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PULSE METHOD OF WATCHDOG DEVICE BUILDING FOR SUBSCRIBER TELEPHONE LINES CONTROL

М.Я. Микитюк, В.В. Хома. Імпульсний метод побудови сторожового пристрою контролю абонентських телефонних ліній. Питання захисту інформації набувають у сучасному світі все більшого значення. Одним з основних джерел загроз інформаційній безпеці є контактні під'єднання до абонентських телефонних ліній (АТЛ) в мережах телефонного зв'язку пристроїв технічної розвідки. **Мета:** Метою роботи є представлення нового імпульсного методу виявлення несанкціонованих підключень до АТЛ, описання варіанту реалізації сторожового пристрою контролю та принципу його функціонування. **Матеріали і методи:** Суть метода полягає в аналізі реакції на імпульсні збудження двох коливних систем другого порядку. Підключення телефонної закладки зумовлює розбаланс сигналів між коливними ланками, що й засвідчує наявність закладки. **Результати:** Описано структуру та функції сторожового пристрою на основі цього методу, який складається із двох частин – аналізатора і блокатора, які розміщено на протилежних кінцях контрольованої ділянки АТЛ. Детально розглянуто варіант реалізації імпульсного лінійного аналізатора і каналу опрацювання сигналів.

Ключові слова: абонентська телефонна лінія, сторожовий пристрій контролю, імпульсний метод, канал опрацювання даних.

M.Y. Mykytyuk, V.V. Khoma. Pulse method of watchdog device building for subscriber telephone lines control. The problems of information security in modern world are becoming increasingly important. One of the main sources of threats is the contact connections to the subscriber telephone lines (STL) in the telephone networks of technical intelligence communication devices. **Aim:** The aim of this work is the presentation of the new pulse method of unauthorized connections identification to the STL, description of implementation and principle of operation of the watchdog control device. **Materials and Methods:** The method consists in analysis of response to pulse excitation of two second-order oscillating systems. The connection of telephone wiretap causes unbalancing of signals in oscillatory circuits and this certifies the existence of the bug. **Results:** The structure and functions of the watchdog based on presented method is described. This device consists of two parts – analyzer and blocker allocated at the opposite sides of the controlled STL. The variant of implementation of the pulse linear analyzer and channel of signals processing is considered in details.

Keywords: subscriber telephone line, control watchdog, pulse method, data processing channel.

Introduction. The problems of information security in modern world are becoming increasingly important. This concerns each of companies that have corporate data, developments and so on and every person that has personal confidential information. One of the main sources for information security is the contact (wired) connections to subscriber telephone lines (STL) in telephone connection lines of technical intelligence devices.

Methods of wiretap detection to STL are based on fact that direct attachment of exterior devices causes changing of physical parameters of lines, i.e. voltage, current and capacity. Analysis of threats for telephone communication has showed that subscriber line is the most vulnerable element of the phone system. This is due to fixed access for unauthorized persons to automatic telephone exchange (ATX) equipment, and the voice message wiretapping in junction lines and main channels of communication systems is hard because of group signal demultiplexing need [1, 2]. A STL has inhomogeneous

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geneous structure. In standard case, it is possible to highlight subscriber's cable line section and the main and secondary cable sections [3].

Information threats are implemented through technical intelligence devices connecting to STL [4...6]. Such connection is low-probable case at the section of multiple-pair telephone cables (especially at the main cable section, where the cable installed as underground communications). The most simple and most probable case is the connection to open sections of subscriber wires [2, 7].

There are many methods of STL control developed for today each of in working so in powerless mode [8, 9]. However, the devices that implement such methods are designed for prospecting, i.e. for carrying out planned or unplanned control of STL parameters for telephone bugs detection. As the control of the STL parameters is not exercised during the period between prospecting works so the threat from unauthorized connection to STL after carrying out prospecting works will not be revealed — that is the main lack of such approach. In this sense, the so-called watchdog devices working by the principle of continuous control of the STL parameters. However, the arsenal of the methods suitable for implementation of watchdog devices is the extremely limited. Usually in a basis of watchdog devices operation the control of supply voltage is imposed. Reliability of control results is low that is caused on the one hand by the low power consumption of modern wiretap devices and with another by natural fluctuations of STL supply voltage. Therefore, search of new methods of watchdog devices creation, which allow getting increased reliability of control results of the STL parameters, is actual. Then it is possible to elicit the facts of unauthorized connections in real time.

