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STUDY OF HF IMPOSING METHOD FOR UNAUTHORIZED REMOVING INFORMATION FROM TELEPHONE LINES

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The paper investigates the features of choosing a carrier frequency for implementing the HF-imposition method, and also assessed the possibility of information leakage using this method from telephone devices of various models. The efficiency of using existing methods was analyzed counteraction to the method of high-frequency imposition, as well as their influence on the quality of speech signals transmitted during a telephone conversation

Key words: *telephone line, telephone set, high frequency interference, information leakage*

Presented in the paper Investigations are focused on special aspects connected with selection of the carrier frequency values for realization of the RF-imposition method. For this method a possibility of the information leak-age from various modern models of telephones is estimated too. It is also analyzed an efficiency of means for blocking of the information leakage by the RF-imposition method and an influence of such means on the speech signal quality during a telephone conversation ***Keywords:***
telephone line, telephone, RF-imposition, information leakage

1. Introduction

The wired telephone network is one of the most common means of telecommunications and, despite the development of wireless information transmission technologies, many organizations do not refuse to use telephone lines communications. Its presence on the territory of the facility represents a threat to information security. In addition to intercepting the telephone conversations themselves, An attacker has the ability to intercept acoustic information when the telephone receiver is hung up using the RF-imposition method.

2. Statement of the problem

To assess the danger of unauthorized To obtain information using the HF-imposition method, it is necessary to solve the following problems: – to investigate the frequency properties of attenuation introduced into the carrier frequency propagation path RF signal imposition taking into account different models of telephone sets;

- to study the effectiveness of known passive means of protection;

– to experimentally estimate the probability of information leakage using the method HF interference from volume level "useful" acoustic signal circulating in the room.

3. Literature review

In [1–3] a general description of the method of RF imposition in a telephone line is given. In [2] also variants of the method implementation (sequential and parallel) and protection of telephone subscriber lines from eavesdropping using blocking filters are considered. It should be noted that in open publications do not show the impact of funds protection of the quality of communication and the possibility of application this method of filming for specific TV models background device, which does not allow for an adequate assessment of the danger of its use in relation to the safety of acoustic (speech) information circulating in the room.

4. Research of the HF-imposition method in telephone line

4. 1. Results of circuit simulation The results presented in the work were obtained in circuit simulation software package Orcad 9.2. Fig. 1, a shows the equivalent circuit unauthorized removal of information by the method HF-imposition. Fig. 1, *b* shows the result of the study of the attenuation of the HF-imposition signal from the values of its carrier frequency at different lengths telephone line [4–6]. In this case, the complex transfer function is described by the following expression [4]:

$$K(j\omega)=\frac{R_n}{R_i+R_n+\dfrac{R_{mic}\cdot\dfrac{1}{j\omega C_{swic}}\cdot\left(R_{line1}+j\omega L_{line1}+\dfrac{\frac{1}{j\omega C_{line}}R_{line2}}{\frac{1}{j\omega C_{line}}+R_{line2}}\right)}{R_{mic}+\dfrac{1}{j\omega C_{swic}}+R_{line1}+j\omega L_{line1}+\dfrac{\frac{1}{j\omega C_{line}}R_{line2}}{\frac{1}{j\omega C_{line}}+R_{line2}}}}. \quad (1)$$

From Fig. 1, *b* it is evident that depending on the length telephone line, the cutoff frequency of the RF-imposition generator can be in the range of 1…10 MHz. Let us determine the range of change of the value dangerous RF signal imposition at the input of the intruder's receiver ÿU due to a change in the resistance of the high-impedance microphone R_{mic} from 162 to 198 Ohm under the influence of acoustic vibrations. At In the calculation we assume that the parasitic capacitance Cswich C_{swich}

is 10 pF, the effective value of the high-frequency oscillations is 1 V, their frequency is 1 MHz [1, 2]. Let us calculate the complex effective values current in the imposing circuit and voltage on the resistance load resistance *Rÿ* according to the following formulas:

$$I\ AM\ RR\ in\ /\ _n\ _i\ _{mic}\ ÿ\ C_{switch} \quad (2)$$

$$U\ IS_{n\ n} \quad (3)$$

For *Rmic* = 162 Ohm we get

$U_{ÿ1}$ =6.266 10-0e j85.772 V.

