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POWER SEMICONDUCTOR PULSERS WITH INJECTION LOCKING FOR MILLIMETER RANGE OF WAVELENGTHS

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The paper is devoted to design of power pulse semiconductor sources of electromagnetic oscillation in the millimeter range of wavelengths. When dealing with short pulses, most appropriate is application of silicon IMPATT diodes with optimal geometry and doping profile. The optimal area of semiconductor structure of the diode, corresponding to a maximum of power at permissible temperatures, is shown to depend on the pulse condition parameters and on the magnitude of ohmic resistance connected in series. Several methods of combining the diodes' powers, most effective in the millimeter range of wavelengths, are considered. The paper shows the possibility of creating power pulsers in silicon IMPATT diodes designed for the pulse power of several hundred watts in the millimeter range.

The power semiconductor pulsers for the millimeter range of wavelengths have found wide application in designing small-size reliable radio equipment of various purposes. The main requirements to these generators are as follows: the necessary level of pulse power over a broad interval of parameters of the pulse mode of operation — pulse duration τ and pulse period-to-pulse duration $Q = T/\tau$ (where T is the period of repetition of pulse bursts); a wide range of working frequencies of the output signal; a high degree of coherency of the output signal at a minimum of phase and amplitude instability within the pulse duration and from pulse to pulse; high immunity of amplitude-frequency responses of the output signal to weather conditions and external mechanical actions. In the majority of applications, of importance is the requirement of minimum weight and size of the sources integrated into a single assembly with the pulse-type supply sources. Meeting the above requirements, contradictory in many cases, demands for compromise decisions in the process of selection of circuits and designs of individual parts and of the whole device.

Creation of the power semiconductor sources of the millimeter range with high levels of pulse power is based on combining the powers yielded by several active elements. Some designs of the pulse sources, with concrete parameters, are described in literature. As for optimization of the power-combining implementations in a broad interval of the energy and frequency parameters of the output signal, this issue has received little attention. The present work is devoted to analysis of optimal ways to power combiners in pulse IMPATT diodes rated at output power from several to several hundred watt, operating in the 8-mm range of wavelengths, with duration of the output signal pulse τ = 0.05–0.3 μs and pulse period-to-pulse duration $Q \geq$ 3–1000. The suggested approach to creation of power pulsers is applicable to a broad domain of frequencies — up to 100–140 GHz. The issue of stability of amplitude and phase characteristics over the pulse duration and from pulse to pulse, in a wide range of ambient temperatures, is considered in detail in [1] and is not discussed in this work.

Selection of a silicon impact avalanche and transit time diode (Si-IMPATT) for active element is dictated by the fact that it permits to attain the highest levels of pulse power — exceeding 20-30 W in the 8-mm range and 10 W in the 3-mm range at $Q >$ 100-200 and $\tau <$ 0.2 μs. These power levels are about ten times higher compared to the most efficient HEMT

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