Therefore, the final reflection coefficient of the layers is

$$\dot{R} = \frac{(\dot{Z}_{вх}^2 - \dot{Z}_1)}{(\dot{Z}_{вх}^2 + \dot{Z}_1)} . \tag{13}$$

Let's consider a two-layer medium, which $n = 3$. The thicknesses of the 1st and the 2nd layers are, respectively, h_2 and h_3, and their propagation constants are $\dot{\gamma}_2, \dot{\gamma}_3$. This medium coefficient (13) is calculated using the formula (12), if we substitute the value $\dot{Z}_{вх}^3$ calculated by formula (11):

$$\dot{Z}_{вх}^3 = \frac{(\dot{Z}_4 + \dot{Z}_3) + (\dot{Z}_4 - \dot{Z}_3)e^{-2\dot{\gamma}_3 h_3}}{(\dot{Z}_4 + \dot{Z}_3) - (\dot{Z}_4 - \dot{Z}_3)e^{-2\dot{\gamma}_3 h_3}} \dot{Z}_3 . \tag{14}$$

In a particular case when the thicknesses of all layers are equal to zero ($h2 = h3 = 0$), the input impedance of the system $\dot{Z}_{вх}^2$ is equal to the impedance $\dot{Z}_4$, as it should be in case of absence of layers.

The above formulas enables expression (14) to take the following form

$$\dot{R} = \frac{\dot{R}_{1-2} + we^{-2\dot{\gamma}_2 h_2}}{1 + \dot{R}_{1-2} + we^{-2\dot{\gamma}_2 h_2}}, \tag{15}$$

where

$$\dot{w} = \frac{\dot{Z}_{вх}^3 - \dot{Z}_2}{\dot{Z}_{вх}^3 + \dot{Z}_2} = \frac{\dot{R}_{2-3} + \dot{R}_{3-4}e^{-2\dot{\gamma}_3 h_3}}{1 - \dot{R}_{2-3}\dot{R}_{3-4}e^{-2\dot{\gamma}_3 h_3}} . \tag{16}$$

This method makes it possible to analyze the layered media, specifically, to determine the physical properties of the layer (e.g., dielectric constant) as well as their number. This method can find its application in geology and geolocation to detect all kinds of deposits.

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MODEL MANAGEMENT SYSTEM THAT IS BASED ON DATA PROCESSING AND ANALYSIS IN REAL TIME WITH INSTRUMENTS MATLAB

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The block diagram and the practical implementation of model management system based on the processing and analysis of data in real time are considered. Interfaces mutual exchange of data streams of MATLAB and external equipment were considered. The example of using the data in real time with application of the system objects MATLAB is given.

Communication and control systems are the most important aspects of work with hardware and software. Direct communication with equipment and peripheral device allows you to quickly test and verify algorithms, and to carry the necessary changes in projects under development. MATLAB software provides a lot of different ways to interact with sophisticated equipment and peripherals.

The MathWorks system of computer mathematics MATLAB is an interactive environment that uses a high-level language for numerical computation, visualization and programming. It is possible to develop algorithms, to analyze the data and to generate models and applications on the basis of this system [5].

The use of digital oscilloscopes and analog-to-digital converters together with mathematical modeling MATLAB program opens up a lot of promising opportunities in the processing and following use of the measured data for the design of various systems.

The transmission of data flow measured in the process into the MATLAB workspace and ensuring hardware and software compatibility of equipment and a personal computer (PC) are the main difficulty in the implementation of the exchange of data.

The problem of processing a large amount of information, which is based on data that is obtained by measurements, in real time often appears in control systems. This treatment is practically impossible without expensive physical prototypes or equipment. However, even if you have such equipment, development, testing and verification algorithms can be very risky and even lead to damage. Method of constructing a model of the target system and simulation of its work (for example, in the MATLAB) in various modes before launching on real hardware is more reliable and less expensive [1].

