Bilateral Comparison LF Power up to 100 kHz

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Introduction

One key area which is often neglected in traditional specifications is that of power measurements at high frequencies. Nowadays, however, there is a demand for power measurement at high frequencies . Calibration of high frequency power has lagged behind the development of power meters to address these applications, and few national laboratories can provide traceability up to 100 kHz: the frequency at which instruments have to be calibrated to provide accurate results in these application sectors.

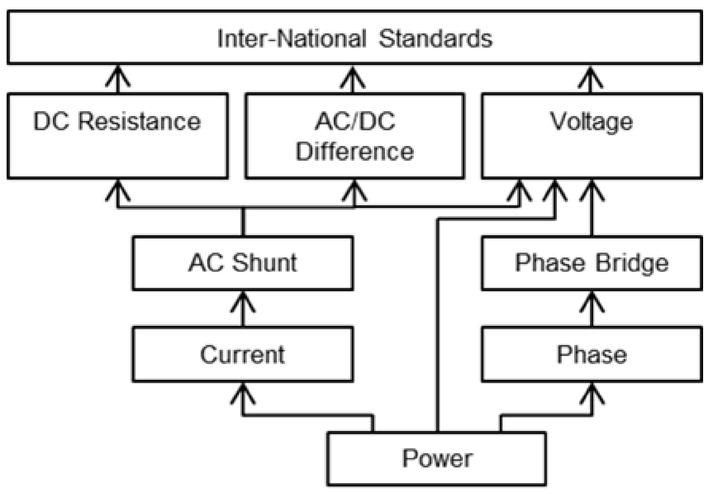
Yokogawa European Standards Laboratory

In Amersfoort (The Netherlands), a calibration laboratory was set up to provide traceability for wide band electrical power meters. Using an own developed wideband power calibration system, traceability is provided to Yokogawa power meter users.



Traceability power up to 100 kHz

Traceability is build up via voltage, current and phase. Voltage is measured using an AC Voltmeter, while for current the AC Voltmeter measured the Voltage drop over an AC shunt. The AC shunt is traceable to DC resistance and the AC/DC difference. The phase is traceable to a phase standard and corresponding phase bridges.



The Comparison

The transfer standard was calibrated multiple times at the Yokogawa European Standards Laboratory before it was sent to [1], RISE . The applied voltage and current (sine waves) was 100 V and 1 A on the fixed range of 100 V and 1 A. The update rate was 2 seconds. No filters or special settings where selected. The results were taken over an average of 16 measurements after the reading was stable. The frequency for the calibration was 1 kHz, 10 kHz, 50 kHz and 100 kHz, while the power factor was set to 1. This gives the amplitude deviations results. Next the power factor was changed to 0 (inductive) to measure the phase influence. After these measurements the transfer standard was send to Sweden. RISE calibrated the transfer standard by using the same settings and values. After receiving the transfer standard back at the Yokogawa European Standards Laboratory the calibration was repeated. A little drift was observed from the transfer standard at the frequency of 50 kHz and 100 kHz at power factor 1. After linear interpolation, this was well in the combined uncertainties of the comparison.

Selecting the comparison laboratory

The amount of national laboratories with the traceability for power up to 100 kHz is very limited. We have selected the national standard institute of Sweden (RISE). There is no dependency between Yokogawa and RISE, due to the fact both laboratories build up their own traceability.

