



OKP 42 7612



ULTRASONIC FLAW DETECTOR

A1214 EXPERT

USERS GUIDE

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Acoustic Control Systems
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The present users guide (further in the text - a manual) contains technical characteristics, description of the device and its action principle. It also includes the data necessary for correct operation of the ultrasonic flaw detector A1214 EXPERT (further in the text – flaw detector or device).

Before the beginning of device operation please attentively study the present manual.

Manufacturer's permanent job in the sphere of perfecting the device possibilities, increasing of reliability and convenience of operation can sometimes lead to some unprincipled changes which have not been reflected in the present edition of a manual and not worsening device's technical characteristics.

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1 APPARATUS DESCRIPTION AND WORK

1.1 DEVICE APPOINTMENT

1.1.1 Appointment of the flaw detector

The flaw detector A1214 EXPERT is related to ultrasonic general-purpose flaw detectors for manual control.

The flaw detector is designed for search, definition of coordinates and estimation of various infringements sizes in continuity and uniformity of a material in products made from metals and plastic.

The flaw detector allows to form, register and keep in non-volatile memory time realizations of echo signals. The electroluminescent display of the electronic block provides displaying of echo signals in the form of A-involute, and also the images of control objects sections in the form of B-scan. Manual and automatic measurement of time intervals, signals amplitudes and automatic calculation of defects coordinates are provided.

The software Advanced Data Manager (ADM), included into the set of device delivery allows to transfer the data from the device's memory to the external personal computer (personal computer) for their subsequent analysis and documenting. Also there is a possibility to make device adjustment through the computer, to observe on the computer screen echo signals in real time and scale, to process them (computer flaw detector mode). Herewith communication with the computer is carried out through USB port.

1.1.2 Service conditions

The device is designed for operation under the following environment conditions:

- temperature from minus 30 to plus 45 centigrade degree;
- relative air humidity up to 98 % with the maximum temperature 35 centigrade degree.

1.2 TECHNICAL CHARACTERISTICS

1.2.1 The key parameters of the device

The key parameters of the device are displayed in the table 1.

Table 1

Parameter's name	Value
Nominal working ultrasound frequencies, MHz	0,5 - 15,0 ($\pm 10\%$)
Dynamic range, dB, not less	100
Range of time intervals changes, mcs	1 - 1200
Range of ultrasound speed in material tuning, m/s	1000 - 15000

1.2.2 Instrumental characteristics of the device

Instrumental characteristics of the device are displayed in the table 2.

Table 2

Characteristic's name	Value
Limit of assumptive value of basic absolute error in thickness X measurements, mm, no more	$\pm (0,01X+0,1)$
Limit of assumptive value of basic absolute error in time interval measurements t, mcs, no more	$\pm (0,01t+0,1)$
Nonlinearity of development on a vertical, %, no more	± 1
Limits of adjustment of a delay in development, mcs	0,0 - 99,9

1.2.3 Characteristics of the probe pulse generator

Characteristics of the probe pulse generator are displayed in the table 3.

Table 3

Characteristic's name	Value
The probe pulse form	Meander
Number of periods	0,5 - 5,0
The probe pulse parameters: Amplitude (half of swing), V Duration of fronts, no more, ns	20; 100; 200 ($\pm 5\%$) 20
Frequency of the probe pulse repetitions, Hz	10; 25; 50; 100; 200

1.2.4 Characteristics of a reception path

Characteristics of a reception path are displayed in the table 4.

Table 4

Characteristic's name	Value
Frequencies strip of a reception path, MHz	0,14 - 21,00
Effective value of the own noise, resulted in to input, mkV, no more	20
Reorganization range of the attenuator, dB	0 - 90
Absolute error of the attenuator steps, dB, no more	$\pm 0,2$
Dynamic range of time variable gain, dB, not less	30

1.2.5 Power supply and power consumption characteristics

Power supply and power consumption characteristics are displayed in the table 5.

Table 5

Characteristic's name	Value
The power source	Demountable accumulator
Nominal value of the flaw detector's source voltage, V	12
The electrical current consumed by the flaw detector under nominal value of the source voltage:	
Minimum level of the screen luminescence, mA, no more	300
Maximum level of the screen luminescence, mA, no more	500
Duration of a continuous work:	
Minimum level of the screen luminescence, h	12
Maximum level of the screen luminescence, h	7

1.2.6 Constructive characteristics and reliability parameters

Constructive characteristics and reliability parameters are displayed in the table 6.

