which is surrounded by an electrical conductor changes, an electrical voltage is induced in a conductor. This law of induction is of great technical importance. Generators, and therefore power generation, transformers and motors operate on the basis of this law.



Measurements on transformers, motors, etc.
Resistance measurements on motors, transformers and transducers can provide a wealth of information about the condition of the test object. In addition to faulty windings, the condition of additional components such as mechanical connections, switching elements and tap changers can be checked. Contact problems, damaged or loose connections and defective conductors, for example, can be detected by means of a resistance measurement.

Problems with inductive components can have electrical causes, such as faults in windings. In multi-phase machines, faults between turns can be detected by comparing the properties of the windings. The resistance value should be in the low ohm range for windings. Large differences between the windings or large resistance values indicate problems. Windings may have been damaged, for example burned, or interrupted.
It is also possible to check for a short-circuit of the winding with the housing. The resistance against each phase winding can be measured from an earthing point on the housing. If there is no defect, the resistance value should go to infinity.

Good results:

- Symmetric and low resistance values on all three phases
- High resistance values during insulation test from phase to ground (reference potential)

Problems:

- Insufficient resistance, e.g. a short-circuit phase to phase
- Asymmetric resistance from winding to winding. Only slight deviation of the measurement values is permissible.

Test equipment

Measuring systems for resistance measurements at low ohm inductances use the four-wire measurement method to achieve the high accuracy required.
It is necessary to saturate the windings at the beginning of the test and to drive a constant current through the measurement object during the test. For this purpose, the measuring systems are equipped with a controllable current source.
In addition, PROMET L10 and PROMET SMO use a special control algorithm to ensure that inductive loads are charged and discharged quickly, keeping measurement times short.

PROMET L10

Safety considerations

When resistance measurements are carried out on inductive loads, energy builds up depending on the size of the inductance and the amount of test current. If the measurement is interrupted, the energy is discharged in an uncontrolled manner and a dangerous induced voltage is generated. This can injure the operator and cause damage to the measuring device. For this reason, the energy should be discharged via an internal function.
As a rule of thumb, if a long period of time is needed for charging, a long period of time is also needed for discharging.
The charging and discharging of the energy stored in the core are visualized on the display of the PROMET systems. The measuring device is also equipped with safety functions to protect against discharge arcs when current leads are disconnected.

Measurement

In preparation for the measurement, the current range must be selected so that a maximum of 10% of the rated current is used as test current. If the test current is too high, the temperature of the windings will increase and the resistance value will be falsified. Once the measurement has been started, it is important to wait until the value has stabilised before reading off the resistance value.

Temperature measurement

If the test object is warm, the resistance value can be measured relative to 20°C.
PROMET systems can determine resistances with temperature compensation. The temperature at the measurement point is measured using a sensor and the resistance value is calculated taking the reference temperature into account. A database with the parameters necessary for temperature compensation is saved in the device and can be extended as and when needed. The resistance value shown on the display thus corresponds to the value which the device under test would have at a temperature of 20°C.
Without temperature compensation, there is a risk that the devices under test will be classified incorrectly.

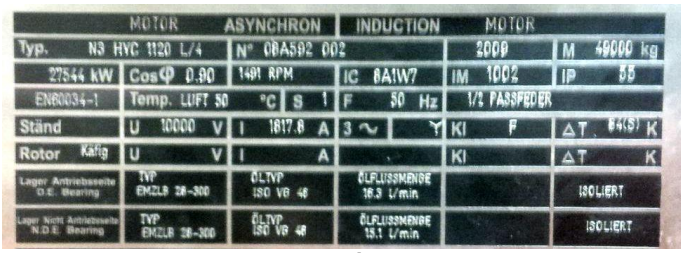
PROMET SMO

Conclusions

Many different requirements and safety aspects have to be taken into account when measuring on inductive loads. Thanks to their extensive functionality, high accuracy and the ability to determine the winding resistances of transformers, motors and measurement transducers, PROMET L10 and PROMET SMO systems are extremely suitable for use in the areas of diagnosis, maintenance and servicing.

"Asynchronous motor" measurement

The winding resistances of the following asynchronous motor were measured:
Stator: U = 10000 V; I = 1817.8 A; 3-phase / star
Rotor: Squirrel cage rotor
Frequency: 50 Hz
Rotational speed: 1491 rpm
Power: 27544 kW



Nameplate

The connection box was removed when the measurement was made. The windings per phase could be measured individually against the neutral point.


Measurement setup

Neutral point with neutral point converter

Phase	Winding 1	Winding 2	Winding 3	Winding 4	All windings/phase parallel
U1	43.7 mΩ	43.6 mΩ	43.8 mΩ	43.7 mΩ	11.0 mΩ
V1	43.7 mΩ	43.6 mΩ	43.6 mΩ	43.7 mΩ	11.0 mΩ
W1	43.7 mΩ	43.6 mΩ	43.6 mΩ	43.7 mΩ	11.0 mΩ

Once the measurement started, it took approx. 1 minute for the resistance value to stabilize.