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A subharmonic mixer for the 220–325 GHz frequency range

A.V. Zorenko[1], N.V. Kolesnik[1], T.V. Kritskaya[1], Ya.Ya. Kudryk[2], Yu.V. Marunenko[1], L.P. Ryzhanovich[1]
[1]*State Enterprise Research Institute "Orion", 03057 Kyiv, Ukraine; e-mail: zav456@gmail.com*
[2]*V. Lashkaryov Institute of Semiconductor Physics, NAS of Ukraine, 03028 Kyiv, Ukraine*
E-mail: konakova@isp.kiev.ua

Abstract. We have made a subharmonic mixer (SHM) for the 220–325 GHz frequency range with conversion losses lower than 30 dB at the intermediate frequency 3 GHz. The subharmonic mixer design was based on a GaAs mixer Schottky barrier diode with beam leads on a quartz 25-μm thick microwave board. The microwave board was placed in a package with a waveguide channel of local oscillator input (cross-sectional area 1.2×2.4 mm^2) and waveguide channel of signal input (cross-sectional area 0.4×0.8 mm^2). The IF signal goes out through a subminiature A-connector, wave impedance of which is 50 Ohm.

Keywords: subharmonic mixer, Schottky barrier diode, millimeter wave band, terahertz band.

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1. Introduction

It is known that progress of communication systems involves transition to compound and digital signals as well as increasing transmission speed of bit streams. This, in its turn, leads to broadening the spectrum of transmitted frequencies and requires the use of microwave frequencies (up to 1000 GHz) [1 – 3].

In this paper, we present a subharmonic mixer (SHM) intended for the 220–325 GHz frequency range. The appearance of an experimental specimen of SHM is shown in Fig. 1. The cross-sectional areas of the waveguide channel of local oscillator (LO) input and waveguide channel of signal input are 1.2×2.4 mm^2 and 0.4×0.8 mm^2, respectively. The intermediate frequency (IF) signal goes out through the subminiature A-connector (SMA) (wave impedance of 50 Ohm). SHM involves a package, microwave board and GaAs mixer Schottky barrier diode (SBD) with beam leads. The microwave board is made of 25-μm thick quartz (metallized on both sides); the thickness of metallization is 3 μm.

To study the electrical parameters of SHMs with SBD, a measuring bench was made, which block diagram is presented in Fig. 2. A signal in the 73…108.3 GHz frequency range came to the SHM LO input from an unconventional oscillator O2. The constant power level of 20 mW was sustained at the oscillator output using a mechanical attenuator ATT. A signal from frequency multiplier FM came to the SHM input. An unconventional tunable oscillator O1 (frequency tuning range of 110–165 GHz) served as a pump oscillator for FM. When measuring the conversion factor, the power output irregularity was taken into account. The triple LO frequency and input signal frequency were set so that their difference equaled 3 GHz. The IF signal power was measured with a scaling amplifier and mW meter PM.

The results of the measurements are shown in Fig. 3. One can see that, as the LO power P_{LO} increases, conversion losses K becomes lower and flatten out. At the maximal LO power of 25 mW, the conversion losses K are lower than 30 dB.

The results of measuring the conversion losses as a function of radio frequency are shown in Fig. 4. One can see that the conversion losses K are better than 30 dB in the 220–325 GHz frequency range.

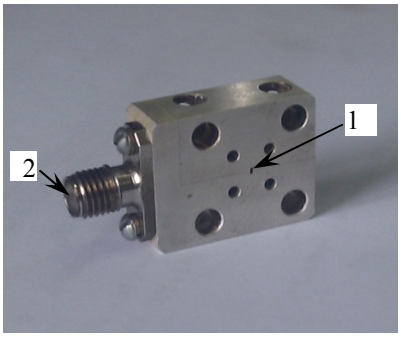

Fig. 1. The appearance of an experimental specimen of SHM intended for the 220…325 GHz frequency range. *1* – microwave signal input (220…325 GHz); *2* – IF signal output (3 GHz).

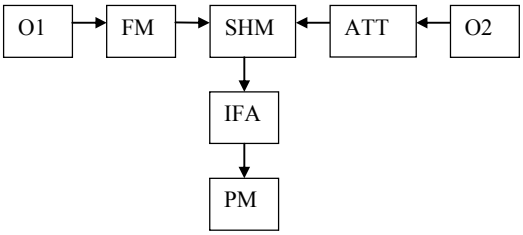

Fig. 2. The block diagram of the measuring bench: SHM – subharmonic mixer; O1 – oscillator of microwave signals (radiofrequency F_{RF}); O2 – microwave heterodyne oscillator; FM – frequency multiplier (frequency multiplication ratio of two); ATT – mechanical attenuator; IFA – intermediate-frequency amplifier; PM – mW meter.

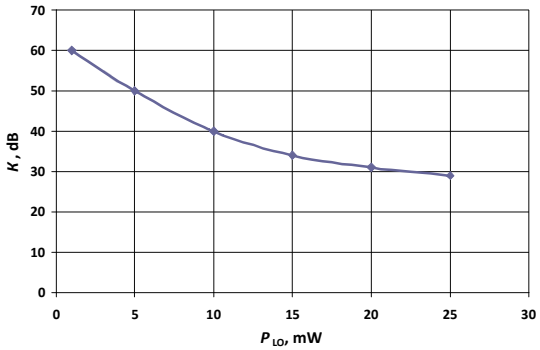

Fig. 3. SHM conversion losses K as a function of local oscillator power P_{LO} at the frequency 280 GHz.

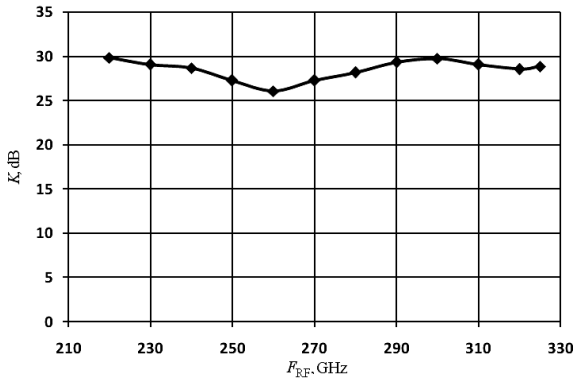

Fig. 4. SHM conversion losses K as a function of radio frequency F_{RF}.

Conclusions. The experimental specimen of SHM with SBD intended for the 220…325 GHz operation frequency range has been made. The study of their electrical parameters under normal climatic conditions has shown that the SHM conversion losses in the operation frequency range are lower than 30 dB at IF of 3 GHz.

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