RESEARCH OF INFLUENCE OF SUPPLY MODE OF DOUBLE-DRIFT AVALANCHE DIODES ON Q-FACTOR OF 3-mm BAND NOISE OSCILLATOR

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Annotation — The experimental research of silicon double-drift avalanche diodes which are the active element of 3-mm super wideband noise oscillators that work in the anomalous mode, was held. The influence of the supply mode of diodes on quality coefficient of the noise oscillator (NO) was shown.

I. Introduction

The characteristics of NO which work in the anomalous mode and based on the avalanche diodes have not changed in the latest years [1-3]. The reached electrical parameters prove the fact that IMPATT mode is the theoretical peak of possible noise levels.

The movement into a shortwave part of the millimeter range requires the increasing of working current, which in IMPATT mode causes decreasing of a sharp noise level. To solve this theoretical conflict, an anomalous mode for avalanche diodes, which is different from an ordinary impulse mode, was offered.

Articles [3, 4] show the possibility of creation of super wideband NO based on 3-mm band avalanche diode with a noise level not less than 55dB/kT_0 (Fig. 1). The oscillator is based on a double-drift avalanche diode with $p^+ - p - n - n^+$ structure, which length of the span area and carrier density correspond to 3-mm band range of middle frequencies.

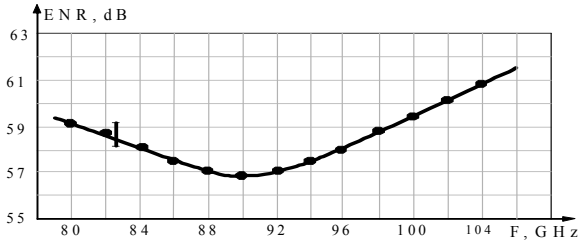

Fig. 1. Characteristics of noise factor in operating range.

Рис. 1. Характеристика уровня шума в рабочей полосе частот

In the anomalous mode the regulate bias voltage, which is lower than piercing voltage, is applied to diode and then short impulses with high voltage amplitude which follow with high off-duty ratio are overlaid.

The aim of the work is to research the influence of the supply mode of double-drift avalanche diodes on electrical parameters of the noise oscillator such as working bandwidth and generated noise levels due the given value of spectral concentration of the noise facility ±1,5dB. To compare the results which were obtained from different oscillators, a new magnitude such as quality coefficient Q of the noise oscillator is introduced. It has been calculated to be equal to product of width of the working range and quantity of spectral concentration of the noise facility.

II. Experimental Part

The anomalous supply mode provides a work of avalanche diodes in the shortwave part of microwave band and obtaining high levels of spectral concentration of the noise facility. Mentioned requirements have been fulfilled due to high supply voltage in impulses and presence of transient processes which have provided the continuity of output noise signal of high frequency in spite of pulsed supply. Constant bias voltage, which is lower than piercing voltage, allows obtaining the high level of microplasma noises that gain strength by high frequency chain of tuning of inclusion of the avalanche diode. This is possible because of non-linear characteristics of a diode and negative resistance.

The research of influence of parameters of the supply mode of double-drift avalanche diodes were held on tuned super wideband NO. The research of the influence of each parameter of the supply mode was held without changes in the high frequency chain of tuning of inclusion of the avalanche diode.

The fig. 2 shows the experimental dependence of quantity of quality coefficient of the noise oscillator on difference of quantity of punch-through voltage U_p and constant bias voltage $U_=$. The magnitude of quality coefficient of the noise oscillator has maximal value only in the areas of bias voltages in which, with a glance at transient processes of voltage changes, microplasmas are implemented.

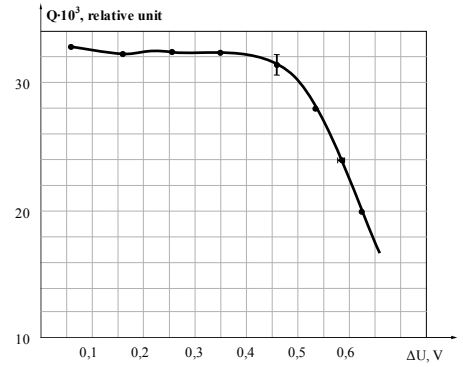

Fig. 2. Experimental dependence of Q factor of noise oscillator on back bias voltage.

Рис. 2. Зависимость величины ККГШ от постоянного напряжения

The figure 3 shows the dependence of quality coefficient of the noise oscillator on impulse amplitude for few batches of diodes. Given dependence demonstrates the presence of an optimal value of impulse amplitude due to given high frequency chain of inclusion of the avalanche diode. Small impulses have a very sharp de-

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pendence and by increasing impulse amplitude of the diode the mode comes to the given frequency. Whilst from the side of high amplitudes the oscillator gradually comes out of working band which leads to graduate changes of Q factor of the noise oscillator.