The block diagram of a simple management model based on data analysis and processing in real time is presented in Figure 1.
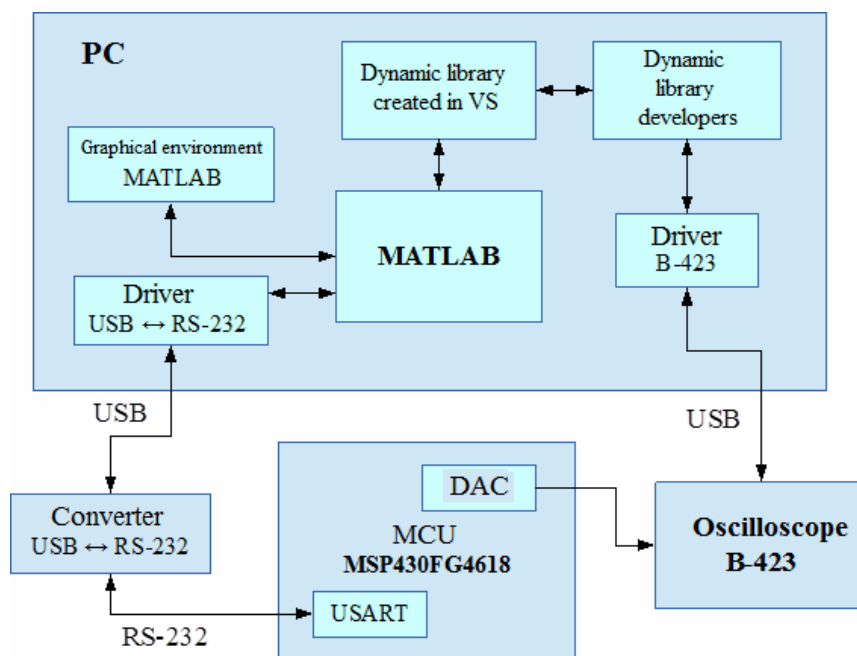

Fig. 1. A block diagram of hardware and software system

The oscilloscope of the Auris B-423 company will be used. Manufacturer does not give us completed solutions for its use in conjunction with MATLAB. However, dynamic libraries (*.dll) are supplied with the software for the development of the off-site software in the use of the equipment purchased.

A microcontroller (MCU) from "Texas Instruments" (series MSP430FG4816) was used as a controlled oscillator. This highly integrated MCU allows you to use almost any combination of family MSP430 peripherals. Connection facility of a variety of integrated peripherals and other devices involves enough opportunities to develop equipment and makes microcontroller an ideal platform for its base [2].

Let's turn to realization the system shown in Figure 1.

1. The interfaces of communication with external equipment.

MATLAB package includes a variety of interfaces for data access, clients, servers, and external routines that are written in other programming languages. The most commonly used interfaces are:

− COM. MATLAB provides access to functions that allow you to create, manage, and delete COM-objects (both client and server).

− .NET. MATLAB provides access to the software platform .NET Framework on Microsoft Windows. It is possible to download the .NET assembly (Assemblies) and to work with objects of .NET classes from MATLAB environment [4].

− DDE. MATLAB provides functions that allow it to access other applications in the Windows, as well as those applications to access data from MATLAB.

− COM-port. Interface to the serial port of MATLAB provides direct access to peripheral devices and scientific equipment connected with the computer through a serial port (COM-port).

− DLL. Interface MATLAB that is referring to the common DLL libraries allows you to call functions that are in the normal dynamic link libraries directly from MATLAB. It also must have a function C-Interface.

USB communication interface is used for connecting the oscilloscope B-423 with a computer, and data communication on which to MATLAB from the oscilloscope can be done in two technologies .NET and DLL. It should be noted that the direct use of a dynamic link library (DLL) external functions (OSCB423Lib.dll) for the oscilloscope in MATLAB was not possible, due to the unknown structure of the developers' library. Therefore, we applied the technology .NET for our model oscilloscope control, and its own dynamic library of simple functions (Osc.dll) in C # environment Visual Studio 2013 was written for that. Written library is a matching link between developers' dynamic library (OSCB423Lib.dll) and MATLAB. Only two functions are amount of the created library: Setting () - for the basic settings of the oscilloscope and Measuring () - for the measurement, and return the data in MATLAB.

COM-port is selected to control the microcontroller interface and provides a simple interface for direct connection of RS-232 communication. Due to the fact that the system was developed on the laptop, not on the personal computer, additional interface was introduced to system – converter USB-RS232.

2. Using MCU to work as a controlled oscillator.

We used 10-bit DAC peripheral module as a signal generator, and the built-in peripheral universal synchronous-asynchronous receiver-transmitter USART was used for verification. A developed program code for MCU was tested with the help of the Code Composer Studio v6 software. [2]

3. Initialization of the oscilloscope to measure.

Connecting of library with the help of .NET technology in MATLAB occurs with the following command in the application's console:

>> NET.addAssembly('путь_к_библиотеке\Osc.dll');

Creating of NET object corresponding to the class of our dynamic link library (Osc.dll) occurs with the help of the command:

>> obj = Osc.Program;

4. Implementation of measurement and transmission of the data stream.

Setting up the oscilloscope for measurement is realized with the command:

>> obj.Setting();

Measurement and transmission of the data stream in the MATLAB workspace are made with the command:

>> X = double(obj.Meas(*ScaleX*, *ScaleY*));

Variables ScaleX and ScaleY are selected to configure the scan, the significance of that will be determined by the number of samplings for a second and the scan potential. Moreover, values that predefined in the library developers are used at the time of the choice of these variables (ScaleY and ScaleX) too.