For *Rmic* = 198 Ohm, respectively

$U_{ÿ2}$ =6.265·10-0e j85.657 V.

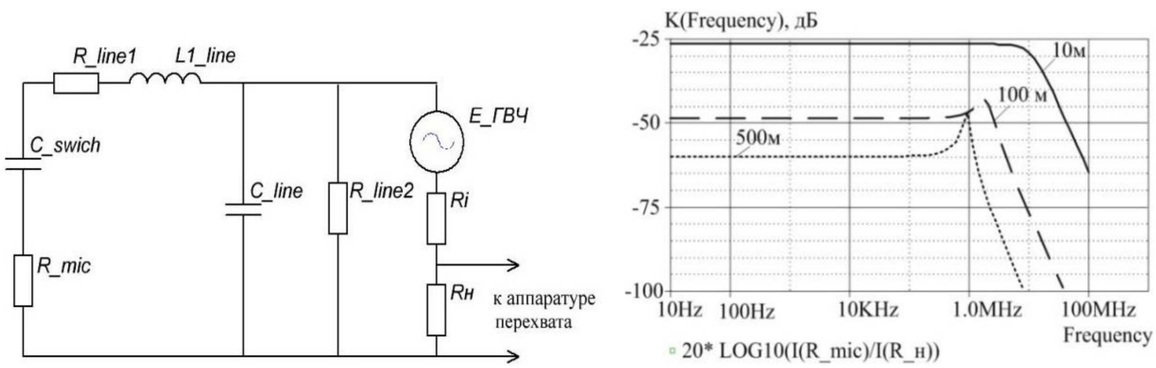
That is, due to the action of high-frequency vibrations on the microphone, the difference in the effective values of voltage the resistance on the load is *j* 0.115 ÿÿUÿ ÿ 0,14 $_{n1}$ $_{n2}$ and mV, which allows to carry out unauthorized removal of information. We will conduct a study of the possibility of applying the method of high-frequency imposition to electronic telephone sets. Fig. 2, *a* shows the electrical circuit diagram of the electronic telephone set TA-72, and Fig. 2, *b* shows the frequency response of the information leakage channel for this TA [5]. The high probability of information leakage by the HF imposition method with the TA-72 (Fig. 2, b) is due to the presence of resonance created by the winding of the differential transformer and the parasitic capacitance of the lever switch.

Fig. 4 shows the frequency dependence voltage of high-frequency imposition on the microphone and frequency response formed information leakage channel for different line lengths taking into account the influence of the microphone audio frequency amplifier TA (Fig. 3). From Fig. 4 it is clear that modern electronic TA must be protected from RF interference.

Let's get the frequency response of the information leakage channel (Fig. 6) [5], implemented using the RF-imposition method for electronic TA (Fig. 5) [7] at different lengths nah lines.

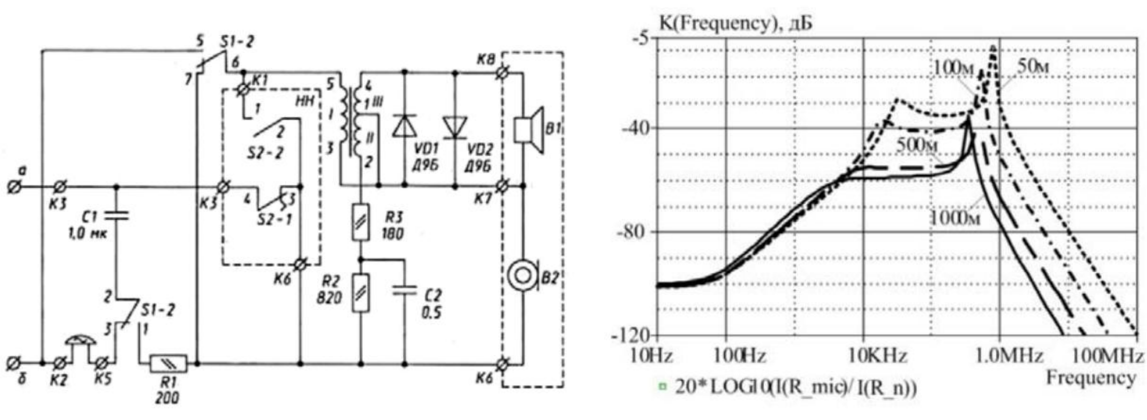
To determine the complex transfer functions, the current in the microphone circuit is selected as the response, and the current in the load circuit is selected as the impact:

$$ÿ\ \left|\ ÿ\ ÿ\ KF(\ )\ 20\lg(\ )\ /\ I_{R_{mic}}F\ I_{R_n}F(\ ).\ ÿ\ ÿ\right| \quad (4)$$



a *b*

Fig. 1. Implementation of the HF-imposition method using the example of a simple TA equivalent: *a* – equivalent circuit of unauthorized information retrieval by the method under study; *b* – frequency dependence of the attenuation of the HF-imposition signal (taking into account the influence of the telephone line)



a *b*

Fig. 2. Implementation of the HF-imposition method using the TA-72 telephone as an example: *a* – electrical schematic diagram of the TA-72; *b* – frequency response of the information leakage channel for the TA-72

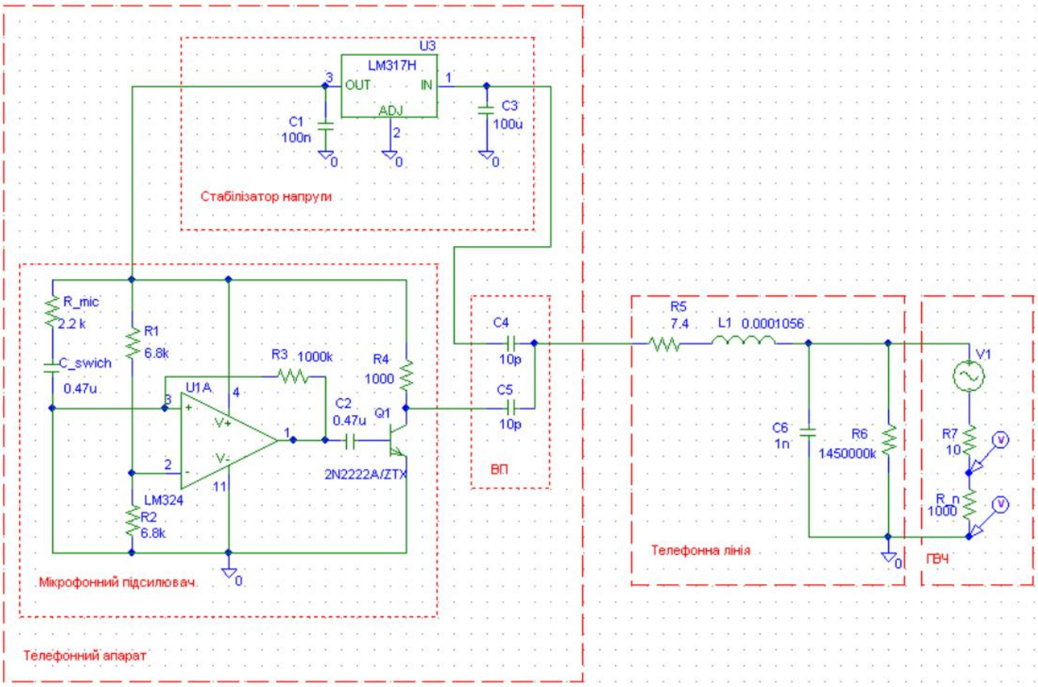
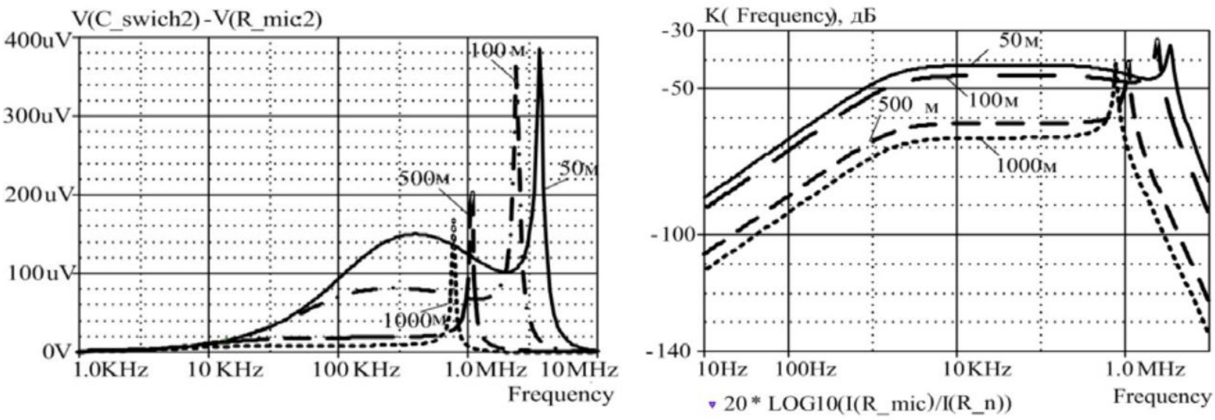


