AN INTERNATIONAL COMPARISON OF LOW AUDIO FREQUENCY POWER METER CALIBRATIONS CONDUCTED IN 1989

P.S. Filipski and W.J.M. Moore
National Research Council
OTTAWA, Canada

R.B.D. Knight and P.Martin
National Physical Laboratory
TEDDINGTON, Middlesex
United Kingdom

N.M. Oldham
National Institute
of Standards and Technology
GAITHERSBURG, MD, USA

Abstract

The results of an intercomparison of audio frequency power meter calibrations conducted in 1989 between the National Research Council, Canada, the National Physical Laboratory, United Kingdom, and the National Institute of Standards and Technology, USA, are described. A time-division watt-converter, developed at the National Research Council, was used as the transfer standard. The measurements were made at 120 V, 5 A, power factors of 1, 0 lead and 0 lag and at frequencies up to 5 kHz.

Summary

National laboratories have traditionally concentrated their efforts on improving power-meter-calibration accuracy at 50/60 Hz. This focus is due to the economic importance of power-frequency electrical energy measurements. The results of an international intercomparison reported in 1987 [1] indicate a 20 ppm agreement between leading laboratories at these frequencies.

This high calibration accuracy is not provided at higher frequencies, i.e. in the frequency range up to 20 kHz. In the past the need for such calibrations was very limited. Recently however a demand for such calibrations is becoming apparent. Wide spread use of thyristor-controlled loads requires new instrumentation, operating properly in the frequency band comprising the harmonics of the generated nonsinusoidal waveforms. This need is beginning to be fulfilled by digital (sampling type) instruments and national calibration laboratories have to be prepared to be able to fully verify their accuracy. This is not a trivial task for quantities such as active and reactive power/energy. It requires not only improved calibration facilities but also that audio-frequency-band, high-accuracy characterization of passive components, such as resistors, capacitors, current and voltage transformers, be performed on a routine basis. These measurements until now have been performed only sporadically.

The standard of alternating power is usually produced in a two-component system: a generator, and a comparator which compares the generated power to reference direct current standards of voltage and resistance. The various national laboratories achieve this function using different means. In the interest of improving and maintaining national standards it is useful to make intercomparisons between these systems when major changes are undertaken; in this instance the extension of the range of calibration frequencies.

This paper describes the results of an international comparison of power at the lower end of the audio frequency band. It was conducted to compare the efforts of the participating laboratories in extending their calibration facilities. Three laboratories took part in the intercomparison, the National Research Council, Canada, the National Physical Laboratory, United Kingdom and the National Institute of Standards and Technology, USA. Measurements were made at 120 V, 5 A, and at power factors of 1, 0 lag, 0 lead.

The intercomparisons of the accuracy of maintaining the unit of electrical power were performed using a transfer standard. A new time-division-multiplier (TDM) type watt converter, developed recently at the National Research Council of Canada [2], was used for this purpose. The short term instability of this instrument is in the order of ±10 ppm, the temperature coefficient is less than 2 ppm/° C, the long term drift 7 ppm/month, and error is 100 ppm after corrections (200 ppm before corrections) in the 50 Hz - 5 kHz frequency range. The instrument was transported between the laboratories during June 1989 - January 1990. At NPL the measurements were performed in the 50 - 1600 Hz range, at NRC 50 - 4800 Hz range, and at NIST in 60 - 10000 Hz frequency range.

Figure 1 compares results of calibrations conducted in June 1989 at NRC and NPL. Comparison between NRC and NIST conducted in December 1989 - January 1990 is shown in Fig. 2. During this time the full scale error of the transfer standard changed by 43 ppm. Results marked NPL (LF) and NPL (HF) refer to measurements with low frequency (voltage and current transformers) and high frequency (current shunt, audio frequency inductive voltage divider) input transducers.

References

[1] W.J.M. Moore et al., "An international comparison of power meter calibrations conducted in 1987", IEEE Trans. Instrum. Meas., Vol.38, pp. 395-401, April 1989.

[2] P.S. Filipski, "A TDM wattmeter with 0.5-MHz carrier frequency", IEEE Trans. Instrum. Meas. Vol. 39, February 1990.

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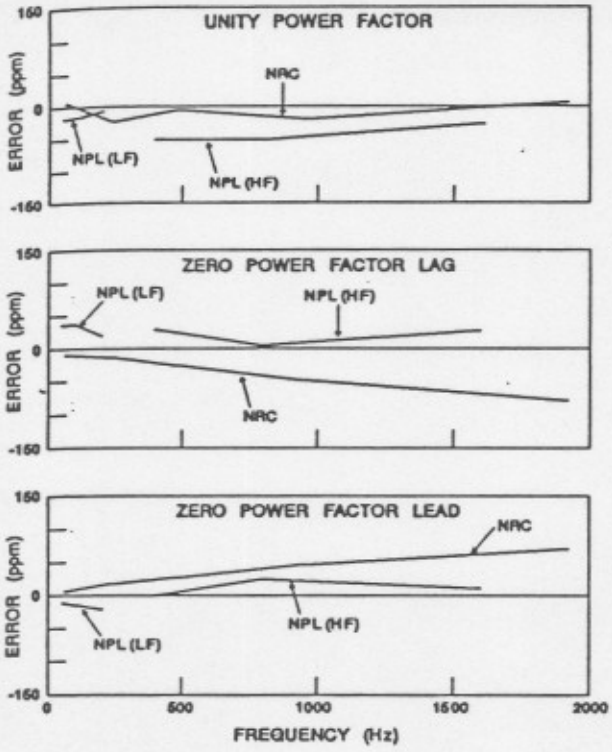

Fig. 1 Calibration of the transfer standard at NPL and NRC, June 1989

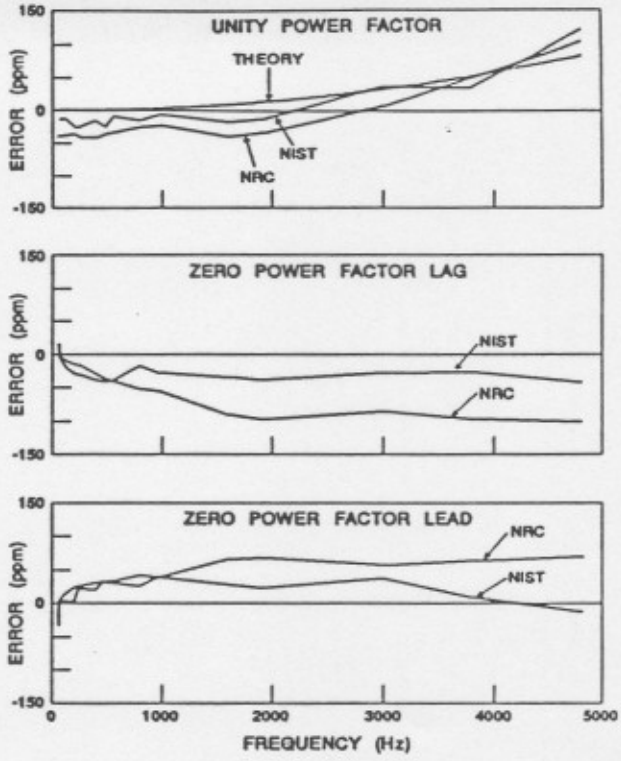

Fig.2 Calibration of the transfer standard at NIST and NRC, December 1989 - January 1990.