5. Digital processing of streaming data.

Using streaming and time-lapse processing technology allows to accelerate simulation due to buffering input data into frames and simultaneous processing of multiple samples of data. Acceleration of simulation is also achieved by focusing on the treatment process fixed immediately a lot of data. In MATLAB streaming signal processing is achieved due to the use of system objects (System objects) to represent data-driven algorithms, tools, data input and output of the models. System objects implicitly manage a lot of aspects of the system such as indexing, data buffering and state regulation algorithms. In one program it can be combined system objects with standard functions and operators of MATLAB.

Here is the example of using the system object dsp.FFT () that computes the discrete Fourier transform (DFT) from the samples of the input signal. System object can use one of several types of fast Fourier transform algorithm (FFT). When you create a system object, it is usually indicated by the parameters: the length of the input digital signal, the estimated window, bit- bidirectional order of output samples and the type of algorithm. Creating a system object in the MATLAB console looks like in the following way [3]:

>> hfft = dsp.FFT('FFTLengthSource', 'Property', 'FFTLength', 1024, 'BitReversedOutput', false, 'WrapInput', true, 'FFTImplementation', 'auto');

Object's uses for calculations

>> Y = step(hfft, y);

Here, y- is the input vector of data or the frame in the data stream. Y is calculating vector for this block FFT.

6. Presentation of the measurements' results.

Large quantity of data is usually obtained as the result of made calculation, so it is difficult to analyze it without visual imaging. In this case, graphics capabilities of MATLAB are high-end and manifold. They are often called high-level graphics. This name reflects the fact that the user is not in need to delve into all the details

of direct work with graphics. At the same time, if necessary, the graphic representations of the processed data can always be easily represented in the form of a single Windows-based application.

The example of a graphical display of the processing effect and data flow analysis that was measured with an oscilloscope is shown in Figure 2. Graphs that are superimposed on the graphical user interface:

− A graph that represents the data obtained from the oscilloscope in the form of a temporary representation of the signal;

− A graph that images the processed data from the oscilloscope with the help of system object in the form of a spectrum.

Analysis of the data takes place by four markers that control the maximum and minimum values of the signal amplitude and the maximum signal power and the harmonic frequency at which it is calculated.
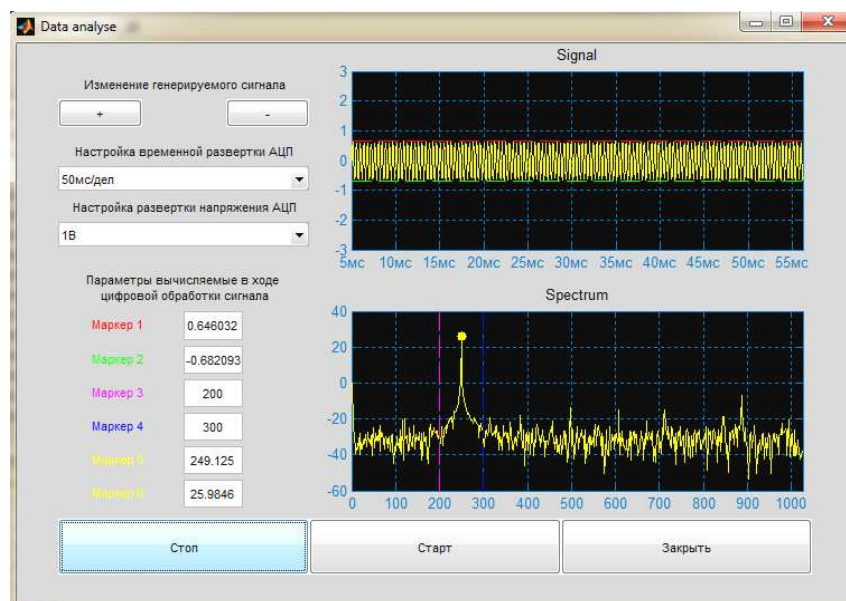

Fig. 2. A graphical interface MATLAB:
Marker 1 – is the maximum amplitude of the signal, expressed in volts; Marker 2 – is the minimum amplitude of the signal, expressed in volts; Marker 3 and Marker 4 – are a setting frequency band management;
Marker 5 and Marker 6 – are a position of a point on the spectral graph

7. Determination of the controlling effect on the signal generator.

MATLAB makes the determination necessary impact on the signal generator based on the analysis of data from the placed markers 3 and 4 (see Figure 3) and calculated values surrounding markers 1, 2, 5 and 6.