Fig. 3. Schematic diagram of the microphone amplifier TA used in the simulation



A *b*

Fig. 4. Implementation of the RF-imposition method using a microphone amplifier as an example: *a* – frequency dependence voltage of RF imposition on the microphone; *b* – frequency response of the information leakage channel for different line lengths with taking into account the microphone amplifier

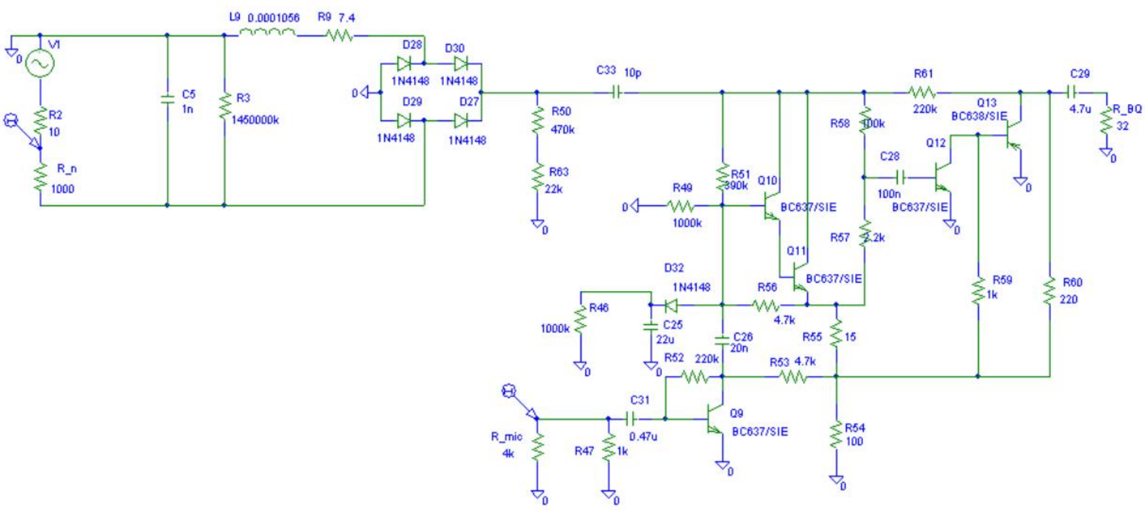


Fig. 5. Electronic TA diagram [7]

