spectrometers, including strong perturbing *rf* fields, INDOR, etc. For experiments with variable sample temperature it has a serious advantage, since the balance drift of the *rf* bridge or crossed coils is eliminated and the influence of the phase drift connected with the probe circuit is halved.

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*A. SÜGIS*

# CURRENT-CONTROLLED DIODES AS VARICAPS IN OSCILLATORS

*A. SÜGIS.* VOOLUGA TÜÜRITAVAD DIOODID KUI VARIKAPID OSTSILLAATORITES

*A. СЮГИС.* ДИОДЫ, УПРАВЛЯЕМЫЕ ТОКОМ, КАК ВАРИКАПЫ В ГЕНЕРАТОРАХ

Voltage-variable capacitors have strongly nonlinear voltage-capacitance characteristics hindering their usage in voltage-controlled oscillators (VCO-s), unless only a small portion of the characteristic is used or rough nonlinearity can be tolerated. Operating of a varicap or even a rectifier diode in a detecting mode solves this nonlinearity problem for VCO-s. We have used diodes in the detecting mode for the improvement of frequency synthesizers [1], while Touissant and Olfs noted only some extension of the tuning range of an oscillator [2].

A diode detector is converted into a current-controlled diode by applying a control voltage $E_{in}$ to the load resistor $R_L$ (Fig. 1, *a*), which controls mean current $I$ through the diode. This diode is switched on and off by the oscillator voltage, while conducting angle is controlled by $E_{in}$. A suitable capacitance $C_c$ which couples the tank circuit $LC$ of an oscillator to the diode, is essential for proper operation. During the "on" cycle,

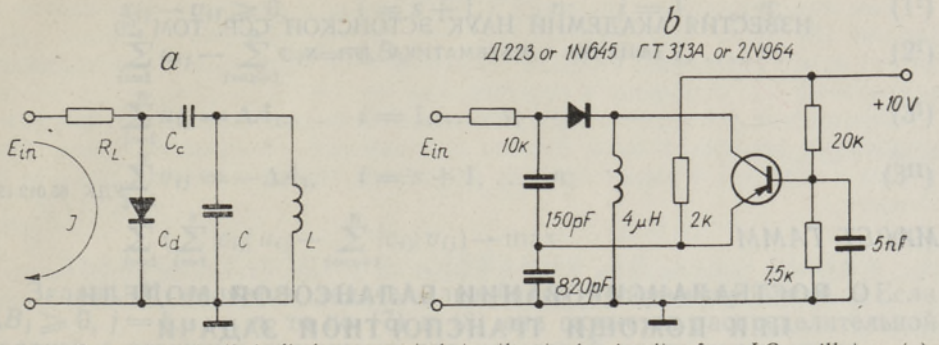


Fig. 1. Current-controlled diode connected to the tank circuit of a *LC*-oscillator (*a*) and an example of a VCO with current-controlled diode (*b*).

$C_d \gg C_c$, and $C_c$ is almost earthed. A suitable diode must be chosen, which has $C_d < C_c$ during the "off" cycle. Hence, $C_c$ and not the diode determines frequency deviation range, the effective capacitance being approximately proportional to the current $I$.

For optimum linearity, the diode must have $C_d = (0{,}1 \ldots 0.3)C_c$ at reverse bias equalling the oscillator peak voltage. Almost every kind or type of diodes, except the point contact ones, has shown linear performance for suitable $C_c$, maintaining good uniformity of characteristics from sample to sample. Besides, effective capacitance range of varicaps is greatly extended, allowing to use one diode instead of several parallel-connected ones. If control voltage $E_{in}$ exceeds oscillator peak voltage $U_m$, the diode ceases to operate in a current-controlled mode and begins to operate in the usual varicap mode (Fig. 2).

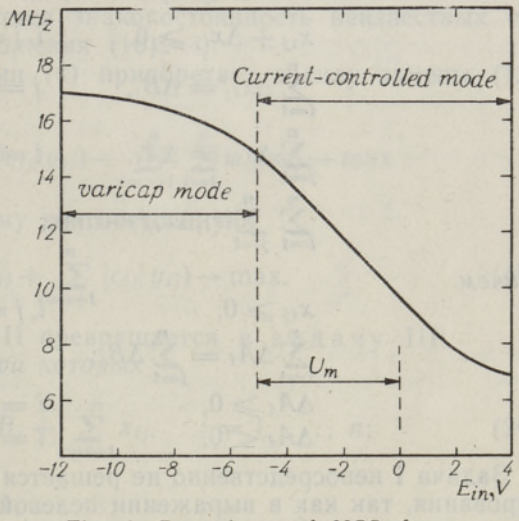


Fig. 2. Dependence of VCO frequency on control voltage.

An example of a VCO with the current-controlled diode is presented in Fig. 1, *b*. The circuit maintains good linearity up to rather large deviation ranges (see Fig. 2). So, frequency versus control voltage exhibits a portion between 9 and 13 MHz with a nonlinearity as low as 1 per cent. The characteristics are quite similar for two rather different pairs of semiconductors (see Fig. 1, *b*). Amplitude variation amounts to 1 : 1.5 for a frequency deviation ratio of 1 : 2.

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