Table 6

Characteristic's name	Value
Overall dimensions of the electronic block, mm	250x160x80
Weight with power elements, kg	1,9
Screen resolution	320x240
The sizes of a displaying field of the screen, mm	115x86
Admissible range of temperatures under the storage and transportation, °C	-40 - +50

Characteristic's name	Value
Working atmospheric pressure range, kPa	84,0 - 106,7
Average time between failures, h, not less	32000
Target date of service, years	5

1.3 APPARATUS ARRANGEMENT AND WORK

1.3.1 Flaw detector's arrangement

The flaw detector includes the electronic block with the replaceable storage battery, a set of cables for ultrasonic converters of the various type connections, the charging device and various accessories.

1.3.1.1 The flaw detector's electronic block

The flaw detector's electronic block provides electric impulses formation for excitation of the piezoelectric converter, strengthening received from the piezoelectric converter signals, their processing, visualization, formation and representation of measurements results, preservation of the data in non-volatile memory, data transmission to the external computer.

Appearance of the electronic block is displayed on the picture 1. Flaw detector management is carried out by means of the film keyboard. Indications of signals, measurements results, flaw detector conditions, etc. are carried out on the display and by means of light-emitting diode indicators on the device case.



Picture 1

Piezoelectric converter connection is carried out by means of the coaxial cables which present in the set of delivery, through sockets LEMO which are located in a niche of the right wall of the case.

Device's power supply is carried out with the help of replaceable accumulator, or from the external power source which includes in the set of delivery, connected to LEMO socket. The socket is located on a back wall of the device (picture 2).



Picture 2

1.3.1.2 Charging device

For the flaw detector's maintenance from external energy sources and charging of the replaceable accumulator established in the electronic block the charging device is used. It consists of the network adapter and charger VS121.

The network adapter provides transformation of the network main alternating current voltage (100 - 240 volt) and frequency 50-60 Hz into constant voltage 12 V necessary for charger VS121 work.

The adapter is executed under the scheme with pulse transformation of voltage. It allows connection with networks of various voltage values and

also reduces voltage instability influences which are present in industrial and household networks.

Charging device VS121 transforms the direct current voltage of 12 V into necessary for flaw detector's work voltage and also carries out accumulator charging and training that increases its service life.

Depending on the flaw detector's battery discharge the accumulator charging can last till 6 hours. In the accumulator charging process the flaw detector can carry out its functions in full volume (except a communication with computer mode).

To avoid device damage under wrong connection, it is recommended to connect devices in the following sequence: connect the charging device cable to the electronic block; connect the charging device cable to the charger; connect the output cord of the network adapter to the charging device; connect the network cable to the network adapter; connect the network cable with the network (picture 3).



Picture 3

ATTENTION! DURING THE CONNECTION OF THE CHARGER AND THE DEVICE WITH THE CABLE IT IS NECESSARY TO OBSERVE THE SOCKETS KEYS AS IT IS SHOWN ON PICTURE 4. ARROWS SPECIFY THE SOCKETS KEYS.



Picture 4

For operating mode indication on the forward panel of charging device VS121 light-emitting diode indicators of three various colors are placed: red, yellow and green. The red light-emitting diode designates voltage presence on charging device VS121 input. The yellow light-emitting diode displays a condition of charging process. After the connection of VS121 to the device and switching it on accumulator testing begins, the yellow light-emitting diode herewith blinks. If the accumulator was nearly discharged then this process can take up to 30 minutes. After that charging process begins, the yellow light-emitting diode constantly lights. The green light-emitting diode signals about the termination of accumulator charging process.

As the replaceable accumulator the assemblage of 10 nickel-metal-hydride elements is used. In assemblage for short circuit and heating prevention protection elements are established.

ATTENTION: IT IS FORBIDDEN TO DEMOUNT AND REPAIR THE DEMOUNTABLE ACCUMULATOR ON ONES OWN ACCOUNT!

1.3.1.3 Converters

The flaw detector is made for working with combined and separately-combined piezoelectric converters of working frequencies from 0,5 to 15,0 MHz

In the device the generator of bipolar probing impulses with regulated duration and number of periods is used. This provides compatibility with piezoelectric converters which have integral interfacial inductances, or don't have them, i.e. the flaw detector is compatible with the majority of piezoelectric converter types presented in the market.

Depending on the converter type two types of cables and accordingly, two ways of connection with the piezoelectric converter are used:

- The combined converters (type S) are connected by means of unary cable LEMO-LEMO to a socket indicated as IN (picture 5).