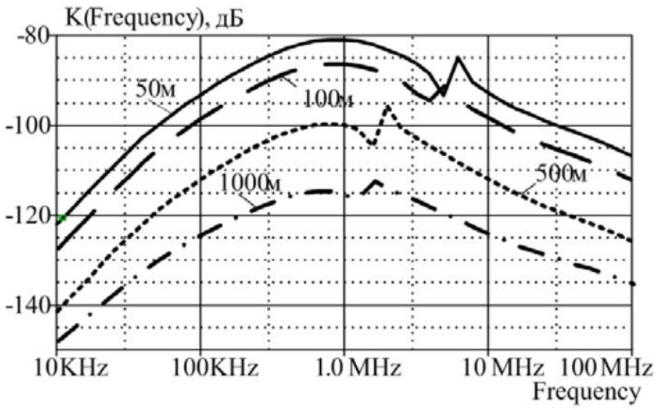
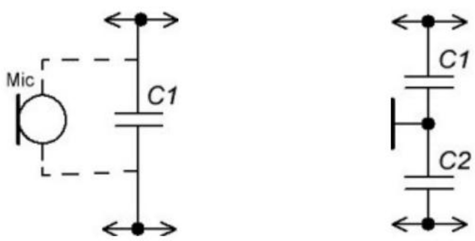


Fig. 6. Frequency response of the information leakage channel implemented by the RF imposition method for an electronic TA at different line lengths

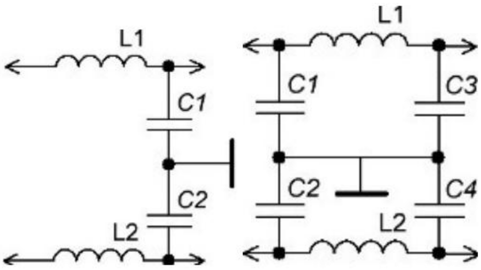
From Fig. 6 it can be seen that the minimum attenuation is 80 dB, so the probability of information leakage, even without the use of protective filters, is minimal, since the resulting level of the high-frequency interference signal is lower

the level of the telephone line's own noise.

Let us consider filters for suppressing high-frequency voltages (Fig. 7) used in practice to protect telephone lines from leakage information using the high-frequency imposition method [6].



A b

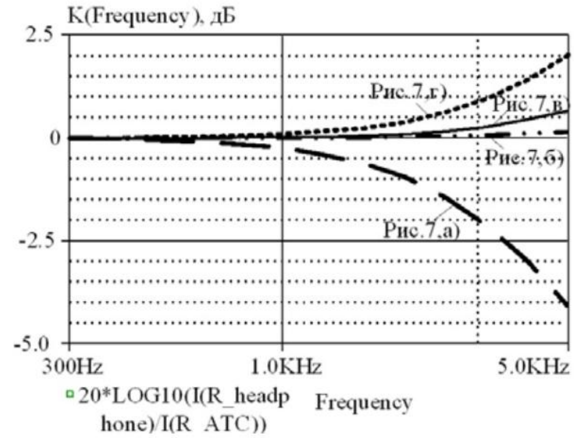


V G

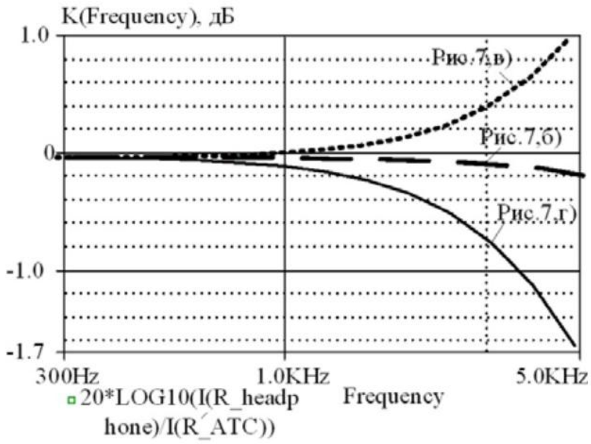
Fig. 7. Different types of filters used for suppression of high-frequency voltages: *a* – shunting of the microphone with a capacitor with a capacity of about 10…47 nF; *b* – shunting of the telephone lines with a capacitor of about 10 nF; *in* – L-shaped *LC* LPF; *g* – U-shaped *LC* LPF

Fig. 8 shows the influence of various filters (frequency response) on the quality of speech signals transmitted during a telephone conversation [5, 6].

