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Classification of Phasometry Techniques for High-Frequency Bands

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Abstract—The paper has presented a classification of phasometry techniques for high-frequency bands developed by the author. The purpose of the study was substantiated, basic conditions were considered under which the classification was performed, and requirements set for the classification criteria were also substantiated. The attribute of "frequency conversion" was accepted as a general priority criterion for distinguishing the phasometry methods of high-frequency bands from the phasometry techniques of low-frequency bands. The classification of techniques is presented in the form of text and tables. It was performed for the techniques that can be implemented in the simplest way and the majority of which are most often applied in practice. The results have been extended to other techniques and circuits of phase meters for different bands of high frequencies.

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INTRODUCTION

Phasometry of high frequency (HF) bands is the area of knowledge that develops and introduces techniques for measuring phase characteristics of multi-port circuits and the phase difference (phase shifts) between two signals compared. The need of priority development of techniques for measuring phase shifts in HF bands has been driven by radio engineering, electronics, radiotechnical phase systems, etc. [1–6]. The techniques of HF phasometry developed for radio engineering and electronics are now extensively being used in other fields of science and technology—physics, robotics industry, metallurgy, extractive industry, agriculture, papermaking industry, etc. Therefore, the task of enhancing the efficiency of methods of phase measurements in HF bands is still urgent.

During the last 30–40 years modulation techniques of phasometry for HF bands have been introduced and materially developed ensuring new qualitative results that were realized in commercial HF phase meters. Other techniques have been also developed.

Hence, the time is ripe now for developing a classification of phasometry techniques for high frequency bands, because this issue has not been adequately handled yet.

The purpose of this study is to provide a description of the developed classification of phasometry methods for HF bands.

Initial prerequisites. Classification was performed with due regard for the following conditions: consideration is being given to the phasometry techniques for HF bands, i.e., bands of high, very-high, ultra-high, microwave, and extremely-high frequencies; relevant criteria or attributes (hereinafter criteria) of the measuring techniques bound to the band of microwave frequencies are used. The attributes of phase meters such as names of modules and units are also used; consideration is being given to the measuring techniques that are implemented by using simple two-channel circuits of microwave phase meters. The results are transferred to other kinds of circuits; we use a generalized functional block diagram of microwave phase meter consisting of three series-connected parts: modulation circuit of signals compared (SC), the circuit of data processing that includes detection, display circuit, which ensures indication of the phase shift in analogue or digital form by using voltages of intermediate frequency (IF) [3, 7–15]. Thus, the circuit of microwave phase meter contains two kinds of frequency conversion (FC): modulation and detection (demodulation); modulation is performed by harmonic, pulsed, saw-tooth, and other modulating signals; detection is performed by detectors having a quadrature characteristic; variants of IF voltages obtained in implementing different measuring techniques shall be considered equivalent. The IF values under consideration satisfy the best technical specifications of an appropriate microwave phase meter; the techniques ensure direct reading in measuring the phase shift within the cycle 0–360 between two signals compared.