Picture 5

- Separately-combined (PC) converters (type D) are connected by means of a double cable LEMO-LEMO. The socket indicated as OUT serves for connection of the transferring piezoelectric element, indicated as IN - for receiving piezoelectric element. Usually on PC converters the socket of a transferring piezoelectric element is marked by a red or a white point (picture 6).



Picture 6

1.3.1.4 Cables and sockets

Connecting cables of the device are produced from the high-quality coaxial cables and sockets of leading world manufacturers («Raychem», «LEMO», etc.).

Application of the cable products described above provides necessary flexibility of cables at low temperatures (up to -30 centigrade degree), reliable fixing of connections at small dimensions and connection places sockets and cables protection against fractures. This finally minimizes refusals in connecting elements and facilitates work with the device.

1.3.2 Main interface principles

In A1214 EXPERT there is an intuitive interface principle. Associative menu pictographs in various modes, explanatory pictures near the parameters, names and designations of keys allow to master work with the flaw detector easily and simply.

The data output on the screen is realized in such a manner that the necessary for operative control information is always there.

The flaw detector work is accompanied by sound signals which can be deactivated.

The work with flaw detector is considerably facilitated by presence of settings library in which up to 99 configurations of the device settings can be stored. For each configuration user can appoint a name in length no more than 14 symbols. Before a configuration name its serial number is automatically displayed. Thus flaw detector adjustment under various situations and objects of control can be made in advance. Then you need simply to choose in the menu the necessary one.

All flaw detector options remain in the device's memory after it's switching off, device storage without the battery and under the accumulator discharge.

1.3.3 Flaw detector's operating modes and their interrelation

There are some basic work modes in the flaw detector: the SEARCH, the REVIEW, the MAGNIFIER and the B-scan. In this modes formation of a probing signal, strengthening of accepted signals, their representation on the flaw detector's screen, measurement performance and results preservation in the device's memory are carried out.

In the MENU mode change of the flaw detector adjustment parameters is made on modes OK or piezoelectric converter. The installation of necessary auxiliary parameters is also carried out there.

In the modes SEARCH, REVIEW and MAGNIFIER the device work is provided in the mode of classical flaw detector, allowing to visualize signals in the form of A-involute and thus manually or automatically measure the signals amplitudes, time intervals, and also distances taking speed into account .

In the SEARCH mode the A-scan of a signal is displayed with the maximum screen displaying of the numerical measuring information. The mode SEARCH is convenient during the work with inclined converters. In the REVIEW mode the A-scan of a signal is displayed with the maximum size on the screen while the numerical measuring information is minimized.

This is convenient during the analysis of the general ultrasonic signals form and work with direct converters.

In the MAGNIFIER mode the maximum quantity of the operative measuring information is presented on the screen and the sizes of signals displaying area are limited. Herewith two A-scans are simultaneously displayed - the general and stretched time interval corresponding to area of the first strobe. The feature of the given mode using is measurement with the raised accuracy.

The B-scan mode is made for formation of one cross-section section OK (B-scans).

Besides the main there are auxiliary modes: STOP, COMMUNICATION, CALIBRATION OF THE INPUT PIEZOELECTRIC CONVERTER CORNER, ADJUSTMENT OF THE SWEPT GAIN, DGS-DIAGRAM ADJUSTMENT.

The STOP mode realizes “freezing” possibility which means preservation and viewing of measurements results and single realizations of the signals received in modes SEARCH, REVIEW and MAGNIFIER. The saved files can be transferred to the personal computer for storage and using for ultrasonic control protocols making.

In the COMMUNICATION mode data transmission to the personal computer is carried out. It launches automatically after connection the flaw detector with personal computer. Herewith management of the device is completely transferred to the computer. During the connection to personal computer the device cannot be switched off.

The CALIBRATION OF THE INPUT PIEZOELECTRIC CONVERTER CORNER mode is used for semi-automatic procedure of input corner measurement and delay of inclined piezoelectric converter.

