Comparison measurement of various measurement systems –
Round Robin test „Measurement uncertainty“ of the DKE

The relating standards:
IEC/EN 61000-3-2
IEC/EN 61000-4-7

Some years ago, it was found that there was a great variation in the measurement results obtained from various test systems when performing tests in accordance with the standard IEC/EN 61000-3-2. Deviations of up to 100% were apparent, although the standard defines a measurement accuracy of 5%. As a direct result, the German national (DKE) founded the “measurement uncertainty” working group to investigate this problem.
The members of the working group agreed to commence an inter-laboratory test, with the aim of establishing the reason for the variation in the measurement results. Several measurement laboratories, and companies, participated in the inter-laboratory test. The participants received two different rectifier circuits, each of which was assembled from very precise and accurately measured components. Each participant then carried out a series of measurements in accordance with the standard IEC/EN 61000-3-2.

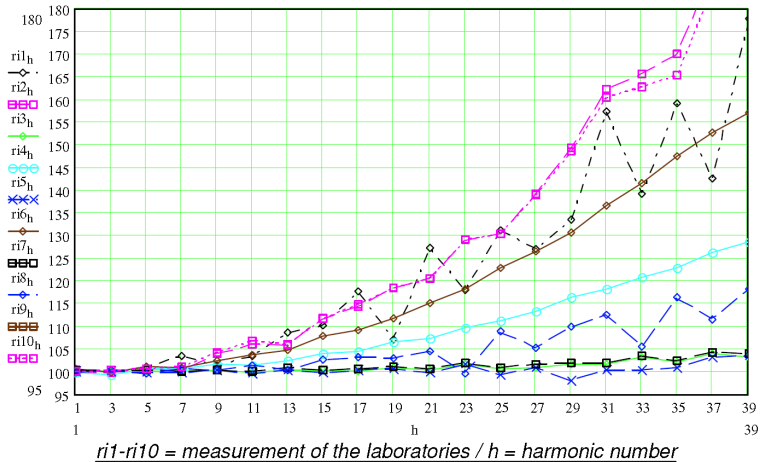
The results of the first Round Robin test:

The results confirmed that the measuring devices (harmonic analyser) produced more or less acceptable measurement results. Comparison showed that the various sources (amplifiers) caused the greatest deviations. Now, the behaviour of these precisely constructed and measured test specimens could also be characterised by various simulation methods. Therefore an exact FFT analysis was conducted, by way of calculation, utilising PSpice. As a result, the precise behaviour of these test specimen candidates was thus defined.

Pic 1 compares the measured data with the theoretical data (100%). The higher the harmonic order, the bigger is the deviation of several measurement systems and therefore the measurement uncertainty.

Deviations of more than 80% are clearly shown in Pic 1. A source from another manufacturer even had a deviation of up to 90%.

Pic 1 Deviation of the theoretical data (theory= 100% - deviation of 50%=150%)



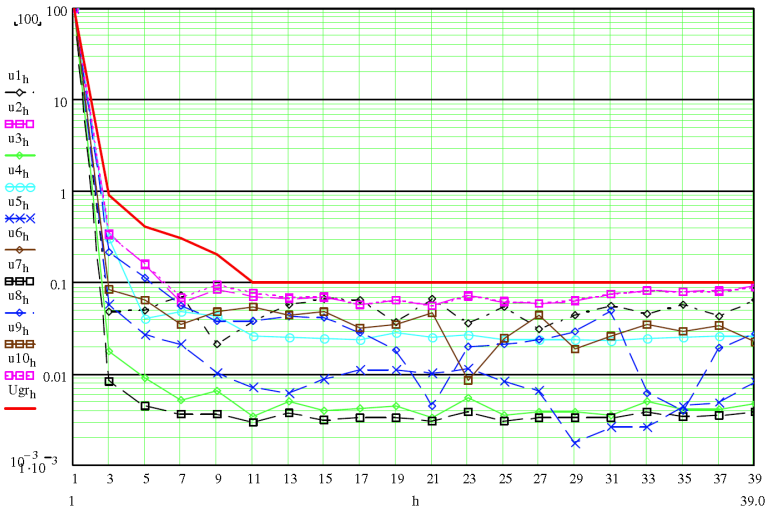
ri1-ri10 = measurement of the laboratories / h = harmonic number

The results of the second Round Robin test:

A second inter-laboratory test was started. The harmonics of the supplied test specimen were adjusted to the result of class A in the range of approx. 13th up to the 39th harmonic. Furthermore, various real-life test specimens (e.g. a TV-set, various lamps etc.) were also measured in the second test for comparison purposes. Again, the measurements were performed according to the standard IEC/EN 61000-3-2.

During both the first and second inter-laboratory tests, most of the laboratories also measured the harmonics of the voltage (see pictures 2 and 3). Analyzing the voltage harmonic data, it was noticeable that the measurement data of the test equipment with the closest correlation to the simulation analysis also produced the smallest voltage harmonics. Comparing the simulation data with the actual measurement data of those test equipment units showed that the measurement results of these devices were within the 5% limit (actual was within approx. 4%).

