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# ANALYSIS OF DESIGNS OF SOLID-STATE COHERENT HIGH-POWER TRANSMITTERS IN KA-RANGE

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**The paper contains the results of design of high-power solid-state coherent transmitters for the 8-mm range of wavelengths. The transmitters, providing for high phase stability and fast switching of frequencies, are intended for a new generation of short-range radar systems with high detection characteristics.**

The designing of pulse coherent semiconductor devices for the millimeter range of wavelengths is of considerable interest for creating a new generation of small-size low-range radar with high resolving capacity and noise immunity. In order to detect small-dimension targets at distances not exceeding several kilometers, we have to generate sounding signals with pulse power up to 100 W in the 8-mm range of wavelengths, when the pulse duration is 100–200 ns and pulse period - to - pulse duration ratio is within 200–300. To attain the resolving capacity in terms of a range no worse than several meters, we must expand the interval of operating frequencies up to 1–1.5 GHz, with the possibility of rapidly changing the frequencies in this interval. The need for fast switching of stable operating frequencies also arises in shipborne radar systems — to decorrelate the reflections from the sea waves. The major requirements imposed on transmitter devices of this class are as follows: maximum stability of microwave parameters (amplitude and phase) of the output signal within the pulse duration; and high immunity of microwave parameters to environmental and mechanical impacts.

Below we give the description and results of designing of pulse coherent power amplifiers and of multifunction phase-stable frequency synthesizers with fast switching.

The principle of construction of the transmitters under consideration is based on application of pulse adders of power with the use of IMPATT-diodes. The latter are locked in by a signal formed by a frequency synthesizer providing for high frequency stability, low level of power spectral density of phase noise, and able to switch the partial frequencies in a wide interval (beyond 1 GHz) with the switching time not exceeding several microseconds. With the synthesizer power less than 10 mW we have to use 3 or 4 synchronized stages with overall gain factor up to 40 dB. The functional diagram of a 4-stage transmitter with output pulse power 100 W, operating in the 8-mm range of wavelengths, is presented in Fig. 1. As can be seen from the block-diagram, the first two stages are single-diode-type, with their gain factor 16–17 dB per stage. The driver and output stages are power adders with 2-3 IMPATT-diodes in each stage. The stages are connected so as to obtain cascade summation.

The design of transmitters of this class has required tackling a number of problems, particularly:

1) Creation of effective pulse silicon double-drift IMPATT-diodes for the millimeter range of wavelengths, with pulse power level beyond 20 W, pulse duration 100–200 ns, and minimum pulse period-to-pulse duration ratio 200. The high efficiency of the diodes is attained due to optimization of the doping profile of the $p^+$-$p$-$n$-$n^+$-structures, and due to special geometry of the structure, ensuring the maximum attainable power level at the prescribed parameters of pulse mode of operation (pulse duration and pulse period-to-pulse duration ratio), and minimum of ohmic losses in the substrate of the semiconductor structure as well as in the wiring elements inside the metal-ceramic casing of the diode.

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