OPTIMIZATION SUBMILLIMETER-WAVE ORBOKLYSTRON OSCILLATORS

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The generating capability of submm-wave oscillators operating at 200 to 1360 GHz is provided by widely used BWOs that allow the output signal power to be produced from units to tens of mWatts [1, 2]. The technological limit achieved by submm-wave BWOs is dictated by the series factors. Orotrons [3] and orbotrons [4] are currently in the stage of laboratory investigations.

The present paper deals with one of the trends in developing orbotrons, specifically with the klystron interaction mechanism responsible for generating oscillations and multiplying a frequency with a high factor (over 1000 GHz). A multibeam klystron-type orbotron arrangement delivers a considerable high power of an electron flow within a device. A non-linear discrete-interaction model presented in [5] has been utilized in the course of computational procedures. This model uses the relativistic equations of motion in the system t, t_0 at one-dimensional approximation. To simulate an electron beam a large-size particle method is employed. Voltages around slots are distributed according to the normal law, with a distribution center around the last slot. For the calculation purposes we assume a voltage V_1 at the 1-*st* slot and a voltage V_n at the last slot. Then the voltage at the $k-th$ slot is calculated by the formula $V_k = V_n \exp\left[\left(\frac{X_k - X_n}{X_1 - X_n}\right)^2 Ln\frac{V_1}{V_n}\right]$ where X_k is the distance between the centers of the 1-*st* and $k-th$ slots.

	f [GHz]	V_0 [kV]	I_0 [A]	P_{5out}, W	N_b	N	h, *cm*	Δ, *cm*	d, *cm*	L, *cm*
A1	200	3	0.1	3	4	5	0.02	0.01	0.01	0.5
A2	100	3	0.5	7	8	7	0.02	0.01	0.01	0.5

The voltages $V_1 \ldots V_n$ at the slots and the lengths of drift interaction between the slot were optimized. The remaining parameters are listed in Table bellow: V_0 - acceleration voltage; I_0- operating current of an electron flow; P_{nout} -output power at a submm-wave band; N_b- the number of electron beams, beam channel width h; ribbon-shaped EB thickness Δ; EB width L; interaction gap slot width d; number of slots N. The results were obtained from designing two-stage devices operating at 200 GHz in the first stage and 1000 GHz in the second one (prototype A1) as well as the devices operating at 100 and 1000 GHz (prototype A2 –see Tabl.) respectively. The oscillator construction provides for smooth electric tuning of an output frequency signal over a range of around 20%. The versions of multibeam orbotron-klystrons which were reffered to in the paper hold great promise, because they provide an excellent basis for developing submm-wave oscillators that are operated at frequencies between 500 and 2000 GHz.

References

[1]. E.M.Gershenzon, M.B.Golant, A.A.Negirev, V.S.Saveljev. *Backward wave oscillators of mm and submm wave bands.* (in Russian). Ed. N.D. Devjatkov. - Moscow, Radio i svjaz'. 1985. - 136 p. [2]. L.Ives, C. Kory, J. Neilson, e. a. “Development of TeraHertz Backward Wave Oscillators”. *IVEC’2004. Monterey. USA. Conf. Dig. p.67-68. 2004.* [3]. V. G. Bratman, F.S. Rusin. Orotron of Submm Wave Band . *Proc. 28th Int. Conf. IRMMW’2003.* [4]. V.D.Yeryomka, A.A. Kuraev, A.K. Sinitsyn. Orbotrons - multibeam oscillators of villimeter and submillimeter waves”, (in Russian), in *Proc. 14-th Int.Conf.”Microwave & Telecommunication Technology”* Sevastopol: Weber Publishing Co*: 2004, p.199-202.* [5]. A.V. Aksenchik, A.A. Kuraev. *High-Power Microwave Devices with Discrete Interaction (Theory and Optimization).* (in Russian). Minsk: Besprint, 2003, 376 p.