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MeterEMI Project News

EU Project, Electromagnetic Interference on Static Electricity Meters, MeterEMI

Static Meter Errors induced by fast current edges

The EU funded MeterEMI project was conceived following the publication of a **paper** at the University of Twente. The paper reported new findings that some models of static electricity meter show deviations of over 500 % when exposed to certain current waveforms. This despite the 2008 introduction of EMI tests for the frequency range 2-150 kHz as specified in IEC61000-4-19. The difference with the Twente study was that the current waveforms contained very fast edges such as may occur when the waveform is chopped using power electronics. Indeed, the waveform that induced the worst error was that caused by using a dimmer switch on some non-dimmable LED and CFL lighting.

The aim of the MeterEMI project is to investigate whether these findings will require changes to international standards for electricity meter testing. If changes are required, the project will devise new tests based on real-world conditions to ensure that meters read within their accuracy specification when exposed to this type of interference.



MeterEMI Project

- 3 year project stared May 2018.
- 5 National Metrology Institutes (UK, NL, CH, CZ, NO).
- 2 Universities, UTwente (NL) and UPC (ES).
- Funded by European Metrology Programme for Research and Innovation (EMPIR) and national governments.
- 25 stakeholders including standards committees, utilities, regulators and meter manufacturers.

Possible Causes of Static Meter Errors



The meters with the highest errors in the Twente study, and in a more extensive study at the Dutch Metrology Institute VSL, were those that use Rogowski coil current sensors which naturally differentiate current signals. In order to make use of a Rogowski coil output, an integrator is used to "reverse" this differentiation. The problem revealed in the Twente study could be caused by the differentiation of the fast edges in the current signals by the Rogowski coil. The resulting differentiation output will be a very large pulse which will need to be properly processed by the associated integrator. If the integrator saturates and takes time to recover, or if it is implemented as a numerical integrator, this could give rise to meter errors.

Although the Rogowski coil error mechanism is a good candidate for the causes of these errors, more recent measurements by VSL has shown that some Hall effect meters and even some shunt based meters, also gave substantial errors when measuring fast current signals. Neither Hall nor shunt sensors differentiate the current so another unknown error mechanism must exist.

Do these signals appear at real meter connection points?

One of the criticisms of the Twente study is that the fast edge current signals were produced by using a dimmer switch to dim LED lamps which were "un-dimmable". As the LED lamps attempt to maintain constant power output, the chopped sinewave output from the dimmer switch causes the LED to take a large pulse of current in a time shorter than the full 20 ms mains cycle. The more that the dimming is increased, the shorter the conduction time and the bigger the current pulse amplitude. As the lamps were dimmed against the manufacturer's advice, it is questionable as to how often this scenario would occur in practice.

Other mass market appliances contain power electronics which effectively "chop" the voltage waveform in the same way as a dimmer. However, these appliances must be tested to the EU's EMC directive which includes tests to ensure the current harmonic interference in the frequency range to 2 kHz, is less than harmonic current limits published in IEC 61000-3-2. However, any appliances with *average power* consumption of less than 75 W are exempt from this testing. As already seen from the dimmer scenario, a chopped waveform can concentrate the power into a short pulse and still maintain a relatively small average power. It is an open question as to whether any appliances exist that have average powers of less than 75 W and still produce current waveforms that cause meter errors.



Switching currents from mass-market appliances

In an attempt to understand the type of waveform produced by consumer electrical products, a number of appliances will be tested in the laboratory and their current waveforms measured. The appliances will be chosen for their potential to generate switching currents and will include those using power electronics.



This testing will initially be carried out using a laboratory power amplifier, however the output drive capability (output impedance) must be sufficient as to not limit the rise time of the current pulse induced by the appliance. For this reason direct mains drive may also be necessary.

These waveforms will be captured using wideband current transducers and fast sampling equipment to record the current waveform time series. The recording can then be used for analysis of the signal component parts and for the testing of electricity meters.

Switching Currents at Meter Connection Points

As mentioned above the impedance of the source will determine the shape of the current pulse induced by an appliance. For example, the source inductance will limit the rate at which the current can change and cause the rise time of the pulse to be reduced. So, it is important to examine waveforms at typical meter connection points in a variety of settings to observe the types of waveforms that meters are exposed to in the real world.

To do this, the project is arranging a number of test sites in The Netherlands, Czech Republic, Spain and Norway where high speed sampling equipment will be installed to measure the currents at meter connection points. Data will be collected over at least a week to capture variable loading conditions.

The recorded data sets have the potential to have a huge size and a detection and triggering method will be needed to capture data only at times when certain waveform characteristics, such as rapid current changes, are seen.

The captured data taken together with the laboratory appliance data will represent the typical disturbance waveforms that could occur in the real world, and importantly, that electricity meters must be exposed to and still measure energy within their allowed accuracy class.

The sampling equipment and associated transducers are currently being purchased and calibrated and site testing is expected to start in the spring of 2019.

Capturing Switching Waveforms

Measuring high speed waveform data 24/7 will produce unmanageable amounts of data. For this reason a trigger mechanism is required to record data only when predefined conditions occur. This may relate to the rate of change of current, the width of a current pulse or the phase of the current pulse.

Triggering based on the rate of change of current is difficult because it relies on differentiation which amplifies noise. So more advanced techniques are being examined using **Wavelets**. This signal processing method uses a specially shaped short lived wave shape. By looking at the correlation between certain shaped wavelets and a current signal, it has been seen that results containing a high correlation coefficient imply a fast current edge. This wavelet method can be used as the basis of a trigger method, provided the processing is efficient enough for real time implementation.



Future Meter Testing



Once a set of potentially disturbing waveforms is found, it will be important to test a range of electricity meters to determine any errors caused by these disturbances. This will be done in the laboratory by "replaying" the waveforms and exposing the meters under test to the disturbances.

The project is currently building test beds to apply these waveforms to test meters against a traceable power standard. This will be done by use of two methods. The first method is familiar to industry and uses a split signal method that sums the interference signal with the main sinewave signal; this sort of test bed is used in IEC61000-4-19. The second method uses an arbitrary waveform generator and amplifier to essentially replay the waveform.

It is envisaged that these test beds will form the basis of the new equipment that will be specified in future international standards for meter testing.

Reporting the project findings and results

The project has been running for six months and already many interesting findings are emerging from this detailed follow-up to the Twente study. The project team will keep industry involved through future newsletters such as this and by presentations to industry conferences such as **CIRED 2019**.

As more findings and proposals emerge it is important to have a discussion forum with experts in industry. With this in mind the MeterEMI project hopes to hold a special workshop at **EMC Europe 2019**, 2nd to 6th September 2019 in Barcelona.



The project is also closely connected with the standards community and will regularly update progress to the relevant committees and working groups.



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