EFRE 2020

Nanosecond Microwave Pulse Compressor

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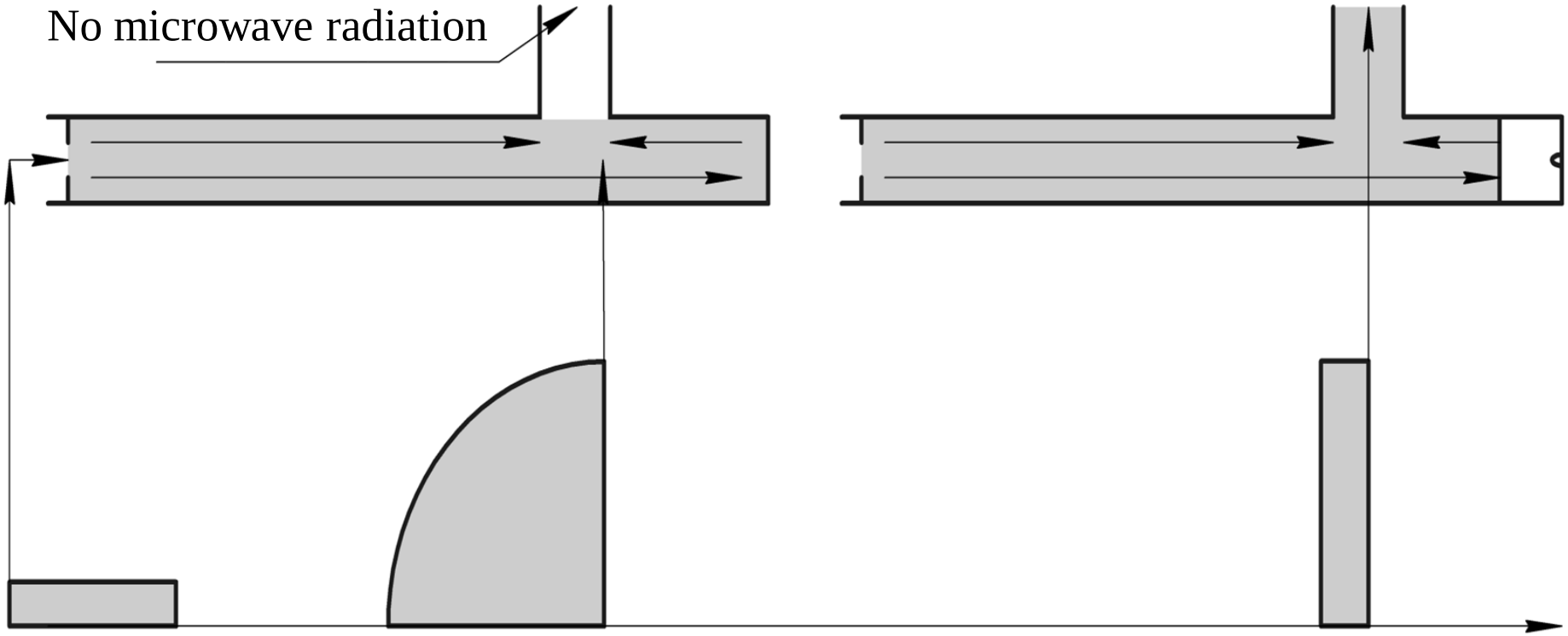
INTRODUCTION

Radar technologies are one of the promising technologies that provide protection against terrorist threats acts on objects of national importance. Using of radar probing signals with a wide and ultra-wide frequency band allows us to create new highly informative radar systems that operate in the radio mode of the target. Probing radios pulses of nanosecond duration can increase the range resolution up to tens of centimeters. The signal duration in this case usually varies between 1–10 ns. A significant drawback of such systems is the wide availability of only low-power short-pulse generators due to the complexity of creating high-power pulse generators of about 1 ns duration. This drawback can be overcome with the help of a microwave pulse former, which generates short pulses of high power. This former is a design operating on the basis of the accumulation of the microwave signal from an industrial generator into the storage resonator and the quick output of the microwave signal in the form of a short, increased pulse power.

In this way, the former can solve problems of radar systems. The ultrashort pulse will increase range resolution and detection accuracy over a distance. Increased repetition frequency will eliminate the accumulation of a large number of pulses, which will lead to a more rapid detection of the object. Increased power will enhance radar system range and stealth object detection probability.

Purpose: Development and construction of nanosecond microwave pulse compressor.

