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AMPLIFICATION OF PHASE-KEYED SIGNALS BY DEVICES IN IMPATT-DIODES

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The paper considers transient processes when settling discrete phases in the process of amplification of phase-keyed signals by devices in IMPATT-diodes. The possibility for diminishing the settling time of output signal phase is shown.

The problem of raising the range of action of radar systems without loss of resolving capacity necessitates application of signals of complex shape, characterized with considerable energy and wide frequency spectrum. In the case of maximum attainable pulse power, considerable energy in the pulse can be obtained by increasing the pulse duration. On the other hand, expansion of signal spectrum can be achieved by introduction of intrapulse frequency or phase modulation. One of techniques permitting to expand the radio pulse spectrum consists in application of phase-keying, when the pulse of duration t_p is broken into n partial pulses, adjacent to one another, with their duration $\tau_0 = t_p/n$, and each of these pulses is supplied with its own phase shift $\Delta\varphi = 2\pi/m$, where m is an integer. At $m = 2$, only two different values of $\Delta\varphi$ are possible (0 or π), and this modulation is called counterphase (binary phase-shift) keying. At $m > 2$ the phase-keying is called multiphase. In the receiver, with the use of optimal filtering methods, we can compress the received pulse (of duration t_p) n times (i.e., to the duration τ_0), and raise the power level n times [1].

When creating the transmitters of phase-keyed powerful signals with the use of passive or locked-in semiconductor amplifiers, another problem arises: to set the phase jumps, equal to $\Delta\varphi$, with minimum time of transient process precedent to settling the phase of every partial pulse. A rather long time of phase settling may hamper the shortening of τ_0 necessary for improving the resolving capacity and, in the injection-locking mode of operation, lead to noise-like bursts of output signal during transient processes. In this work we consider transient processes of settling the discrete phases in the process of amplification of phase-keyed signals by devices in avalanche (IMPATT) diodes.

In conformity with [2], the steady-state mode of amplification (both passive and lock-in) is defined by the equation

$$\overline{H}(\omega_0, U_{m0}, I_0)U_{m0} = H_0 e^{j\chi_0} = i_s e^{j(\varphi_s^0 - \varphi_U^0)}. \qquad (1)$$

Here ω_0 and U_{m0} are, respectively, the frequency and amplitude of voltage across the diode terminals under steady-state conditions; φ_s^0 and φ_U^0 are stationary phases of the locking signal current i_s and of the diode voltage. $\overline{H}(\omega_0, U_{m0}, I_0) = \overline{Y}_d(\omega_0, U_{m0}, I_0) + \overline{Y}_{ld}(\omega_0)$, where $\overline{Y}_d(\omega_0, U_{m0}, I_0)$ is complex conductance of the semiconductor diode, and $\overline{Y}_{ld}(\omega_0)$ is the load complex conductance reduced to the diode terminals.

If the phase of the synchronization signal at the time instant $t = 0$ changes by $\Delta\varphi_s$, a transient process $\Delta U_m(t)$, $\Delta\varphi_U(t)$ starts, and the equation describing this process takes the form

$$\left[\overline{H}_0 + \Delta\overline{H}(\Delta U_m, \Delta\varphi_U)\right](U_{m0} + \Delta U_m)e^{j(\varphi_U^0 + \Delta\varphi_U)} = i_s e^{j(\varphi_s^0 + \Delta\varphi_s)}. \qquad (2)$$

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