The aim of the work is the presentation of the new pulse method of unauthorized connections identification to the STL, the implementation case description and the principle of operation of the watchdog device.

Materials and Methods. *Basics of STL pulse control method and concept of watchdog devices constructing based on this method.* Permanent improvement of technical intelligence devices complicates the problem of its detection. The reason is in reducing of their influence on parameters of telephone lines. This requires not only sensitivity improvement of control tools but also the invariance supplying to various destabilizing factors against which the control of informative parameters provided.

The capacity of a telephone line is one of the parameters by which you can identify unauthorized connections. Despite the fact that the input capacity of the modern telephone bug is only a few PF, contact STL connection will lead to a sudden capacity increasing, though relatively modest.

This work describes the new pulse method of STL capacity control. The essence of this method is in reactions analyzing to the impulse excitation of two oscillating second-order systems. The impulse response of one of the systems is directly determined by the parameters of controlled telephone line.

As known, “a clean line” in simplified view (line without unauthorized connections) can be represented as capacity C_K between two wires of telephone line. The connection of parallel wiretap in model is represented by capacity C_W . So, the capacity of controlled telephone line C_X can take such values:

— for “clean line”

$$C_X = C_K ; \quad (1)$$

— in case of wiretap connection C_{T3}

$$C_X = C_K + C_W . \quad (2)$$

The model of pulse linear analyzer is shown in Fig. 1. This figure shows that sequential LC-circuits are the oscillating systems.

Controlled telephone line connected to the pulse source through the represented in the diagram inductor L_1 and resistor R_1 , forming the first controlled CLR-circuit. The second CLR-circuit is also composed of inductor L_2 , resistor R_2 and adjustable capacitor C_0 , but in a different sequence. So, the built controlled and exemplary CLR-circuits can be described as voltage dividers with the output voltage U_1 and U_2 :

$$U_1 = U_p \frac{1}{1 + sC_x R_1 + s^2 C_x L_1}, \quad (3)$$

$$U_2 = U_p \frac{sC_0 R_2 + s^2 C_0 L_2}{1 + sC_0 R_2 + s^2 C_0 L_2}, \quad (4)$$

and the output signal of linear analyzer U_{out} is their sum

$$U_{out} = U_1 + U_2, \quad (5)$$

where s — Laplace operator,
 U_p — input voltage.

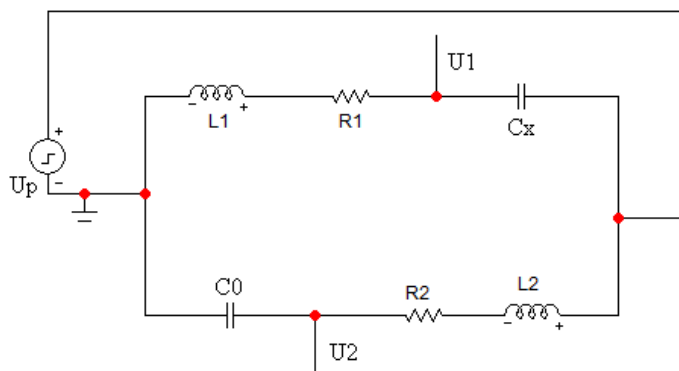


Fig. 1. The scheme of linear pulse analyzer

Adjustment of the linear analyzer provides selection of the adjustable capacitor capacity C_0 for fulfillment of the condition of expression (1), i.e. is uniformity of values of capacitor capacities and the “clean line” C_K . Then on condition of identity of inductor coils parameters ($L_1=L_2$ and $R_1=R_2$) drop in voltage U_1 and U_2 have the identical amplitude and frequency, but opposite phases therefore their sum is equal to zero. The telephone wiretap connection causes voltage unbalance of signals between oscillatory chains and testifies about availability of wiretap.