Resonant microwave compression method



Generation of microwave radiation

Energy storage

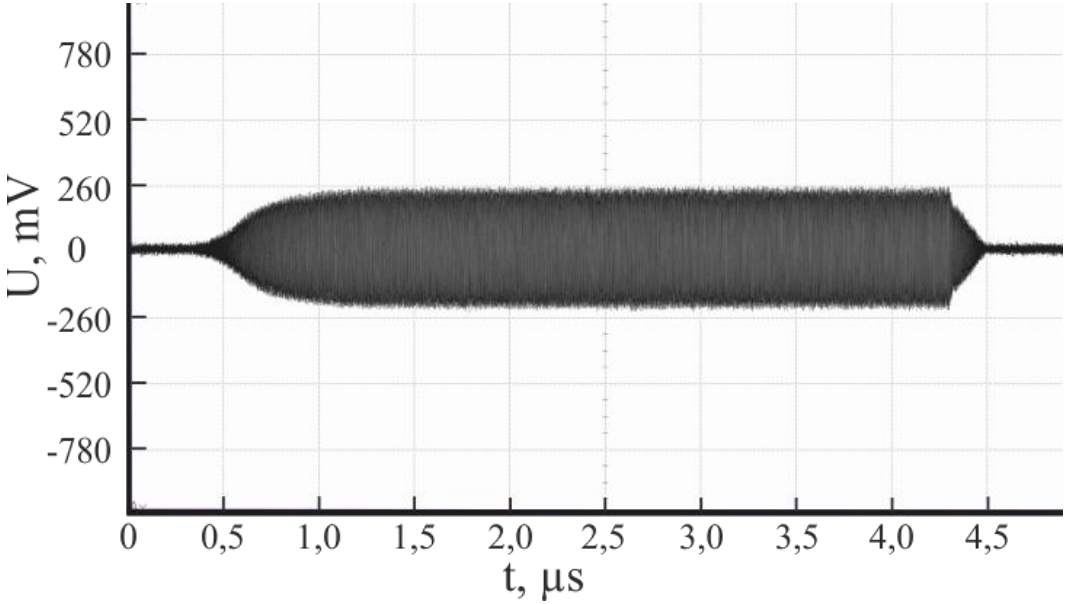
Formed pulse at the exit from the resonator

Microwave generator parameters

Main characteristics NR-900EK3M «KORSHUN»

Parameter	Value
Pulse power, W	200
Duration of generated pulses, μs	4
Pulse repetition rate, Hz	250
Carrier frequency, MHz	848

The exterior appearance NR-900EK3M «KORSHUN»



Oscillograph recording of the microwave generator pulse

The exterior appearance of a nanosecond microwave pulse former

The microwave pulse former consists of the coaxial resonator and the commutator. On the coaxial resonator there are screws for the resonant frequency adjustment, the input communication connector and the accumulated microwave power control connector. The commutator includes control P-I-N diodes and a toroidal resonator with connector of bias supply to the P-I-N diodes and connector of control of the field in the commutator. Locking frequency adjusting screws are also located on the toroidal resonator. Solenoid of inner diameter 30 mm whose frame was placed at floating potential with respect to the other electrodes and was simulative of the protective shield by which the electrodes of a vacuum circuit breaker are normally surrounded.

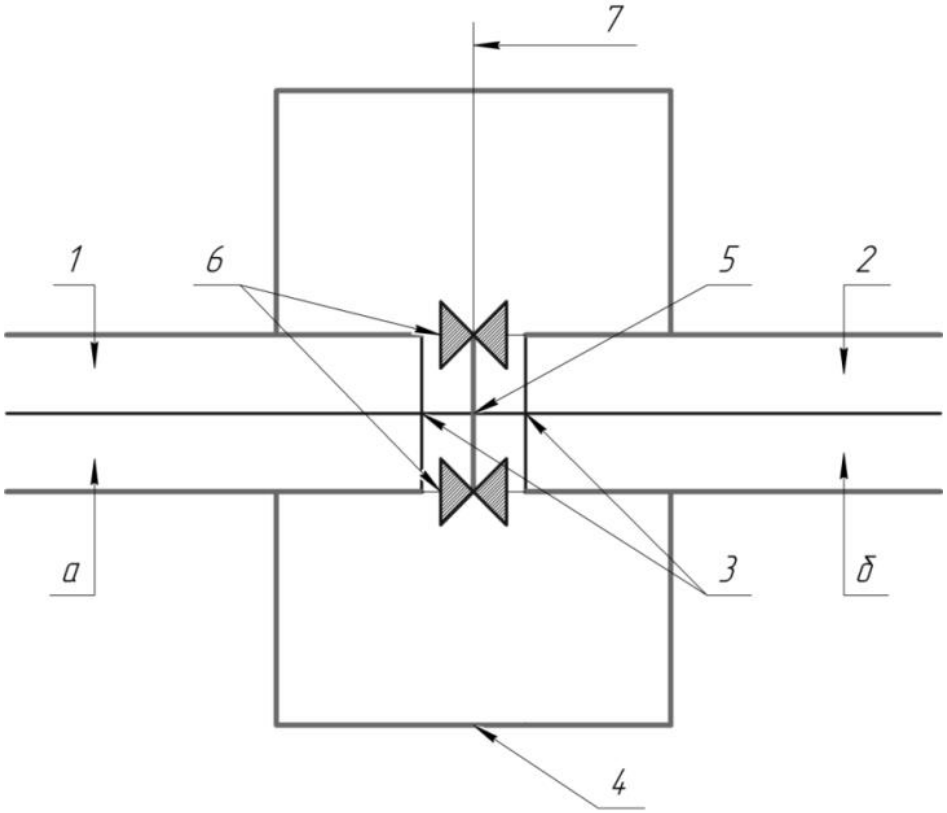
The exterior appearance of a nanosecond microwave pulse former.