From Fig. 8, *a* it is clear that when talking with a subscriber, the quality of communication (speech intelligibility) is most affected negative impact (in terms of distortion of the frequency response shape) voice channel) has a shunting effect on the microphone by a capacitor (Fig. 7, a).



A



b

Fig. 8. Frequency response of the authorized signal distribution channel for different filters: *a* – from the telephone set to the PBX; *b* – from the PBX to the telephone set

Fig. 9 shows the results of the study. efficiency of using various filters counteracting high-frequency imposition (Fig. 9) [5, 6].

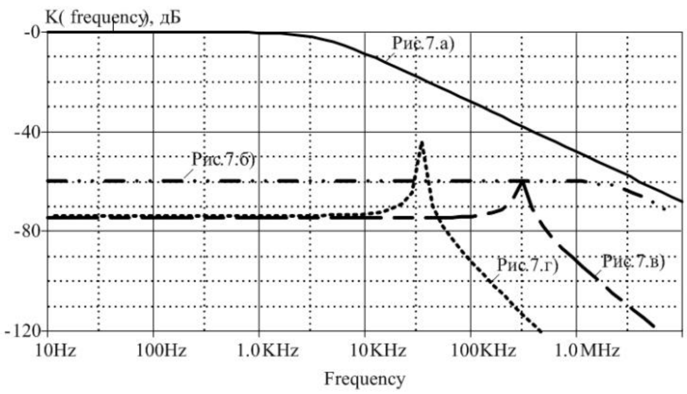


Fig. 9. Frequency response of the information leakage channel using the RF imposition method with the use of various protective filters

Based on the simulation results, it can be concluded the conclusion that the studied filters provide suppression at frequencies of probable application of the method High frequency interference (50–1000 kHz) within 60–80 dB.

One more feature should be noted. method of high-frequency imposition, associated with the presence of parasitic capacitances between the conductors on the printed circuit telephone board. The existence of such capacities, when using the RF-imposed method ation, can both help and hinder the un- authorized removal of information. Let's calculate the parasitic capacitance between two parallel conductors on example of the printed circuit board of the TA-72 telephone. The presence of a piecewise homogeneous medium (air and dielectric) is an additional factor that complicates the calculation (Fig. 10), since

the conditions of homogeneity of the environment are violated. Due to This dielectric medium must be brought to a homogeneous state. The calculation system must have at least one plane of symmetry.

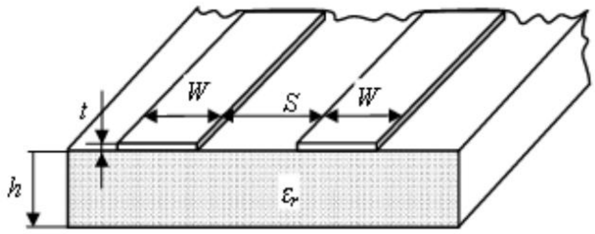


Fig. 10. Designation of printed circuit board parameters

When placing plates in a homogeneous environment, it is necessary to stipulate the parameters of the environment by setting its effective permittivity [8]:

ÿ eff ÿ (f ÿ r1,2 ÿ). (5)

Since the method uses infinite thin plates need to bring the system to this form, where the thickness of the plates will be equal to zero. Since the system has an axis of symmetry, it is possible calculation of its capacity using the conformal method transformations [8]:

With pF ÿ ÿ ÿ ÿÿ 8,85ÿ C l), eff (6)

where 8.85 is the permittivity, pF/m; *ÿeff* is the effective permittivity of the dielectric medium; *C1* is the normalized capacitance

unit of length (dimensionless quantity); *l* is the length conductor systems, m. Since the conductors are located in a homogeneous medium, then *ÿeff=ÿr(base).* Since the telephone board is made of foil-clad

getinax, then *ÿeff=5.* The system of conductors from the topology of the printed circuit board TA-72 has a length of l=5 cm. The normalized capacitance per unit length is associated with geometric parameters of the conductor cross-section and is determined by the formula [9]:

C KK ÿ `/ . (7)

where *K* is the complete normal elliptic integral Legendre of the first kind, and Kÿ is an additional function K`( ) *k Kk* ÿ ( `), in which *kÿ* is found by the formula:

k 1( )ÿ 2 s W ÿ s 2 . (8)

where s=2 10-3 m is the distance between the tracks, W=1.5 10-3 m is the track thickness.

Substituting the obtained data, we get that the parasitic capacitance between two parallel conductors will be 3 pF. This capacitance can be located between the tracks running

to the capacitor *C1* and the key *S1-1* (Fig. 2a). When using the RF-imposition method, this capacitance will be applied in parallel to the parasitic capacitance lever switch, which will be additional facilitate the passage of the RF signal.

In general, the parasitic capacitance of the installation of the TAs considered in the work does not exceed 5...7 pF, which does not has a significant impact on the passage RF signal imposition.

4. 2. Results of experimental studies

The experimental setup diagrams are shown in Fig. 11–12. The studies were conducted using a KX-TS2361UA (Panasonic) type telephone, and also for TA type TULIPAN-319 (1990, Poland) and TA-72, TA-600, TA-4100 [7]. Fig. 13 shows the dependence of the amplitude coefficient

modulation from the sound pressure level. During the experiment it was revealed that the above mentioned phones are not susceptible to wiretapping by the HF-imposition method, since m<10% in the entire range of speech volume levels. Such "protection" is due to the presence of a differential transformer (with a winding inductance of 24 mH), which blocks the high-frequency signal, and the capacitance of the tube cable (300–500 pF) additionally

shunting the RF signal of imposition.

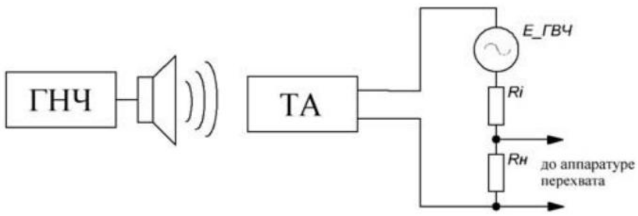


Fig. 11. Scheme of experimental setup No. 1

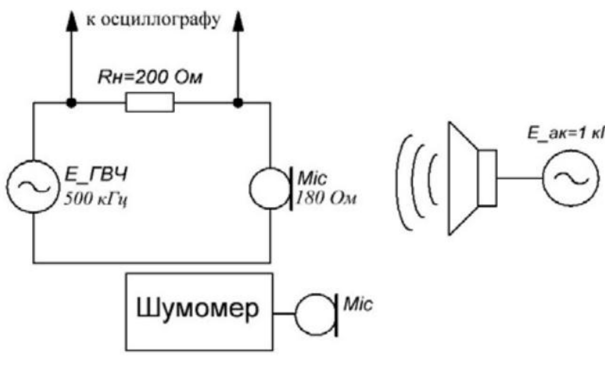


Fig. 12. Scheme of experimental setup No. 2

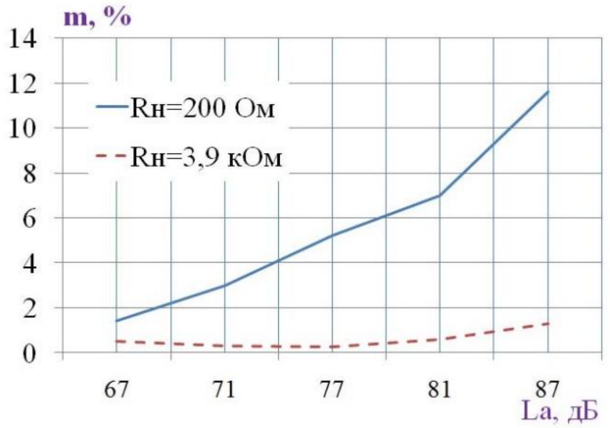


Fig. 13. Dependence of the amplitude coefficient modulation from sound pressure level

