# On-Site Testing of Electricity Meters

Testing electricity meters and metering installations in situ has many advantages over laboratory tests. Just one of the benefits offered by on-site tests is that meters do not need to be de-installed and transported to another location in order for the necessary tests to be performed.

The measurements carried out on site include an accuracy test. Reference meters also provide a number of additional functions permitting further tests which are of particular relevance for transformer-rated metering installations.

When testing electronic meters in particular, for example, special measurements need to be made in order to check that the transformer burdens are correct.

Two different methods can be used when testing meters in situ. The first method is to use the existing network load for measurements. The second method is to test the meter with an external load provided by a power source.

## 1. Testing meters in situ

Reference meters are used to perform on-site tests under the real load conditions of an electricity meter. The meter remains in situ and all tests are carried out under genuine operating conditions. Using this approach, it is possible to determine whether an electricity meter is influenced by its installation.

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*Fig. 1: An on-site test with METES 320*

### 1.1 How reference meters work

Reference meters measure electrical energy by carrying out voltage and current measurements. Currents are measured with high-precision measurement shunts or error-compensated current clamps. The recorded signals are processed by amplifiers and converted by A/D converters. The digitalised current and voltage values are then subjected to further processing by a programmable logic component and fed to a digital signal processor. This processor calculates the quantities required, such as voltages, currents, power values, work etc. Which reference meter and which accuracy class are most suitable in a particular situation depends on the specific circumstances on site.

### 1.2 Measurement methods

When using a reference meter, the voltage measurement path of the meter under test and the voltage measurement path of the reference meter must be connected in parallel. Currents can either be measured directly or with current clamps. If the currents are measured directly, the current measurement path of the meter under test and the current measurement path of the reference meter must be connected in series. This ensures that the reference meter and the meter under test measure in the same way and calculate power and work on the same basis.