Results

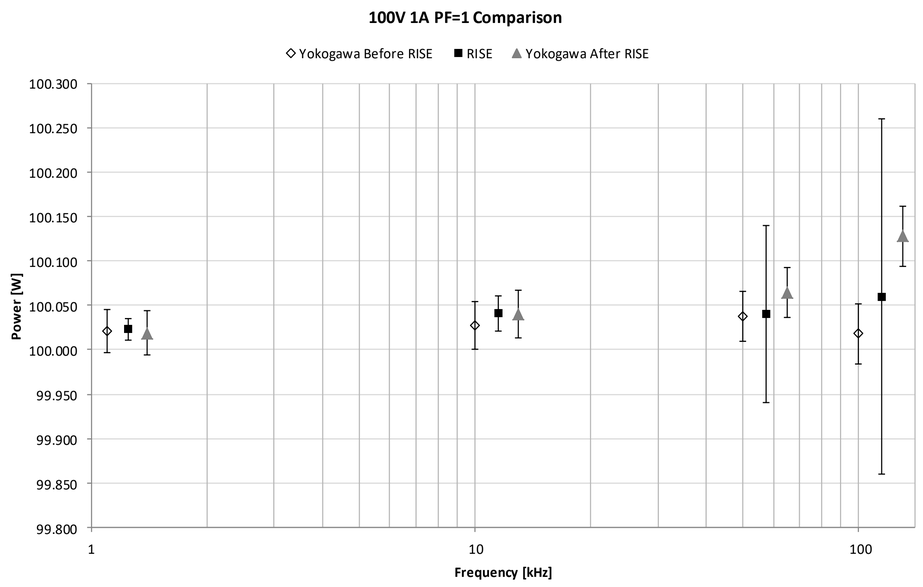
From the results the |En| factor was calculated. The factors where all < 1. Hereby the numeric results:

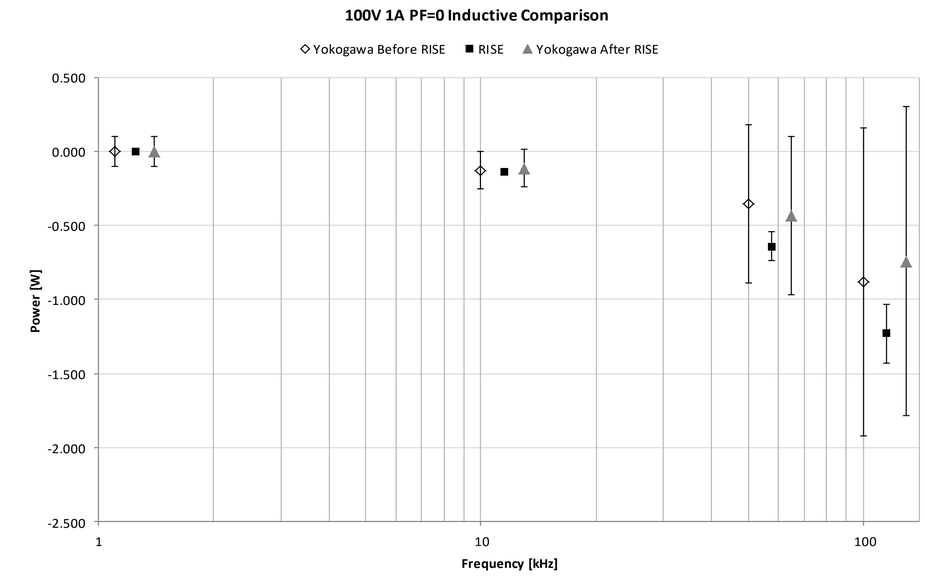
Frequency [kHz]	Power [W]	Yokogawa before RISE [W]	Yokogawa after RISE [W]	Uncertainty k=2 [W]	RISE [W]	Uncertainty k=2 [W]	En
1	100.0	100.021	100.019	0.025	100.023	0.012	0.10
10	100.0	100.027	100.040	0.027	100.041	0.020	0.27
50	100.0	100.04	100.06	0.03	100.04	0.10	0.07
100	100.0	100.02	100.13	0.03	100.06	0.20	0.01

Table. 1. Comparison results Power factor 1.

Frequency [kHz]	Power [W]	Yokogawa before RISE [W]	Yokogawa after RISE [W]	Uncertainty k=2 [W]	RISE [W]	Uncertainty k=2 [W]	En
1	0.000	0.002	0.003	0.100	-0.002	0.012	0.04
10	0.000	-0.126	-0.115	0.126	-0.134	0.020	0.09
50	0.00	-0.35	-0.43	0.54	-0.64	0.10	0.48
100	0.00	-0.88	-0.74	1.04	-1.23	0.20	0.38

Table. 2. Comparison results Power factor 0 (inductive).





Conclusion

The comparison shows a good result and gives confidence in the power calibration system at the Yokogawa European Standards Laboratory.

References

[1] T. Bergsten, V. Tarasso and K. E. Rydler, “An electrical power reference system Up to 1 MHz ," 2016 Conference on Precision Electromagnetic Measurements (CPEM 2016), Ottawa, ON, 2016, pp. 1-2.