One of variants of implementation of the watchdog device based on a pulse method is included below. To increase the reliability of watchdog device operation it is reasonable to perform control of STL section where unauthorized connections are the most probable: STL section from a telephone set (TS) to a distribution cabinet. Therefore, the watchdog device functions are referred also allocation of a controlled section of STL in addition to change of capacity control.

Structure and functions of the watchdog device for STL condition control. The watchdog control device (WCD) consists of two parts – the analyzer and a blocker placed on the opposite ends of a controlled section of STL (Fig. 2). The blocker is established near TS and the analyzer is placed from the opposite side of the line, for example, in a telephone cabinet. Analyzer and a blocker are the components of one device. During functioning they transfer data among themselves that is reflected by a dashed line in figure.

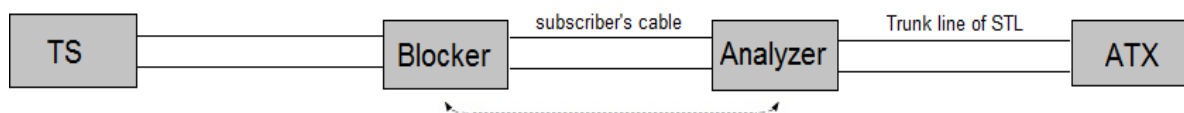


Fig. 2. The scheme of connection watchdog control device for STL

The blocker provides:

- disconnection of telephone set from STL in the absence of current at local line (hand receiver);
- telephone handset pick up control;

- communication with analyzer;
- signaling about the detected unauthorized connection.

Two aspects cause the need for a blocker:

- increasing the reliability of results of control by elimination of the destabilizing shunting influence of a call chain of TS, first of all the separating capacitor against which it would be impossible to commit the minor changes of STL capacity caused by connection of a telephone wiretap;
- blocking of technical channels of the voice information leakage from a room with picked down telephone handset of TS caused, for example, by microphone effect or “high-frequency intrusion”.

The analyzer functions are following:

- de-energization of a controlled STL section by detachment of the main cable for reduction of influence on results of control of the different destabilizing factors;
- forming of the probing signal in the form of short pulses;
- control of an ATX call signal;
- communication with telephone blocker.

Operation of the watchdog control device of STL in more detail is explained by the function chart (Fig. 3). The watchdog device can be in STL control mode if the tube is postponed and in a waiting mode at the picked up handset or at receipt of a call signal from ATX.

The picking up of a telephone handset causes disconnection of a circuit. The lack of a current in circuit is registered by sensor of current (SC), the blocker control unit (BCU) breaks contacts of the blocker (CB) disconnecting the TS from wired line. In addition, there is an activation of the analyzer. Analyzer control unit (ACU) switches for this the contacts of analyzer selector switch (AS), then the controlled section of telephone line is disconnecting from main cable and connecting to pulse linear analyzer (PLA).

At connection of a telephone wiretap, the capacity of a controlled line section suddenly changes and there is an imbalance signal at the output of the pulse linear analyzer. Based on this, the channel of signals processing (CSP) starts a signaling device (SD).

Changing the state of watchdog device into standby mode can be proceed in two ways.

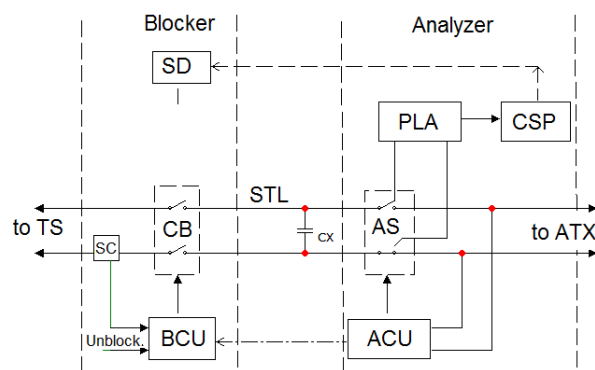


Fig. 3. Function chart of watchdog device control of STL

To initiate telephone connection the subscriber picks up the handset and unblocks the telephone set by manually pressing buttons on a blocker. Shunting of a subscriber line by impedance of colloquial part of the telephone set breaks the fluctuating process, is recognized by the analyzer, causing a connection of a controlled section of STL to main cable. Thus, whole subscriber's line goes to the regular mode and subscriber hearing a buzzer can dial a number.

