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**NONLINEAR JUNCTION LOCATOR WITH THE POSSIBILITY
 OF IDENTIFYING NONLINEAR OBJECTS**

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It is concept of nonlinear radar with the ability to identify nonlinear object using DSB-signal in the role of the probe. The block diagram developed nonlinear junction radar. Here formalized tasks that are necessary for the efficient operation of the nonlinear radar, which helps to raise the accuracy of the identification of objects that include elements with nonlinear current-voltage characteristics.

Currently nonlinear locators are used to search for artificial man-made objects, containing nonlinear electrical contacts. It is principle of operation of nonlinear junction radar: the frequency signal is converted to higher harmonic due to the nonlinear properties of the above elements with their subsequent re-emission in air during irradiation high-sounding call objects that contain non-linear electrical contacts [1].

Almost complete absence of non-linear properties of the electromagnetic natural background (soil, water, vegetation) can effectively use nonlinear radar for finding various artificial objects, including small-sized and fixed use, which is practically impossible to carry out by means of traditional radar.

Nonlinear junction radars can be used to detect eavesdropping devices, regardless of whether they are turned on or off, the radio-controlled devices, such as remote detonators; wreckage of planes and helicopters, small arms. Also used in nonlinear radar remote marking, for example, underground objects, "black boxes" of aircraft and certain terrain. There used for this the so-called non-linear markers (usually – semiconductor diodes loaded on antenna reflectors) [2].

It is known that the spectrum of the non-linear feedback element is different from the spectrum of the acting signal. It is enriched in components of higher harmonics acting a signal. Static IVC any nonlinear element can be represented as a power series.

$$i = i_0 + a_1 U + a_2 U^2 + a_3 U^3 + \dots, \quad (1)$$

here i_0 – quiescent current operating point; a_1 – IVC slope at the operating point; a_2 – the first derivative of the slope; a_3 – the second derivative of the slope and etc.

When exposed to the non-linear element DSB-signal:

$$u(t) = U_0 + U_{m1} \cos(\omega_0 + \Delta\omega)t + U_{m2} \cos(\omega_0 - \Delta\omega)t, \quad (2)$$

here: $\omega_0 + \Delta\omega$ – the band centrum of the upper sideband spectrum;

$\omega_0 - \Delta\omega$ – the band centrum of the lower sideband spectrum;

ω_0 – suppressed carrier,

$\Delta\omega$ – suppressed subcarrier.

feedback of the nonlinear element represented by the expression:

$$\begin{aligned} i(u) = & a_0 + a_1 U_{m1} \cos(\omega_0 + \Delta\omega)t + a_1 U_{m2} \cos(\omega_0 - \Delta\omega)t + \frac{a_2}{2} (U_{m1}^2 + U_{m2}^2) + \\ & + \frac{a_2}{2} U_{m1}^2 \cos(2\omega_0 + 2\Delta\omega)t + \frac{a_2}{2} U_{m2}^2 \cos(2\omega_0 - 2\Delta\omega)t + \\ & + a_2 U_{m1} U_{m2} \cos(2\omega_0)t + a_2 U_{m1} U_{m2} \cos(2\Delta\omega)t + \left(\frac{3a_3 U_{m1}^3}{4} + \frac{3a_3 U_{m1} U_{m2}^2}{2} \right) \cos(\omega_0 + \Delta\omega)t + \\ & + \left(\frac{3a_3 U_{m2}^3}{4} + \frac{3a_3 U_{m2} U_{m1}^2}{2} \right) \cos(\omega_0 - \Delta\omega)t + \frac{a_3 U_{m1}^3}{4} \cos(3\omega_0 + 3\Delta\omega)t + \frac{a_3 U_{m2}^3}{4} \cos(3\omega_0 - 3\Delta\omega)t + \\ & + \frac{3a_3 U_{m2} U_{m1}^2}{4} \cos(3\omega_0 + \Delta\omega)t + \frac{3a_3 U_{m2} U_{m1}^2}{4} \cos(\omega_0 + 3\Delta\omega)t + \\ & + \frac{3a_3 U_{m1} U_{m2}^2}{4} \cos(3\omega_0 - \Delta\omega)t + \frac{3a_3 U_{m1} U_{m2}^2}{4} \cos(\omega_0 - 3\Delta\omega)t. \end{aligned} \quad (3)$$

Fig. 1 shows the principle of conversion form, and therefore the spectrum of the input signal by a nonlinear element (a semiconductor diode).