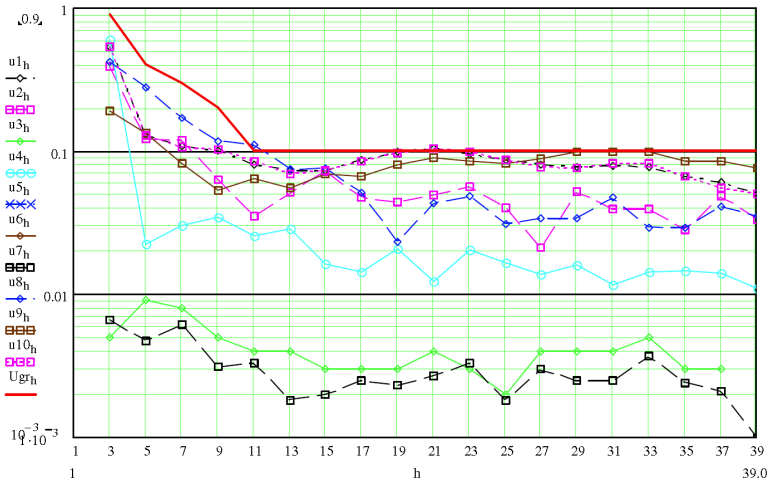
Pic 2 voltage source harmonics caused by the 600W test specimen



n7 and n3 (VDE and SPS) always had the lowest harmonic voltage distortion.

These devices were a test system owned by VDE, which had been completely designed and manufactured by Spitzenberger & Spies, and a test system used at the production plant of Spitzenberger & Spies.
Some other test systems including those with a source made by Spitzenberger + Spies (but with measurement devices from other manufacturers), turned out to have slight deviations but to be acceptable compared to other sources.

Pic 3 voltage source harmonics caused by the 44W test specimen



In spite of the little load of 44W some of the sources are at the harmonic limits.

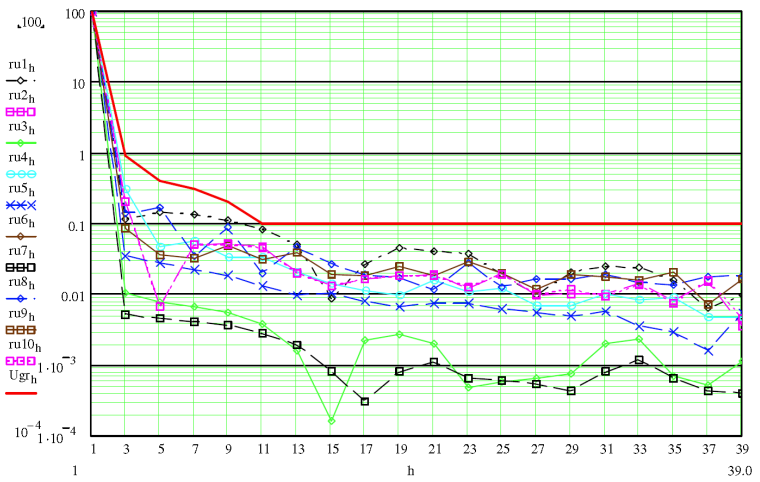
The PAS-power source reaches only 3,5% of the maximum limit.

Fig. 3: Voltage characteristic during simulation (1ms/DIV)

The voltage harmonic currents of the Spitzenberger & Spies PAS sources were more than 30-100 times better than specified in the relevant standards.

A similar result was measured when testing other EUT's like TV-Set's (see Pic 4). Also here the PAS sources had a voltage harmonic distortion much less than requested according to IEC/EN 61000-3-2.

Taking the source with the lowest harmonic voltage content (ru7 = VDE-PAS) as a reference, a comparison of measurement uncertainty can be shown in Pic 5. The VDE-PAS System (ri7) measurement uncertainty defines the reference line (100%). All other measurement systems have a more or less extremely high deviation from the 100% reference value.



Pic 4: voltage harmonics, Pic 5: current harmonics of the TV Set

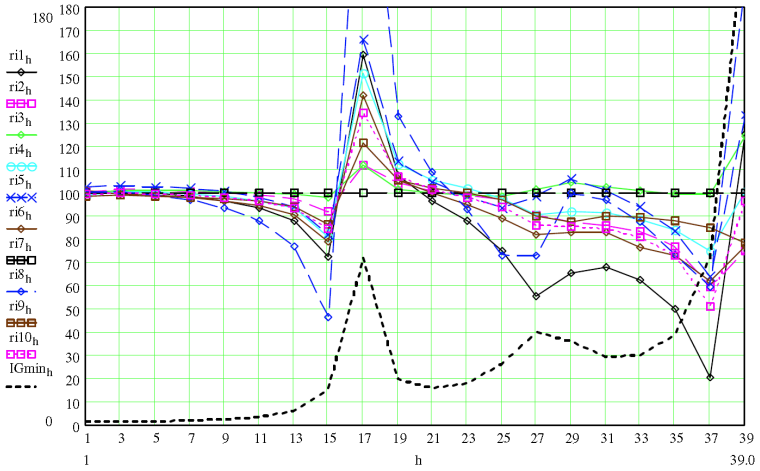


Fig. 4: Voltage characteristic during simulation (5µs/DIV)

Round Robin test Result:

Spitzenberger & Spies
Basic EMC System

The comparison measurement with various measurement systems and three verifiable reference test specimen showed that there are very high deviations when using various sources. Only the test systems with PAS-series sources from Spitzenberger & Spies are able to keep within the defined 5% limits. In most of the other cases, the use of unsuitable sources is generating additional harmonics. However, the opposite result is possible. This causes incorrect measurement results. Specific sources (e.g. switching amplifiers) cause extremely large errors; comparison measurements conducted directly from the utility AC supply hardly resulted in worse values.