On the other hand, shutdown of the watchdog device happens in case of receipt of call signals from ATX. In a node of control of the analyzer, there is a selection of pulses of a call and switching of contacts of the analyzer. This signal is transmitted to a blocker for connection of the telephone set to the line. As telephone handset is picked up, so a call of the subscriber has to trip.

It is possible to apply one of wires of the controlled line and a grounding line of object to communication of management nodes of the analyzer and blocker. It will allow to separate chains of measurement and management and to avoid the shunting impact of elements of management nodes on an impedance of controlled section of STL.

Description of the pulse linear analyzer and channel of signals processing of the watchdog device. Above the structure and functions of the watchdog control device in general is described. These functions can be separated into two categories:

- primary (metrological), involved with registering of line capacity change;
- secondary (commutation), which provide changing state from a verification mode to a waiting mode and vice versa, and also the best conditions for control of a line capacity change.

The core of the watchdog device of control is the pulse linear analyzer, which with the channel of signals processing defines metrological properties of the whole device. The scheme of the pulse linear analyzer and the scheme of the channel of signals processing are given in Fig. 4 and 5 respectively.

Two inductor coils are the parts of the pulse linear analyzer (L_1 and L_2) with identical parameters, adjustable capacitor (C_0), pulse generator (PG) and voltage summation unit (VS). Transformation function of the analyzer is described by the expressions (3)...(5). Research results of the pulse linear analyzer are presented in work [10].

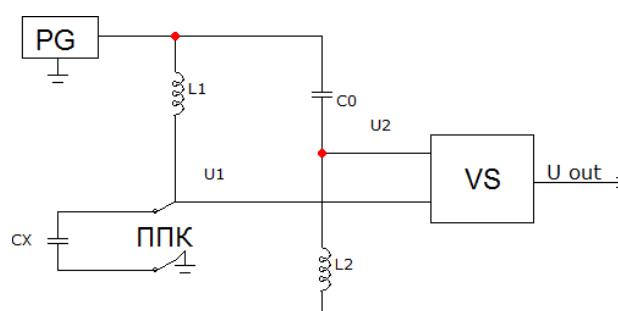


Fig. 4. The scheme of pulse linear analyzer

In case of sudden change of the line capacity there is an imbalance of fluctuations of controlled and standard CLR-circuits. The imbalance signal (after straightening (ST) and integration (INT) using corresponding devices) arrives to the threshold device (TD) which operation establishes the trigger (T) in a high state. That is an informative flag of unauthorized connection to STL. It is possible to use the light and sound signal to the notify about threat for information security.

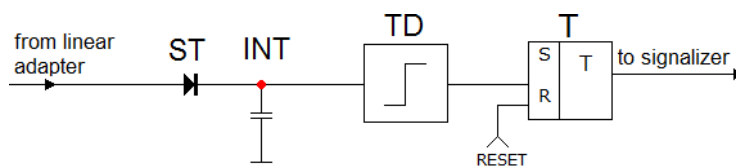


Fig. 5. Scheme of signals processing of the pulse linear analyzer

Conclusions. The need for improvement of characteristics of watchdog devices used for detection of unauthorized connections to STL is proved in this work. The pulse method of telephone lines capacity control is provided. The watchdog devices can be constructed using this method. The structure and functions of the watchdog device constructed on the basis of the developed method is described. The variant of implementation of the pulse linear analyzer and channel of signals processing is considered in details.

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