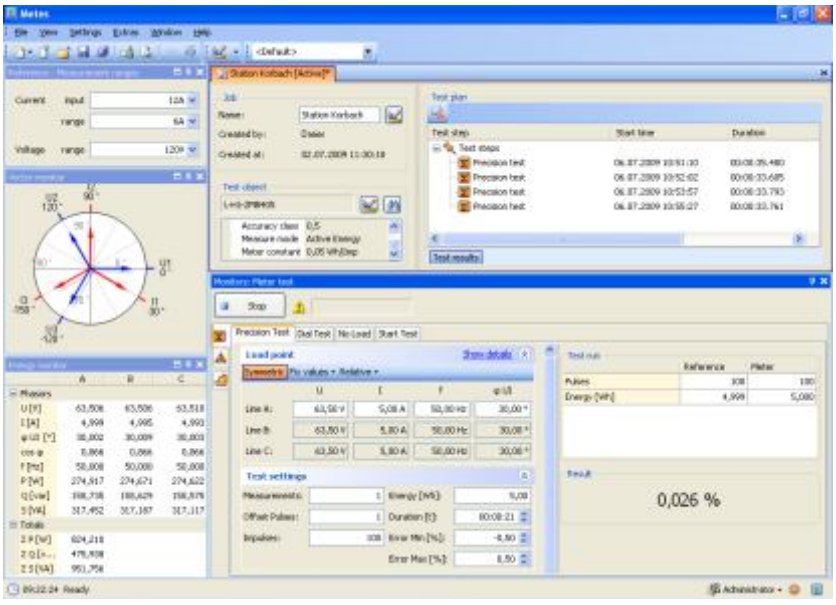


*Fig. 2: An accuracy test with the METES 340 REF software*

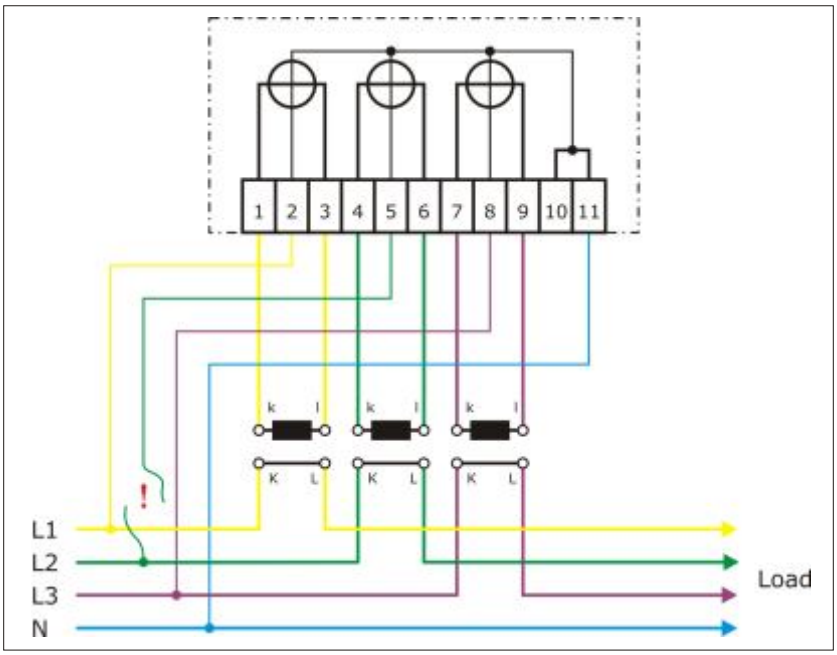


*Fig. 3: An example of a faulty measuring circuit: voltage interruption on L2*

A pulse sensor or scanning head is used to record the power-proportional impulses of the electricity meter, i.e. to scan the meter disc mark of electromechanical meters (Ferraris) or the LED impulses of electronic meters.

Once the necessary parameters have been set, such as the meter constant and the number of impulses to be measured, the meter error calculated for the meter under test is displayed as a percentage value either directly on the screen of the reference meter or in the software.

### 1.3 Installation verification

It is essential to check whether an electricity meter is installed correctly. This is particularly important for transformerrated metering installations. If the measuring circuit is faulty, the electricity meter receives voltages and currents which differ in phase and/or amplitude from those it would receive were the measuring circuit correct.

Faults in the measuring circuit of an electricity meter can occur when a system is wired incorrectly from the start. Other causes include interruptions to the connecting leads or the use of transformers with the wrong transformation ratio. Significant measuring errors can result if meters and transformers are installed incorrectly.

In practice, measuring circuit faults fall into three different categories:

- Incorrect connection
- Open connections
- Short-circuits

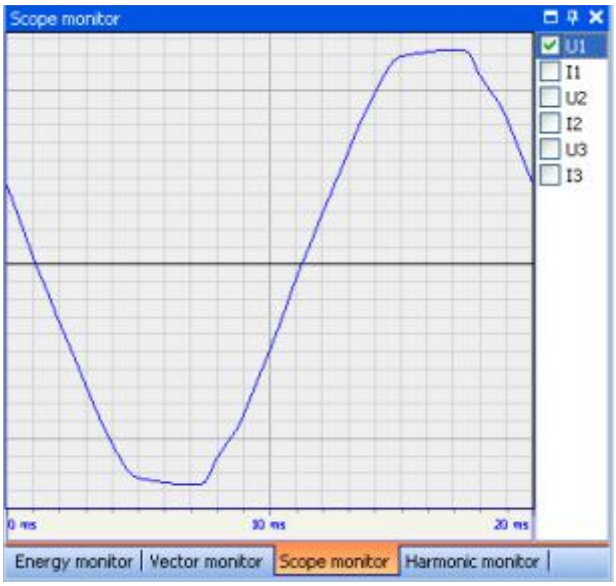


*Fig. 4: Graphical display of the harmonics of the system voltage*

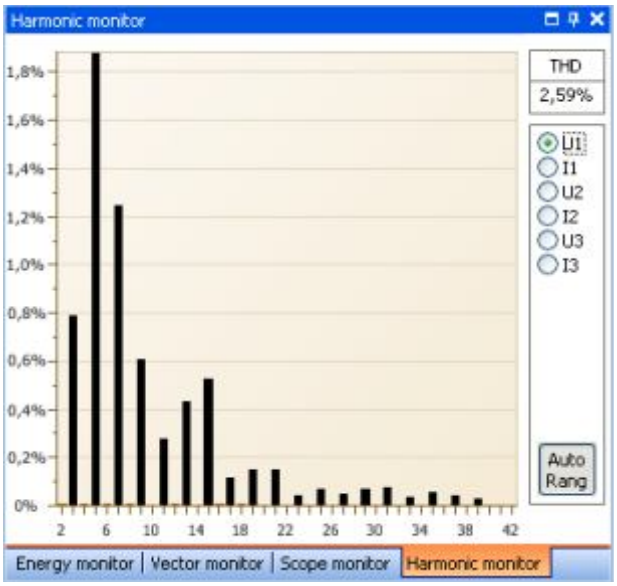


*Fig. 4: Graphical display of the harmonics of the system voltage*

So measuring circuit faults do not only arise when a meter is first installed, but can also occur during ongoing operation. The surest way to find such faults is to check the rotating field and ascertain whether all secondary leads are correctly assigned to the current and voltage paths of the meter.

