**Excitation of Multiresonance Microwave Oscillations in Bulk Lithium Niobate Crystals in Interaction with T-waves of Strip Structures**

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lectrooptical crystals of lithium niobate and other materials are widely used for the manufacture of photonic devices [1-4]. In [5], non-reciprocal properties of backscattering of waves from bulk lithium niobate crystals were investigated and a conclusion was made about the possibility of applying the results obtained when creating Doppler frequency shift simulators, ultrasonic vibration sensors for contactless diagnostics of systems in the millimeter range of microwave and information transmission by means of exposure to ultrasound crystals. Thus, determining the characteristics of bulk electro-optical crystals for the design of functional devices is an urgent task. This paper presents the results of an experimental study of the excitation of multiresonances in a module containing a volumetric lithium niobate crystal as a dielectric filling of the upper half-plane of a coplanar strip transmission line (CPL). The design of the two modules is shown in Fig. 1. Both modules have a matching wave resistance of 50 ohms in the absence of dielectric filling of the upper half-plane. The CPL is made on an FR4 dielectric. The design of the CPL has two gaps between the conductive strip and the side screens. The crystal is exposed to a linearly frequency-modulated quasi-T-wave field in the frequency range from 10 MHz to 26.5 GHz. We experimentally measured the modulus and phase of the transmission coefficient |*S*21(*f*)|, arg[*S*21(*f*)], and the modulus and phase of the return loss |*S*11(*f*)| и arg[*S*11(*f*)].

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| *a* | *b* |

Fig. 1. Module designs based on a coplanar strip line with a lithium niobate crystal placed on it.

The electromagnetic field in the gaps of the coplanar line is conditionally divided into two connected flows. The first flow propagates in the dielectric substrate of the CPL, the second propagates in the crystal. But these flows are strongly coupled. The substrate is made of a homogeneous and isotropic dielectric, and the lithium niobate crystal, being uniaxial and characterized by a trigonal crystal system, has anisotropy of dielectric properties [6]. The electromagnetic field in the gaps of the CPL excites electromagnetic oscillations in the lithium niobate crystal by two dipole-type sources formed in the in-phase mode. When the microwave quasi-T- wave propagates along the current-carrying strip of the coplanar strip line and along the *z* axis of the crystal, the electric field (see Fig. 1, *a*) has two components *Ex*, *Ey*, on the *x* axis and on the *y* axis. This causes an electro-optical effect for waves polarized in the *x*’ and *y*’ directions, with the *x*’ and *y*’ axes rotated by an angle  relative to the *x* and *y* axes of the crystal structure. The velocities of the considered waves with components *Ex*, and *Ey*, are different, because the relative static permittivity’s are not equal ε11 > ε33.

A “slow” wave is formed with a speed of *v*1 and a “fast” one with a speed of *v*2. Due to the alternating sign process of changing the fields *Ex*, and *Ey*, the situation is reversed with the frequency *f* of a linearly modulated signal acting on a segment of a coplanar strip line and a crystal. At the same time, a quasi-T-wave is transformed in the current-carrying strip. This transformation is caused by the influence of the field components arising inside the crystal due to polarization and “splitting” of the quasi-T-wave in the strip structure. Proper waves are excited in the crystal as a volumetric dielectric resonator with a spectrum of proper waves. There are waves associated with the main quasi-T wave of waves, the phase velocities of which differ significantly. The occurrence of combined waves due to the transformation of a quasi-T-wave leads to their interference, because the phase velocities are different. The above processes lead to amplitude and phase quasi-chaotic oscillations of |*S*21(*f*)|, arg[*S*21(*f*)], |*S*11(*f*)| and arg[*S*11(*f*)]. Fig. 2 - Fig. 5 illustrate the phenomenon of the formation of a quasi-chaotic signal in the module under study  
Fig. 1, *a*.

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| Fig. 2. Frequency dependence of transmission coefficient modules |*S*21(*f*)| and return losses |*S*11(*f*)| of CPL without crystal. | Fig. 3. Frequency dependence of the transmission coefficient phase arg[*S*21(*f*)] and the return loss phase arg[*S*11(*f*)] of CPL without crystal. |
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| Fig. 4. Frequency dependence of transmission coefficient modules |*S*21(*f*)| and return losses |*S*11(*f*)| of CPL with a lithium niobate crystal included in the structure. | Fig. 5. Frequency dependence of the phases of transmission coefficient arg[*S*21(*f*)] and the return loss arg[*S*11(*f*)] of CPL with crystal. |

Based on the conducted experimental studies, a module of a quasi-chaotic ultrahigh frequency signal generator has been developed, which provides the possibility of functioning in the range from 5 to 26.5 GHz.

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**Biography:**

**Malyutin Nickolay Dmitrievich** – Doctor of Technical Sciences in the field of antennas and microwave devices. The main areas of scientific interests are in the theory of coupled strip lines, analysis of coupled waves with significantly different phase velocities, as well as the development of microwave devices. The most significant scientific and practical achievements have been obtained in the creation of wide-band phase shifters with low losses, correctors of amplitude-frequency characteristics of electronic devices, stands and devices for measuring vector parmeters of microwave circuits in the pulsed mode of exposure. Since 1996, Nikolay Malyutin has become a professor at Tomsk State University of Control Systems and Radio Electronics. Currently, he is engaged in solving problems of measuring non-reciprocal backscattering from various objects, including electro-optical crystals.