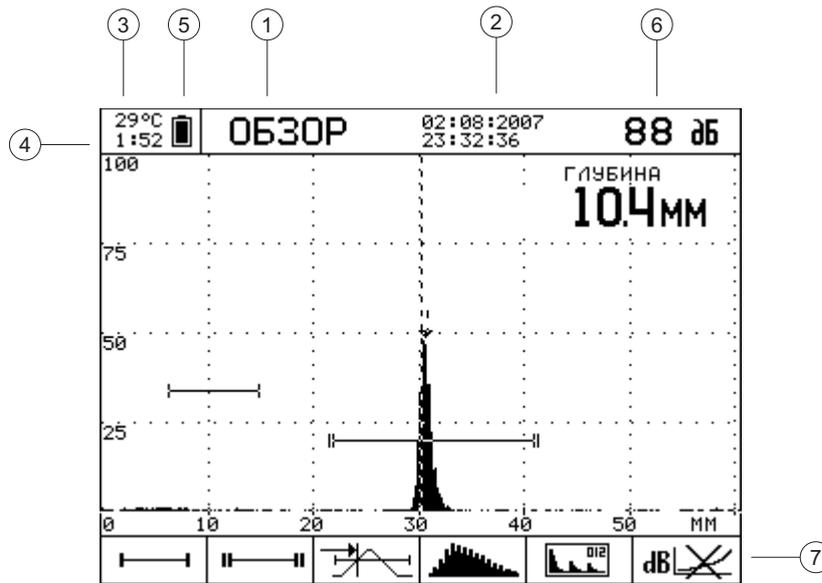
ADJUSTMENT SWEPT GAIN mode is used for corrections of signals abatement with distance effect.

ADJUSTMENT DGS-DIAGRAM mode is used for adjustment of sensitivity and definition of the equivalent reflectors area.

1.3.4 Information representation on the screen

In the flaw detector the monochrome graphic electroluminescent display with the screen resolution of 320x240 points is used as indicator.

The working space of the screen in each mode is divided into some functional areas. For example on picture 7 the screen is seen in the REVIEW mode.



Picture 7

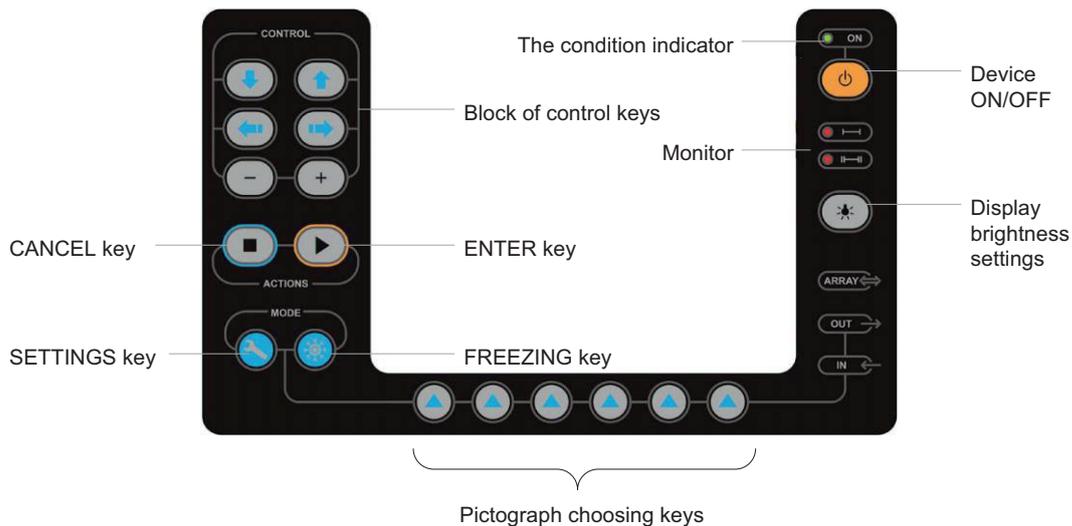
The top line indicates the name of current operating mode ① and the service information. In the field of the service information there is a current date and time ②, temperature inside of a device ③, equivalent time of continuous device work during accumulator (timer) power supply from the last accumulator charging moment ④, power supply source condition ⑤. In the right part of the top line in functional modes measuring information ⑥ can be displayed.

In the bottom part of the screen the area of pictographs is located ⑦. With their help the following operations are made: choice of an operating mode, adjustment of a signals representation way, adjustment of strobes and threshold devices and so forth.

The average part of the screen is used for results measurements displaying, flowing parameters and flaw detector settings.

1.3.5 Flaw detector's keyboard

The flaw detector's keyboard is displayed on picture 8.



Picture 8

There are: tuning the power on/off key, 17 multipurpose keys and three light-emitting diode indicators.

The light-emitting diode indicator over a key  shows flaw detector's condition. Green color means that the device is charging from the accumulator, the blinking green specifies in a low charge of the accumulator. Yellow color - a device charging is carried out from the network adapter. Two red indicators under a key  show how operation monitor works for the first and second strobes accordingly.

