EXCITATION OF PARASITIC WAVES NEAR CUTOFF IN FORWARD-WAVE AMPLIFIERS*

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There is a strong interest in developing high-power amplifiers in the W-band and at shorter wavelengths. To realize high-power operation at very short wavelengths the radiation sources should operate at high-order modes/waves. Such waves have rather dense spectrum of eigenfrequencies. Therefore the operation stability becomes a serious issue. In forward-wave amplifiers (such as traveling-wave tubes) the waves which can be excited near cutoff frequencies are among the most dangerous competitors. The excitation of such waves in the absence of the signal wave was analyzed elsewhere[1, 2].

In the present paper, we analyze the effect of the signal wave on excitation conditions of such parasitic waves. We assume that the signal wave may have large amplitude, while the parasitic wave can be considered in the small-signal regime. Then, our analysis can be divided into two steps. First, we describe the steady-state amplification of the signal wave by an ideal electron beam. This problem had been studied in the theory of traveling-wave tubes long time ago. Then, we formulate the excitation condition for the parasitic wave which can be excited near cutoff in devices with normal and anomalous dispersion of slow-wave circuits. After proper normalization this condition contains only a few parameters characterizing both waves. This makes it possible to carry out rather detailed analysis of self-excitation conditions in the parameter space. Results of this analysis can be used for designing high-power, high-frequency traveling-wave amplifiers.

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* Work is supported by the Air Force Office of Scientific Research under contract number FA95500910670