Application of modern method of calculating uncertainty to microwaves and opto-electronics

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***Abstract*—Recent approach is used to calculate uncertainty for an microwave and optoelectronic system. The deduced global uncertainty on spectral density of phase noise in the range of 2 dB is improved.**

***Keywords*—uncertainty; opto-electronics; microwaves**

I. Introduction

Optoelectronic oscillators (OEO) with high quality factor (Q-factor) resonators present a great interest for several applications in metrology, fundamental physics or telecommunication. These applications require that the OEO deliver an ultra stable signal [1–2]. The resonance frequency of such an oscillator is rarely predictable because it depends inherently on physical or geometrical parameters of the resonator. That's why the measurement of phase noise is not obvious to implement. A new category of instruments specially dedicated to the measurement of phase noise has been developed to determine the phase noise for any delivered signal in X-band (8.2–12.4 GHz). After a brief presentation of the main principle, we detail how the uncertainty is determined by a modern method. The main principle of high precision optoelectronic phase noise measurements were detailed in a previous work [3–4].

II. Guidelines

Starting from the main guideline [5] delivered by the Bureau International des Poids et Mesures (BIPM) in the guide "Evaluation of measurement data – Guide to the expression of uncertainty in measurement (GUM)", we can then evaluate the uncertainty. Previously the ideas of error and uncertainty were unfortunately mixed up until they were clarified by the GUM [6]. Starting from our experience on similar issues all contributions were estimated and their weight were assessed to determine uncertainties [7–9] with certain characteristics due to optics, it leads to a significantly different results from the conventional method [10]. The uncertainty in the result of a measurement consists of several components which may be easily grouped into two main categories according to the way in which their numerical value is estimated. Following the guidelines, the first category is called A–type. It is those which are evaluated by statistical methods such as reproducibility, repeatability, special consideration about Fast Fourier Transform analysis, and the experimental standard deviation. The components in category A–type are characterized by estimated variances. Second family of uncertainties contributions is for those which are evaluated by other mean. They are called B–type and depend on various components and temperature control. Experience with or general knowledge of the behavior and properties of relevant materials and instruments, manufacturer's specifications, data provided in calibration and other certificates, uncertainties assigned to reference data taken from handbooks. The components in B–type category should be characterized by quantities which may be considered as approximations to the corresponding variances.

III. Application and conclusion

By taking into account the contributions mentioned above, practically, the accuracy of determining the 2 dB overall uncertainty is logically improved.

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