Semiconductor commutator

Basic electrical parameters P-I-N diodes 2A542A1

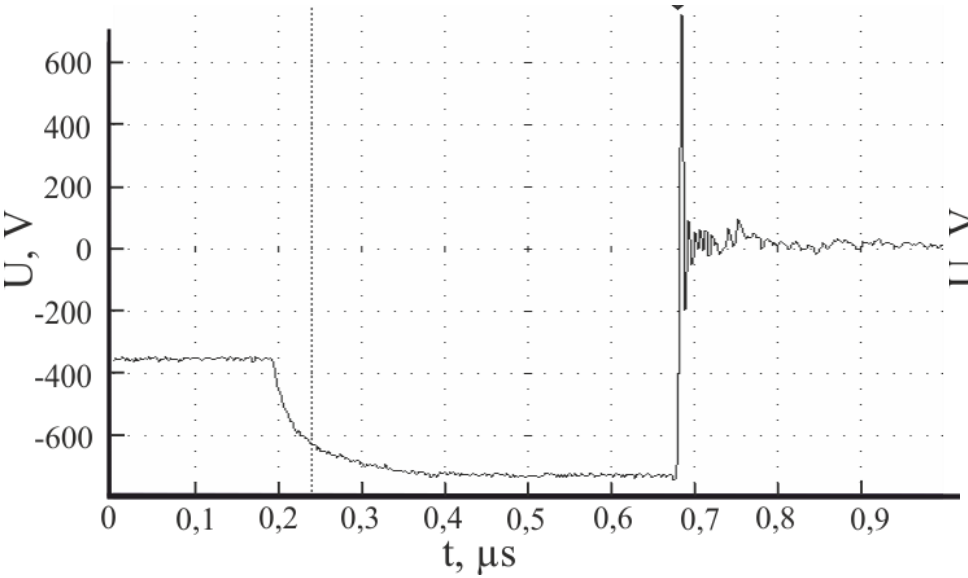
Parameter	Norm
Breakdown voltage, V	1100
Constant forward voltage, V	no more1,1
Diode total capacitance, pF	0,55 – 1,0
Critical frequency, GHz	250

The exterior appearance of P-I-N diode 2A542A1

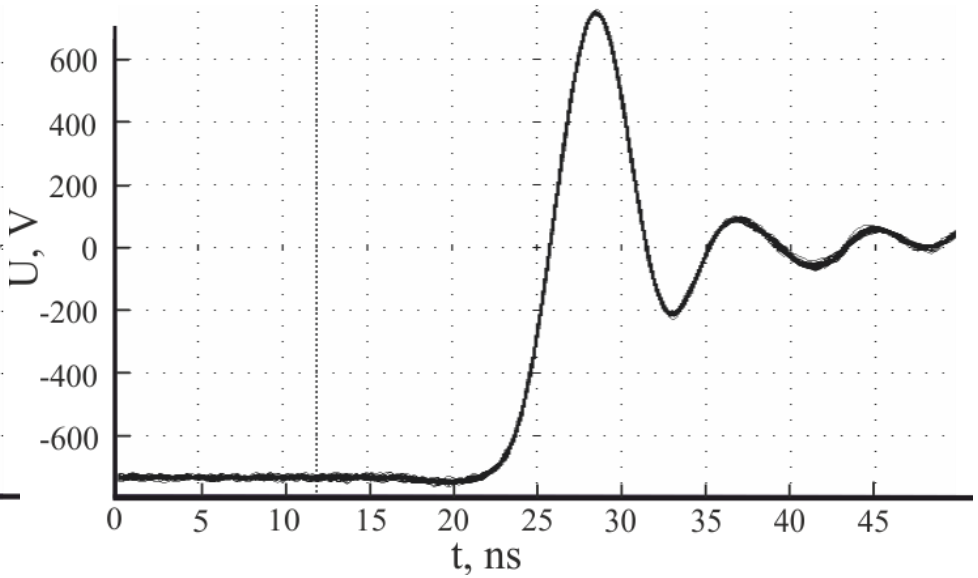


Coaxial microwave switch. 1-2 - segment of the coaxial line, a-b input and output of the coaxial line, 3 - circular gap, 4 - toroidal resonator, 5 - ring, 6 – P-I-N diodes

Semiconductor commutator



Oscillograph recording of the pulse reverse voltage.



