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Promising Ultrabroadband Chaos Generators in the Range of High and Ultrahigh Frequencies

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Abstract—Promising generators of ultrabroadband chaotic high- and ultrahigh-frequency oscillations developed by us are presented. Experimental results on the study of the maximum generation band and output power of developed generator prototypes are considered. The need for sources of broadband and ultrabroadband chaotic radiation is caused by promising systems of data transmission using dynamic chaos, promising systems of noise radiolocation, classical problems of electronic warfare (EW) and countermeasures. In solving a number of problems of engineering processes (e.g., purification and refinement of oil, oil products, and others), such sources also seem to be useful.

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Currently, one of the innovative lines of the development of information and telecommunication systems is the use of chaotic signals as new information carriers in promising communication systems and radiolocation [1, 2]. The need for sources of broadband chaotic radiation is also caused by the classical problems of electronic warfare (EW) and countermeasures. In solving a number of problems of engineering processes (e.g., purification and refinement of oil, oil products, and others), such sources also seem to be useful. At the present time, it seems most promising to use sources of broadband chaotic low- and medium-power signals based on novel principles of chaotic signal generation, i.e., the use of non-laminar (turbulent) electron flows [3].

Table 1. Generators of broadband chaotic oscillations using non-laminar electron flows

Generator type	$P_{\max}$, W	$f_{\max}$, GHz	$\rho_{\max}$, mW/MHz
Retarding-field generators	1	3	0.42
Magnetic-compression generators	0.3	0.8	0.3
Combined-action generators	1.8	1.82	0.54

In this paper, we present the experimental results of the study of the developed prototype of the generator of chaotic oscillations using an intense electron beam with supercritical perveance. The device is based on additional electron flow retardation by a negative potential at the collector, due to which the electron flow becomes non-laminar; structures such as the "virtual cathode", i.e., electron bunches oscillating in space and in time are formed in the electron flow. These structures are sources of high-frequency (HF) and ultrahigh-frequency (microwave) oscillations. The developed and experimentally studied prototype represents an electrovacuum device with an output power to 1 W in the frequency range of 0.05–3 GHz. The main control parameter of the device is the electron beam deceleration factor K which is defined by the ratio of the collector voltage U_c to the accelerating voltage U_0, $K = 1 - (U_c/U_0)$. A change in the retarding potential has an effect on the amplitude of broadband chaotic oscillations and the bandwidth of generated frequencies (from narrow-band almost single-frequency

oscillations to broadband ones with a frequency bandwidth more than 1–2 octaves). "Virtual cathode" structures can be formed under an external magnetic field. It is also possible to use a combined effect of the retarding potential and external magnetic field; this allows generation of chaotic signals with an integral power to 1.8 W and a generation frequency to 1.8 GHz. The results of the study are given in the Table 1.

Possible fields of application correspond to priority areas, i.e., information and telecommunication systems, power engineering and power saving, and enter the list of critical technologies of the Russian Federation, i.e., technologies of data processing, storage, transmission, and security; technologies of the development of energy-saving systems of heat and electric power transportation, distribution, and consumption.

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