In practice, most IVC real objects can be with sufficient accuracy approximated by finite power series, because harmonics generated by such objects are small amplitude. Degree approximating polynomial determines the number of the highest harmonic in the spectrum of the response of the nonlinear element.

Among the nonlinear properties of real objects expressed most strongly in semiconductor junctions and pinch the metal contacts. IVCs are most semiconductor junctions included in all elements of modern electronic equipment, close to quadratic. CVCs dissimilar metals, and metal-oxide-metal corrosion occurring as a result, are approximated by a polynomial of the third degree. When irradiated with nonlinear radar semiconductor junctions harmonic signal at the second harmonic feedback is much stronger (about 20 dB) than the third. For metallic contacts the picture is opposite (Fig. 2) [3].

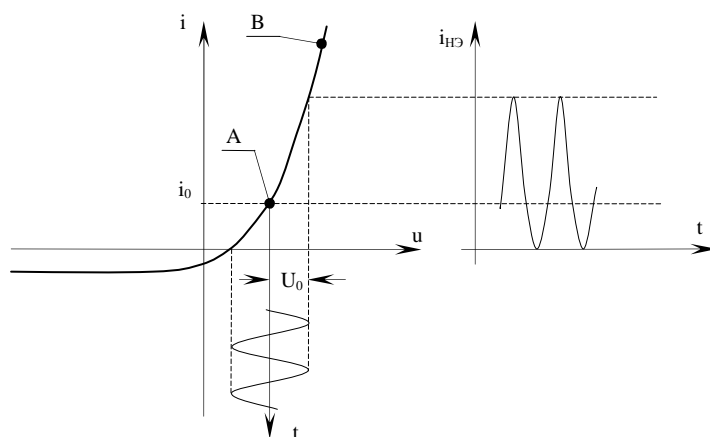


Fig. 1. It is Converting harmonic signal on the nonlinear element:

A – operating point in IVC, approximated by a polynomial of the second degree; B – operating point in IVC, approximated by a polynomial of degree greater than two

Analysis of the available publications on nonlinear junction radar shows that in matters of accuracy and speed of the object localization are by various authors united. This indicator is caused by the characteristics of antennas and receiver, recording the reflected signals. Question of identification of objects at the moment is more in the stage of theoretical debates and depends solely on the experience and skills of personnel using nonlinear junction locator.

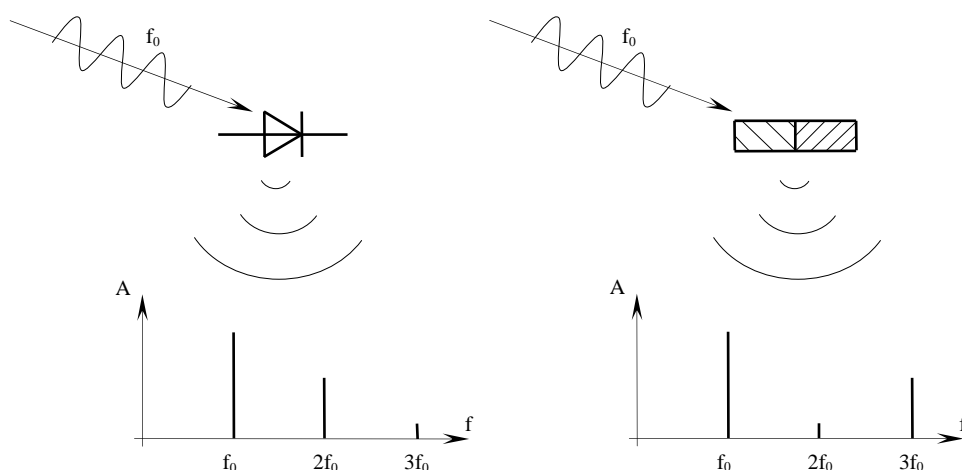


Fig. 2. It is nonlinear transformation of the harmonic signal with frequency f_0 semiconductor devices (left) and objects formed by contact of metal parts (right)

