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MODELING OF TERAHERTZ WIRELESS SYSTEM

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Моделювання терагерцової бездротової системи

У статті представлена змодельована бездротова система на частоті 240 ГГц. Доцільність вибору робочої частоти полягає в тому, що цей діапазон має високу пропускну здатність і низьку втрату через наявність атмосферних вікон прозорості. У склад моделі входять наступні модулі: джерело цифрової послідовності 128QAM, гетеродин 120 ГГц, перетворювачі вверх та вниз по частоті, підсилювач потужності та смугопропускний фільтр. Результати моделювання системи 240 ГГц лежать в межах норми та їх можна побачити у вигляді графіків.

Use of frequencies from 200 to 300 GHz for wireless data can serve as an interesting alternative solution to the problem of insufficiency of bandwidth. This frequency band is well suited for communication and data applications available via high bandwidth and low loss because of atmospheric transparency windows. Communication systems in this mode can succeed data rate greater than 10 Gbit/s. But the problem is the increasing transmission distance without degradation BER and other quality characteristics [1].

To simulate the wireless system was chosen operating frequency of 240 GHz. The feasibility of using it is that the selected frequency of 240 GHz has the lowest value of attenuation in the atmosphere.

To achieve the required capacity and bandwidth data transfer can be improved by using more sophisticated methods of modulation, which comes with the huge amount of data baseband.

The prospective area for wireless systems in terahertz range is the development and implementation of new circuit solutions, the use of submicron and nanoelectronic components in the construction transceiver and antenna equipment, which will primarily reduce the cost of equipment and provide the necessary electrical and energy performance. Small weight and dimensions of terahertz range at high speed information transfer and communication reliability make them attractive for use in airborne equipment as in [2].

The aim is creation model of terahertz system using separated modules, investigation of changes in the basic characteristics of the system to the initial results, and tuning a model system with better performance and analysis of the results.

Modeling the system at a frequency of 240 GHz. To simulate the wireless system was chosen operating frequency of 240 GHz. The feasibility of using it is as follows. Fluctuations of molecular oxygen and water molecules cause high attenuation of waves around the resonance frequency of the molecules. The resonant frequency of water molecules in Earth's atmosphere are at 182 and 325 GHz. Frequency band wireless communications at 240 GHz with a bandwidth of 60 GHz is located in the atmospheric window between the two resonant frequencies and cutoff frequency attenuation values between 2.7 dB / km at 213 GHz and 4.54 dB / km at 280 GHz. Therefore, the selected frequency 240 GHz has the lowest value of attenuation in the atmosphere.

To create a system at a frequency of 240 GHz were used modules transmitter and receiver technology for MMIC. Each module can be manufactured on a single chip. The system structure includes the following components: a local oscillator, two mixers, amplifiers, passband filter and receiver (Figure 1). The input RF mixer to the transferor receives QAM signal with pseudorandom bit sequence. Signal simulated 128 QAM modulation. LO input signal is 120 GHz, then passed through doubler and oscillator phase noise. The presence of phase noise in the subcircuit is used to add phase noise at 28GHz tone.

