INVESTIGATION OF LOCKING SUBSYSTEMS FOR TRACKING RADIO-RECEPTION DEVICES FOR BROADBAND SIGNALS HAVING COMPLEMENTARY FREQUENCY MODULATION

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Results have been presented of theoretical and experimental investigations of a locking subsystem for tracking radio-reception devices for broadband signals with complementary FM. A procedure has been described for performing the experimental investigations.

In [1] an investigation was made of the interference immunity of tracking radio-reception devices for analog broad-band signals with complementary frequency modulation (FM).

The results of the investigations are a very important stage in the study of such devices. However, a more complete estimation of the performance of broad-band radio-telephone communication systems requires the investigation of one of the most important links in tracking radio-reception devices - the locking subsystem.

The present work presents the results of theoretical and experimental investigations of such a subsystem when phase-shift automatic frequency control (PAFC) of the carrier oscillator of the receiver is used.

When methods of tracking reception of broad-band signals with complementary frequency modulation are used, the satisfactory operation of the overall communication system requires the existence of a time reference common to both the transmitter and receiver. In this connection, such a communication system is locked overall (see [2]).

The block diagram of a tracking radio-reception device for broad-band signals with complementary FM is shown in Fig. 1 for the case in which the system contains a phase-locking system. The following notation has been used: 1) tracking input circuit and RF amplifier; 2) mixer; 3) intermediate-frequency amplifier; 4) detector; 5) output stages; 6) additional compensating device; 7) phase detector; 8) low-pass filter; 9) frequency-drive element; 10) carrier oscillator; 11) frequency-control heterodyne.

The principal merit of PAFC when it is used in locking systems is its high interference immunity.

In tracking radio-reception devices, the locking band will be significantly smaller than the locking band of the phase-locking system (PLS) proper. This is due to the fact that the time for which the useful signal remains within the passband of the reception device without phase and frequency control of the carrier oscillator is inversely proportional to the magnitude of the initial frequency detuning between the "auxiliary" transmitter wave and the wave produced by the carrier oscillator in the receiver (see [3]). In this connection, the locking of the useful signal is possible (see [3]) only for fulfillment of the condition

$$\tau_{ccd} + t_l \leqslant (\arcsin \Delta\omega_{pa}/\Delta\omega_a)/\pi\Delta F_s, \tag{1}$$

where τ_{ccd} is the time constant of the component 6 in the block diagram (Fig. 1); t_l is the time required for locking of the frequency and phase of the carrier-oscillator wave after the useful signal has entered the receiver passband; $2\Delta\omega_{pa}$ is the passband of the intermediate-frequency amplifier; $\Delta\omega_a$ is the frequency deviation of the useful signal due to the additional frequency modulation; ΔF_s is the frequency difference between the "auxiliary" wave of the transmitter and the signal produced by the receiver carrier oscillator.

From Eq. (1) it follows that the locking band for a low interference level may be defined as

$$\Delta F_l < (\arcsin \Delta\omega_{pa}/\Delta\omega_a)\, 2\pi t_l. \tag{2}$$

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