Oscillograph recording of the pulse generated by the commutator control unit that opens the commutator

Extraction of accumulated energy to the load. After the pulse locking voltage is fed to the diodes for 500 ns and the field level in the resonator reaches a maximum value, the commutator control unit forms a pulse of negative polarity of 800 V, with duration of 5 ns, and a rise steepness of 320 V/ns, as a result of which the commutator opens. The energy accumulated in the resonant system is radiated through the opened commutator into the load in form of a pulse with increased amplitude. The pulse amplitude is determines using markers. Thus, the amplitude of the pulse generated in the nanosecond microwave pulse former is 0.76 V.

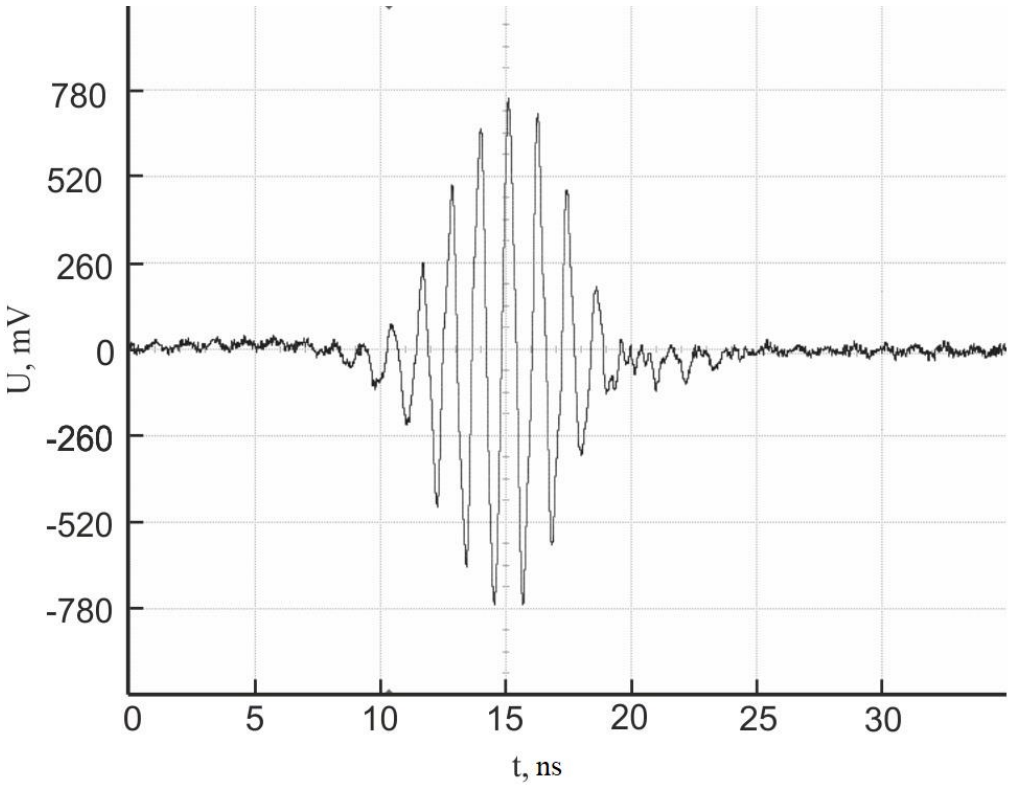
Parameters nanosecond microwave pulse compressor and formed pulses

Parameters of the formed pulses

Parameter	Value
Pulse power, W	2090
Duration of generated pulses, ns	10
Pulse repetition rate, Hz	250

Parameters nanosecond microwave pulse compressor

Parameter	Value
Gain	10,5
Q-factor of the resonant system	500
Accumulation time, ns	500
Carrier frequency, MHz	848



Oscillograph recording of the pulse at the compressor output.

CONCLUSION

- A nanosecond microwave pulse generator has been developed for a nonlinear radar with increased pulse power and a short radiation pulse. This device is able to increase the level of security at the most vulnerable objects of the transport infrastructure, life support facilities and at strategically important facilities. Also, this device, which generates ultrashort signals with a gain of 10.5, solves problems when using standard non-linear radars that are designed to detect listening devices and explosive objects. The use of ultrashort pulses will increase the resolution in range, which will allow an approximate analysis of the number of explosive objects in the direction of sensing the terrain. The increased power of the probing signal will increase the range of the nonlinear radar, as well as increase the likelihood of detecting subtle objects.

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Thanks for your attention

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