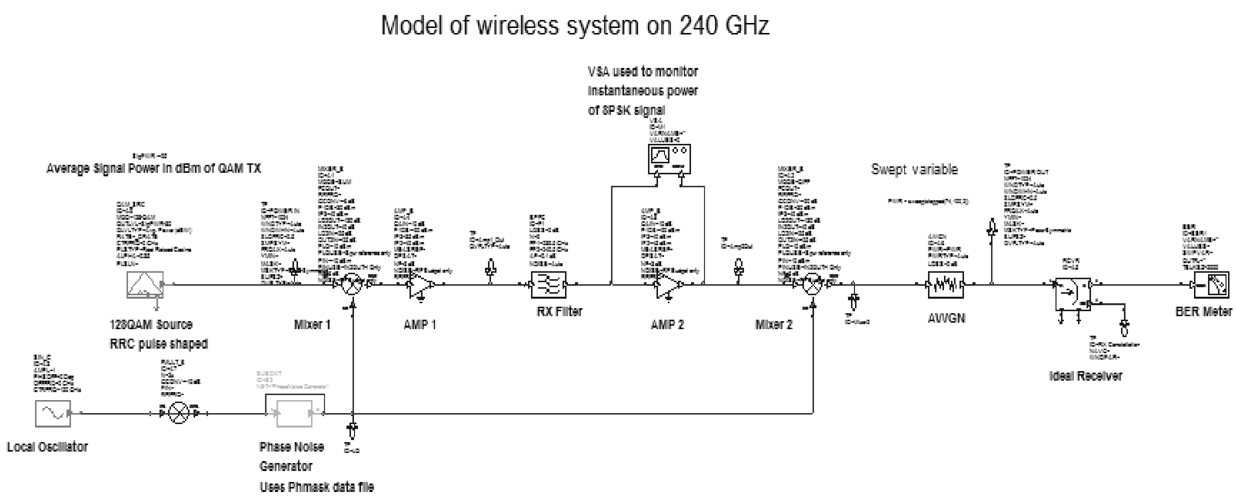

Fig. 1 The model wireless system

Mixer circuit implements a model nonlinear mixer. Intermodulation distortion automatically calculated using the basic equations. Harmonic distortion is clearly defined. Loss conversion is -6 dB. Third order of intermodulation point is at 40 dBm. The ratio of input to output noise is 6 dB. The noise is implemented as thermal noise at the output.

Further, the output signal is fed to a nonlinear amplifier with gain equal 10 dB after passing through the filter. The lower frequency is equal to 239.5 GHz and upper is 240.5 GHz.

Results of modeling. The spectrum of the signal shown in Figure 2. It can be seen at the operating frequency of 240 GHz signal has its maximum and after passing is -2.7 dBm power amplifier (pink curve), the output of the filter is -25.66 dBm (brown line) and after amplifier is - 4.86 dBm (blue curve).

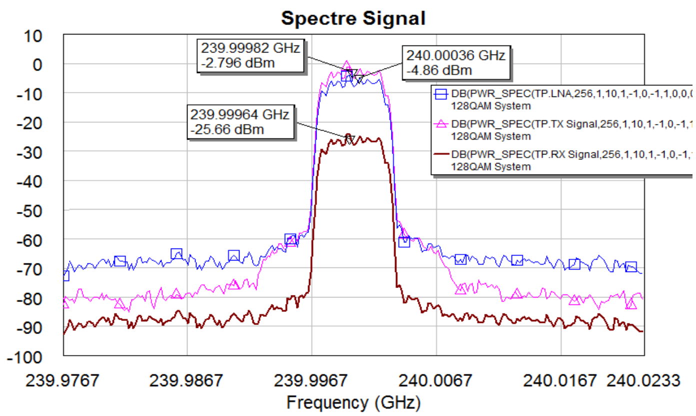

Fig. 2 Signal power in different parts of the system

The simulation results of bit error probability (BER) is calculated as a function of the signal at the receiver input based simulation Monte Carlo (Monte Carlo). The weakening of the signal at the input of the transmitter power amplifier is used to set a suitable level of spectral characteristics.

At the level of BER equal 10-4, SNR is 27.2 (Figure 3).

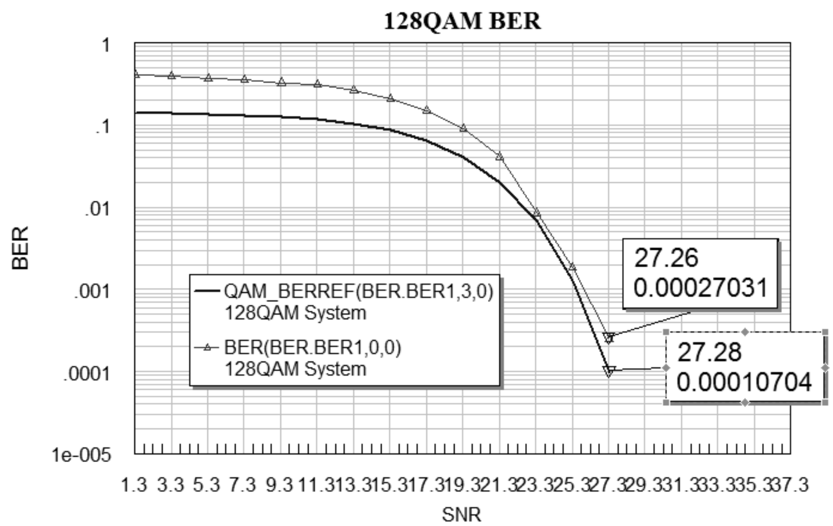

Fig. 3. Simulated BER characteristics when using a non-linear amplifier mode

Conclusions. There has been implemented a model wireless system at a frequency of 240 GHz and analysed of the results. The basic criteria was to obtain the best possible quality characteristics and BER - 1 * 10^{-4} result that, based on the analysis of other systems is in the normal range for the frequency of 240 GHz.

References

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2. Kallfass, A. Tessmann, H. Massler, A. Leuther, M. Schlechtweg, O. Ambacher, "A 200 ghz active heterodyne receiver mmic with low subharmonic lo power requirements for imaging frontends," *in Proc. 4th European Microwave Integrated Circuit Conference, Rome*, pp. 45–48, September 2009