### 1.4 Burden measurement

When instrument transformers are used, it is important that the burden is correct, i.e. the total resistance of the secondary measuring circuit. The impedance or burden which can be connected to the secondary terminals varies depending on the specific transformers in use and must be adhered to if the measuring error is to remain at an acceptable level.

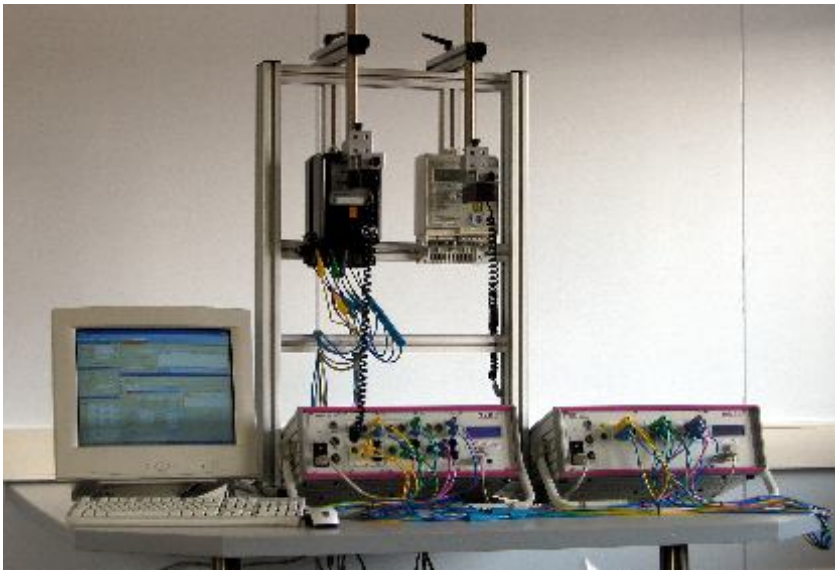

*Fig. 5: A test stand with METES 340 REF and EPOS 300*

### 1.5 Functions of a reference meter

A number of different display monitors are used to check a metering system, its installation and accuracy.

A vector diagram and an instantaneous value display of voltages, currents, phase displacement and power values are useful aids when checking whether a meter is connected correctly.

The display of the signal shape and an analysis of the harmonics help identify problems which are due to system disturbances. System disturbances can cause a supplementary measuring error

Display monitors for burden measurements and for voltage drop measurements between current or voltage transformers and electricity meters show whether a metering system is functioning within defined limits.

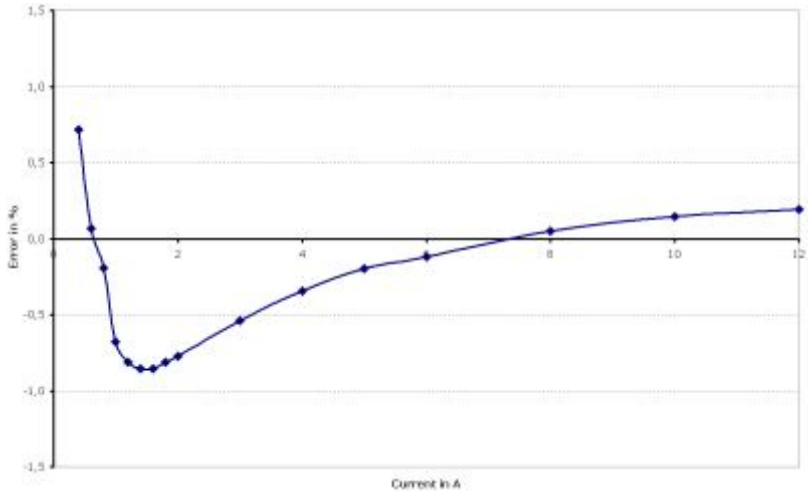


*Fig. 6: Load curve of an electromechanical meter*

## 2. Testing with an external load

In some situations it can be necessary to generate currents and voltages independently of the power supply:

- When metering equipment has been newly installed and has not yet been connected to the power system
- When the load of the meter under test is too low
- When tests are to be carried out under a range of different load conditions
- When customer-requested meter tests are to be carried out in a laboratory.