The symbolical designation of their basic functions is put on keys. The English-speaking designation of keys is chosen for unification of device's design and flaw detector's operational documentation while using in various regions.

The keys ,  and also keys of pictographs choosing for strobes management and work with swept gain/DSG-diagram realize the following principle: «The First pressing - Enter, repeated - Exit». Other keys of a pictographs choice carry out switching of modes on unitary pressing.

Regulating keys , , , , ,  Influence on the current active object. Their actions are similar for various operating modes of the device. They are intuitively understood by the operator, i.e. their symbols correspond to character of their action.

For some keys there is a mode of auto repeat with acceleration when pressing more than 1 second.

When the sound is on pressing the keys are accompanied by a short signal.

The short description of keys appointments for the basic device operating modes is resulted in table 7.

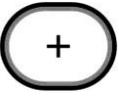
Table 7

Key	Key functions in different modes					
	Search	Rewiew	Loupe	B-scan	STOP	MENU
	Apparatus switching ON and OFF. You need to hold the key not less than 0,5 s					
 	Time-base range switching			Moving the cursor in B-scan, rewiew of the A-scans written	Choosing of active pictograph	Choosing of settings menu mode
 	Metric cursor moving					Active parameter changing
 	Attenuator management			Threshold shift	-----	Choosing of the active string in the settings menu
	Cross-over to the MENU mode. When holding more than 3 seconds the window with current configuration parameters is opened					MENU mode exit
	Cross-over to the STOP mode				Exit the STOP mode	-----

Key	Key functions in different modes					
	Search	Rewiew	Loupe	B-scan	STOP	MENU
	Display brightness setting. Each pressing increases the brightness. After the maximum brightness is achieved if press again then it will become minimum again.					
	Pictographs choosing buttons					
	Basic level switching ON / OFF			Record of the next section	Record into memory	Function activation
	Informational window with current configuration opening			Section clearing	-----	-----

Management of the separate device functions is carried out by means of a key combination (while the 1st key is pressed it is necessary to press 2nd key). The key combinations used and their appointment are displayed in table 8.

Table 8

Key 1	Key 2	Appointment
		Apparatus switching on with default value of all settings and parameters
	 	Direct choice of a device configuration options from the settings library in active modes; SEARCH, VIEW, LOUPE and B-SCAN

1.3.6 Using of pictographs

The feature of the device's interface is presence of associative pictograph menu which are located in six rectangular windows in the bottom part of the screen. Pictographs are symbolical images, associated with object or operation they execute. Each mode has its own set of pictographs.

Pictographs can be passive (yellow symbols on a black background) and active condition (black symbols on a yellow background). The active condition means that change of device parameters properties corresponding to the current pictograph is possible.

During the work in functional modes SEARCH, REVIEW, MAGNIFIER (LOUPE), B-SCAN pictographs are in a passive condition and display a current condition of device's options.

In these modes pressing the pictographs choosing keys leads to pictographs activation and changing of corresponding parameters. At keys release the given pictograph comes back into a passive condition. The exceptions are the pictographs of strobe management and work with swept gain/DSG-diagram. They work with a principle: one pressing – entrance, the second one - exit. For editing of these parameters it is used the key .

In modes MENU and STOP one pictograph is always active. The active pictographs window choosing is carried out with the pictographs choosing keys and in the MENU mode also with the help of keys  .

ATTENTION: FURTHER UNDER THE TEXT THE CONDITIONAL NUMERATION FROM 1 TO 6 (FROM LEFT TO RIGHT) IS USED FOR PICTOGRAPHS WINDOWS AND CORRESPONDING PICTOGRAPHS CHOOSING BUTTONS!

2 PROPER USE

2.1 OPERATIONAL RESTRICTIONS

The device is made for operation in the surrounding environment conditions which are specified in item 1.1.2.

2.2 APPARATUS PREPARATION FOR USE

When delivered by air transport according to safety requirements the flaw detector's accumulator is disconnected from electric schemes. In this case it is necessary to insert the accumulator in directing slots which are located on the back side of the electronic block and accurately move it before clamp click.

Note - for accumulator removal is necessary to press a clamp and accurately move the accumulator from the directing slots.

Protection glass on the flaw detector's screen is covered by the polyethylene film preventing occurrence of scratches during manufacturing and transportation. Before the operation begins it is recommended to remove a protection film. This will raise contrast and brightness of the image on the display.