From Figure 2 it is obvious that it is theoretically possible to distinguish objects containing electronic components, metal structures, or combinations thereof, to an object of the re-spectrum signal. However, in practice this approach is accompanied by a number of difficulties. Difficult problems, for example, are the right

choice of power and frequency of the signal. Low power (amplitude) of the probing signal does not allow force to produce a nonlinear harmonic. Too high power probing signal shifts the operating point of the nonlinear element beyond his typical IVC (quadratic area for semiconductor junctions), see Fig. 1, point B. As a result, the spectrum of the response element varies. Additionally, it is necessary to consider that power of the probing signal determines the detection range of the radar objects nonlinear. Moreover high power radiation may result, for example, to actuation the electronic detonators. Regard to the selection frequency sensing real objects is a complex set of dipoles of different geometry, loaded on nonlinear elements. Obviously, these objects will have a different response to different frequencies (different nonlinear effective dispersion surface). Type of response is characteristic of a particular type of object. To increase the range of detection of objects, it is desirable to use the frequency at which feedback is maximal goals, determine the frequency of such advance either extremely difficult or impossible.

To solve these problems, modern nonlinear junction radar can use different modes of signal emission (pulsed or continuous) and power control algorithms radiation [4, 5]. It should also be noted that according to the technical characteristics of the existing nonlinear junction radars frequencies use they radiation in the range from 400 to 1000 MHz (receive frequency from 800 MHz to 3000 MHz respectively). Interesting solutions to improve the characteristics of nonlinear junction radars as proposed in [2, 6, 7, 8]. American authors suggest the use of several harmonic probing signals to increase the range of nonlinear junction radar.

The authors of this article suggest the idea to develop a sensing using DSB-signal, programmable power control radiation. Such an approach can increase the reliability of the identification of objects by reflected signal, as well as increasing the range of the radar. Nonlinear object emits modified probe signal, when irradiated nonlinear object DSB-signal. You can get information about the nonlinear effective scattering surface of the object at a given frequency and it is highly likely to restore IVC nonlinear element in appearance and character reflected signal. (fig. 3).

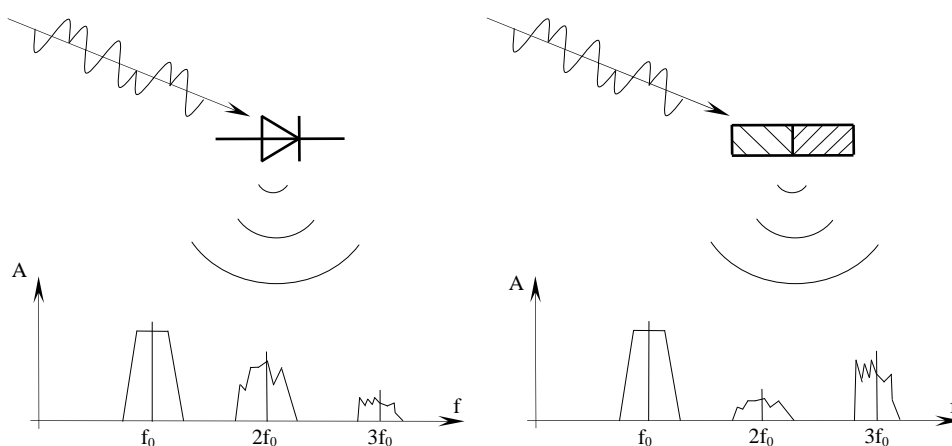


Fig. 3. It is nonlinear transformation of the spectrum noise-like signal (PSK signal, the center frequency f_0) semiconductor devices (left) and objects contacts containing metal parts (right).