5. Testing the research results

The results of the work were discussed at the All-Ukrainian competition of student scientific works in the field of "Information Security" in Ternopil 2015, as well as at the following conferences:

- 69th scientific and technical conference faculty, scientific employees, graduate students and students in Odessa National Academy of Communications named after A.S. Popov in 2014;
- scientific and technical conference "Information Security of Ukraine" in Kiev Taras Shevchenko National University in 2015; – 19th International Youth Forum "Radio Electronics and Youth in the 21st Century" at the Kharkiv National University of Radio Electronics in 2015.

6. Conclusions

As a result of the work, it was revealed that, depending on the length of the telephone line, the upper limit frequency of the RF-imposition generator can be 1…10 MHz. Using the example of the TA-72 telephone set, it is shown that the frequency characteristic of the attenuation introduced by the set into the propagation path of the HF-imposition signal has a resonant minimum (frequencies corresponding to minimum attenuation lie in the range from 10 kHz to 1 MHz). Also It is shown that this resonance phenomenon is caused by the winding of the differential transformer and the parasitic capacitance of the telephone hook switch. The calculations performed show that the parasitic capacitance of the printed circuit board, applied in parallel to the telephone hook switch, is no more than 3 pF. This value

The capacity additionally ensures the passage of signal of high frequency interference into the microphone circuits of the telephone set. Despite this, the attenuation of the high frequency interference signal introduced by the line and some telephone sets is more than 80 dB. This makes it difficult to isolate the "imposed" signal on the background noise of the telephone line and puts the practical feasibility of this is in doubt method of collecting information. The results obtained in the work can be useful when carrying out complex activities to protect telephone lines from unauthorized information collection.

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MATHEMATICAL MODELING OF POLYPHENOL ADDITIVE FROM GRAPE SEED FOR MEAT PRODUCTS

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The article identifies the optimal parameters for obtaining a polyphenol supplement from grape seeds. antioxidant purpose – “Maltovin” by the method of mathematical planning of multifactorial experiments. The studies were conducted according to the matrix D-optimal quadratic experimental plan. The results of the microwave extraction process of phenolic compounds from maximum antioxidant activity. It was found that the selected model provides the detection of set of values that minimize the deviations of calculated and experimental data
Keywords: *mathematical modeling, multifactorial experiment, optimization, complex additive, antioxidant, polyphenolic compounds*

In the article the optimal parameters are defined to obtain polyphenol additive made from grape stone of antioxidant purpose – "Maltovyn" by the method of mathematical planning of multifactor experiments. Research is conducted under the matrix of D-quadratic optimal plan of experiments. The results of microwave extraction process of phenolic compounds with maximum antioxidant activity are obtained. It was established that the selected model provides a set of detection values that minimize divergence of calculated and experimental data
Keywords: *mathematical modeling, multifactor experiment, optimization, complex additive, antioxidant, poly-phenolic compounds*

1. Introduction

One of the promising ways to develop meat products with guaranteed safety and extended shelf life are used in formulations of biologically active substances (BAS) of natural origin, which provide antioxidant and antimicrobial effects. As a rule, the main The source of BAS is plant raw materials. Possibility the use of herbal supplements requires development optimal parameters for their production and improvement of technologies for using these additives in food products.

In production, various mass-exchange processes are used to obtain BAS. Considering structural features and specific properties of the extracted substances, it is necessary to select such processing parameters for them in order to maximally preserve the functionality of valuable

ingredients. The complex problem of optimizing technological processes can be solved by applying mathematical methods for rationalizing research. An important advantage of mathematical modeling technological processes based on fundamental of the physicochemical laws of nature is their universality