The experimental dependence of Q factor of the noise oscillator on the impulse length is shown on figure 4. The dependence is characterized by the sharp decreasing of generated noises and Q coefficient of the noise oscillator whilst the length of impulses increases. The behavior of the dependence is explained by the increasing of time between transferring processes which implement noises. Besides, changes in the length of supply impulses cause changes in the rate of modulation in the spectrum of a signal, therefore the ripple of ENR in working band. This also decreases the Q factor of the noise oscillator.

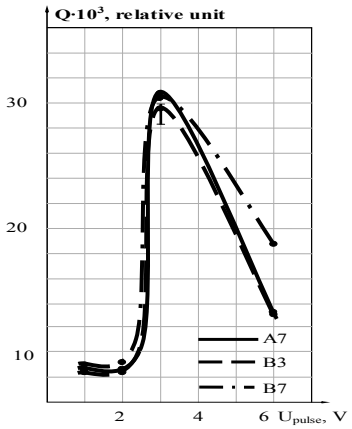

Fig. 3. Experimental dependence of Q factor of noise oscillator on amplitude of pulses.

Рис. 3. Зависимость ККГШ исследуемых ЛПД от величины амплитуды импульсов

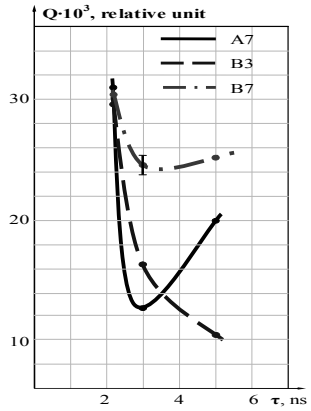

Fig. 4. Experimental dependence of Q factor of noise oscillator on length of pulses.

Рис. 4. Экспериментальные зависимости уровней ККГШ от длительности импульсов

The figure 5 shows the dependence of Q coefficient of noise oscillator on period of repeating of impulses for different batches of diodes and amplitudes of impulses. The dependence of the behavior is defined by changes in average current which flows through the diode and defines the increase of noise. Small values of amplitude of impulses (1-2 V) nearly do not increase the operating band in spite of off-duty ratio so the Q factor of noise oscillator is small and constant. 3 V amplitude corresponds to maximum increase in the working band so Q coefficient of noise oscillator is high and decrease only when pulse time is increased. Further increase of an amplitude (until 6 V) leads to mismatch between diode and its high frequency chain of inclusion. The dependence of Q factor of the noise oscillator is hyperbolic.

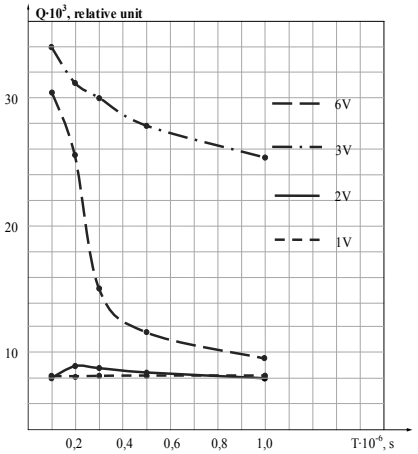

Fig. 5. Experimental dependence of Q factor of noise oscillator on time of repetition of pulses.

Рис. 5. Зависимость уровня ККГШ исследуемых ЛПД при изменении периода повторения импульсов

III. Acknowledgments

The investigations of the influence of the supply mode of double-drift avalanche diodes on 3-mm band noise oscillator which were held allows us to make statement about the flexibility of the anomaly mode, which allows implementing of a high level of ENR of the noise oscillator in a wide frequency range. The reach of high levels of ENR is bounded by low frequency noise amplification and removes them to the shortwave part of mm range. Other methods might not be used to obtain wideband noises with a power level not less than 55dB/kT0.

IV. References

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ИССЛЕДОВАНИЕ ВЛИЯНИЯ РЕЖИМОВ ПИТАНИЯ ДВУХПРОЛЕТНЫХ ДИОДОВ НА КАЧЕСТВО ГЕНЕРАТОРОВ ШУМА

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Аннотация — Проведены исследования двухпролетных лавинно-пролетных диодов, являющихся активными элементами при построении широкополосных генераторов шума 3-х мм диапазона. Показано влияние параметров питания диодов на коэффициент качества генераторов шума.

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