The necessary equipment basically consists of a reference meter used in connection with a three-phase power source to generate a range of different load points and test conditions. Automated tests present no problem as the same software is used to control both devices.

### 2.1 Measurement methods

To test an electricity meter with an external load, the meter must be disconnected from the power system and connected up to an external power source. Using this method, the meter can be tested independently of the current situation within the power system.

### 2.2 How a power source works

The signal characteristics of the test voltages and currents generated by a modern, three-phase source are computed by a signal processor and issued via high-accuracy D/A convertors and transformerless linear power amplifiers. Independent signal generation allows the amplitude, phase angle and frequency of the output values to be varied widely. Even flicker signals or records (from a fault recorder, for example) can be output as transient signals.

### 2.3 Functions

The use of an external power source brings a number of advantages. By simulating different power system situations, electricity meters can be tested under a range of different load conditions. Tests across the entire load range are possible. Additional test and output functions also allow other unfavourable conditions to be simulated, such as voltage and current harmonics. These functions help give a comprehensive overview of the meter under test.

## Conclusion

Rising energy costs, the increasing frequency of system disturbances and the lack of customer confidence in the accuracy of electricity meters all contribute to the growing importance attached to testing electricity meters in situ.

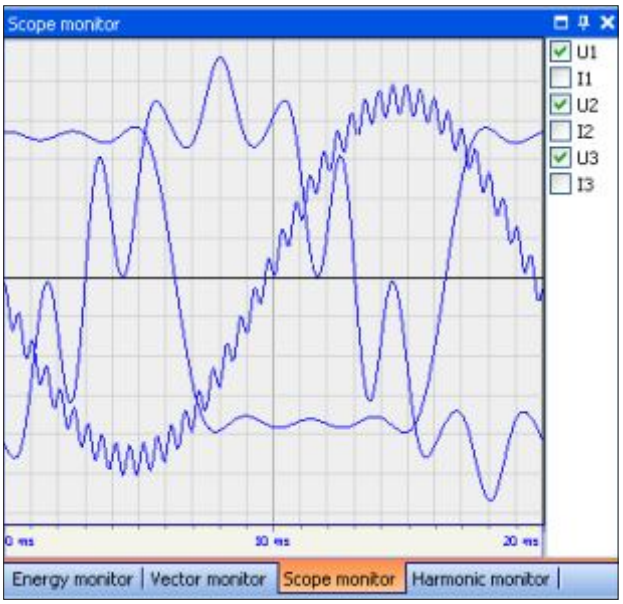


*Fig. 7: Generation and measurement of harmonics*

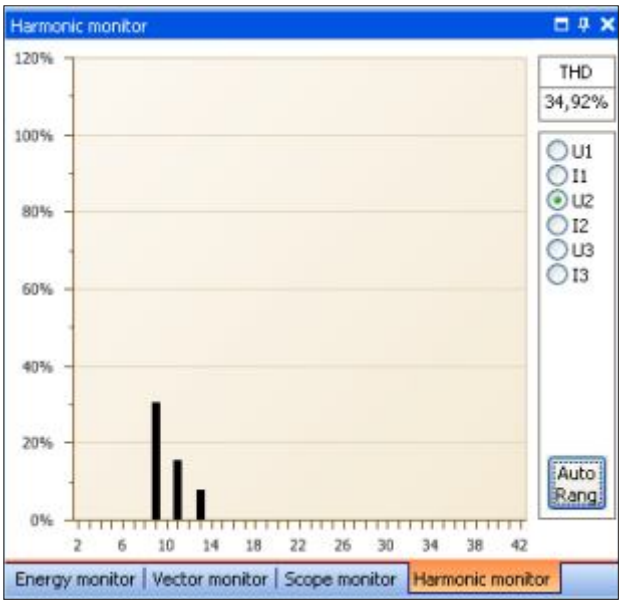


*Fig. 7: Generation and measurement of harmonics*

The use of portable reference meters and portable power sources to check the performance of electricity meters and metering installations brings numerous advantages to manufacturers, service providers, power plant operators and electricity supply companies alike. Portable test equipment provides a low-cost, simple and fast means of testing electricity meters on-site or in a laboratory.