Fig. 4 shows a block diagram of the nonlinear radar. Function of the main block does not require explanation. It should be noted that additionally includes a fast digital-to-analog converter. It is controlled by Matlab program that is installed on the PC (personal computer) and it provides her with the data for visualization. DSB-signal generator generating a probe signal and run the program MATLAB, which he changes the power output. In this case it is possible to more effectively explore the object for its characteristic frequencies increase radar range, improve the accuracy of identification of nonlinear objects.

In conclusion, we pose questions that are critical to the effective nonlinear junction radar that uses noise-like signals. Firstly, it is necessary to simulate the process of re DSB-signal array of dipoles of different geometry, loaded by linear loads, in order to determine how the signal spectrum will vary for different objects. It would be interesting to conduct field trials.

Secondly, you need to define the characteristics of DSB-signal (center frequency, amplitude and form of the side lobes of the spectrum), which will ensure optimal tactical and technical characteristics of the device in terms of accuracy, range, stealth, etc.

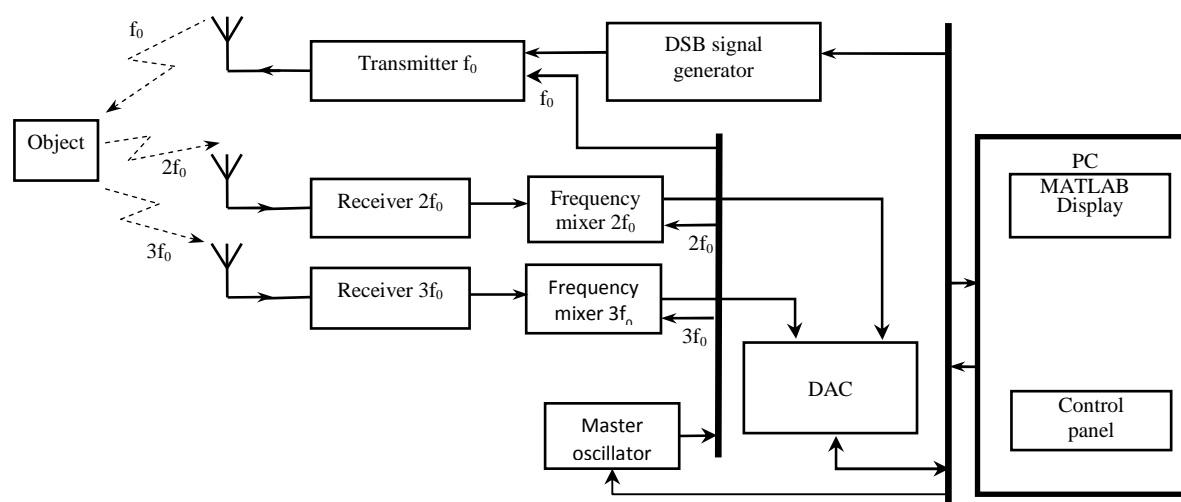


Fig. 4. It is block diagram of the proposed nonlinear junction radar using DSB-signal

Interesting technical challenges for future research could be the development of decision-making algorithms for the identification of various objects on the basis of information extracted from the spectrum of re-signals, as well as adjust the emission power of the nonlinear radar.

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THE BASIC PRIMITIVES OF DIGITAL CIRCUIT OBFUSCATION

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Features of obfuscation as applied to specifications in VHDL language are considered. Brief survey of obfuscation types is given and their drawbacks are investigated. Circuit obfuscation methods are considered. Basic primitives of circuit obfuscation are proposed and ways of their usage are explored.

Hardware piracy assisted by modern equipment turned into a threatening problem during past decade. Today the financial loss from illegal manufacturing and usage of digital devices is estimated in more than 1 billion dollars a day [1]. Piracy is not the only danger. Other threats are evolved and improved, new threats are