Task designed management system to provide retention of the frequency of the oscillations generated within the established using markers 3 and 4. The system can adjust the amplitude of vibrations and frequency through the MCU command via RS-232. The algorithm for deciding on the choice of a team at this stage is quite simple:

− The command to increase the voltage is issued at low values x of the measured voltage;

− The command to change the sweep voltage is issued in that case if the command to increase the voltage does not work for one second;

− The command to change scan at the time base is given in the case if the frequency range defined by the markers will be at the beginning or in the middle of the entire frequency range at the given sampling rate;

− The command to increase or decrease the frequency of the generated oscillations issues according to the position of the calculated value of the frequency with regard to range defined by markers 3 and 4.

As a result of this work, a model block diagram of a control system that is based on the processing and analysis of data in real time was developed.

Integration of oscilloscope B-423 "Auris" for receiving the data stream was realized through the use of .NET technology.

Your own graphical user interface for displaying and analyzing data obtained from oscilloscope in real time and generator control in automatic or manual mode was written.

The example of using the data in real time was presented with the help of the MATLAB system objects.

We have created a model that covers almost all the main stages of management development systems based on the data obtained in real time.

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SENSORS OF ALARM SYSTEMS

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The standard structure of alarm systems has been considered. The description of the principles of operation of sensors has been provided. Alternative options of touch elements of security system have been shown.

Security alarm is a complex of electronic security devices, which allows to provide object's protection from offences by means of the owner or law enforcement bodies alerting. There are two main types of alarm acute for Belarus: 1) the alarm using MIA security department brigade of the Republic of Belarus call, with monthly pay; 2) GSM-alarm, the activation of which alert message by means of SMS or mobile phone-call is delivered to the owner.

The security alarm system consists of the control unit (with GSM-module or without it) and different sensory devices depending on the guarded object. The system also contains uninterruptible power supply unit with an accumulator battery and security systems' cable. Control-security device may be wire-connected – with sensory devices, as well as unwired – the connection between sensory devices is realized with the help of radiofrequency signal (power supply is wire-connected). Control of radio-security may be realized by means of wireless radio-breloques [1]. Control unit shows current alarm mode ("Attention", "Warning", "Removal"), it's also activates/deactivates with the help of Touch Memory key or SMS-message. Let's look at the principles of sensory devices' working and its configuration. There are three main sensory devices in the system: a movement-detecting device, the device of a door opening/locking fixing process and the one of glass-breaking.

Let's consider a movement-detecting sensory device. It is based on IR-detector, that uses deposition of thermal energy the perimeter breaker emits. Movement-detecting IR-sensors are used for the security of armed bank buildings - cash operating units, depositories. The principle of thermal movement-detecting method is based on the physical theory of electromagnetic waves' radiating by objects, the temperature of which is above the absolute zero point. Movement-detecting and presence sensory devices react on the photocell IR-light occurrence and disappearance. Such IR-light occurrence-disappearance are often caused by human activity, more seldom – by factors which aren't connected with man, for example, by warm air moving from a radiator etc.

That's why false activations are observed with all of the movement-detecting (presence) sensors. Movement-detecting devices are more simple in its construction and they react only on active movements, of a walking man, for example. A general arrangement drawing of IR-sensor work is represented at figure 1 [2].

There are various constructions of movement-detecting IR-sensors, which are intended for specific technical objectives and conditions. The most popular construction of the movement-detecting IR-sensor is given in figure 2 [3].

The principle of movement-detecting sensor on pyroelement is the following: perimeter breaker's thermal stream goes to the Fresnel lens, which focuses radiation on the pyroelement, after that thermal stream is transformed into pyroelement's temperature change. The internal structure of the pyroelement redistributes (charges rearrange themselves) and potential (voltage) appears on the pyroelement's leading-outs. This signal enters sensory device control unit, i.e. cascade of growing and its transformation into digital form.

One of the important parts of modern security system is a door opening/locking sensory device.