2.2.1 Flaw detector switching on and off

For flaw detector switching on it is necessary to press a key . Herewith the melodic signal (if the sound is on in the MENU) will sound and the green or yellow light-emitting diode lights up. Simultaneously on the flaw detector's screen for 1,5 - 2 seconds prompt with the name of the device and number of the insertion version appears.

After switching on the device there are options which were used before its last switching off.

Device switching off is carried out manually by pressing the key  or automatically after 30 minutes of non-use.

2.2.2 Choosing of the converter

The flaw detector A1214 EXPERT provides products control by echo-method, an echo-mirror, mirror-shadow and shadow methods. For realization of this monitoring methods there are various direct, inclined, combined and separately-combined ultrasonic piezoelectric converters with working frequencies from 0,5 to 15,0 MHz.

For thickness of products definition straight combined (type S) and separately-combined (type D) converters are used.



Straight combined piezoelectric converters are used for flaw inspection and measurements of a thickness of products concerning the big thicknesses.

The maximum depth of control depends on working frequency of the converter, diameter of its working surface and attenuation of ultrasonic fluctuations in a controllable product material. The dead zone is thus defined by quality decrement of the ultrasonic converter.

Straight combined piezoelectric converters due to the ceramic protector are poorly subjected by deterioration. Due to the high electro-acoustic properties they also are suitable for thickness of polymeric products measurement.



Direct PC piezoelectric converters are widely used for thin-walled pipes of small diameter control, butt welded connections with the removed strengthening of a seam control and also for detection of stratifications in sheets and defects in the soldering.

PC piezoelectric converters are used, when control of products with small thickness with the greatest possible sensitivity is required. More often such converters are controlling thicknesses from 0,8 to 50 mm.



Inclined piezoelectric converters are use for flaw inspection of products and their fragments in places where there is no access to a surface over a control zone.

Depending on the geometrical sizes of object, the most probable site and orientation of defect, acoustic properties of a material and the control scheme there can be used inclined converters with an input corner from 40 to 90 degrees and work frequency from 1 to 5 MHz.

In table 9 there are general recommendations for choice of frequencies, input corner and other inclined converters for control of welded seams from carbonaceous steels of various thickness parameters.

Table 9

Seam thickness, mm	Frequency, MHz	Piezo slab maximum size, mm	Minimum arrow, mm	Input corner (at control by a direct beam)	Input corner (at control by the reflected beam)
4-8	5	6	5	70	70
8-12	2,5; 5	8-12	8	65; 70	65; 70
12-20	2,5	8-12	12	65	65
20-40	2.5	12	12	65	50
40-70	1,8	18	22	50	40
70 -120	1,8	18	22	50	---

More certain recommendations about ultrasonic converters choosing are contained in specialized techniques, supervising documents, basic positions and other methodical materials about ultrasonic flaw inspection.

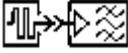
2.2.3 Installation of parameters

Adjustment of flaw detector parameters is made in the MENU mode. Adjustable parameters are divided into key and general.

Key parameters define reliability of control. Among them there are such parameters as frequency, sensitivity, an input corner, development etc. Herewith the equipment key parameters are distinguished (PIEZOELECTRIC CONVERTER PARAMETERS, PARAMETERS OF THE ELECTRONIC PATH) - they depend only from the flaw detector type and method of control. While the control parameters depend on equipment and a controllable material.

Control key parameters are displayed in the table 10.

Table 10

CONVERTER PARAMETERS	
Piezoelectric converter type Piezoelectric converter frequency, MHz Corner of input Delay, mks Arrow, mm	
ELECTRONIC PATH PARAMETERS	
Pulse, V Number of periods Poll frequency, Hz Filter B-scan temp, Hz	
CONTROL PARAMETERS	
Velocity, m/s Thickness, mm Search threshold, dB Cutoff, % Scale X	

The combination of all these groups of parameters forms a device settings configuration. Creation and preservation in non-volatile device's memory of 99 various configurations are provided.

During the preparation for control it is necessary to choose in the MENU a necessary configuration. In case of absence of configuration with necessary options in memory it is necessary to establish and keep it in any free configuration under a new name.

The general parameters are valid for all modes of the device. They are: brightness, sound, dump of the time counter, language switching.

All parameters except brightness of the display are established in a current configuration of the MENU mode.

2.2.4 Calibration of the inclined piezoelectric converter (PEC)

During the work of the inclined converter there occurs the erasure of a refracting prism owing to what the corner of input and a signal delay in a prism are changed. For operative definition of an input corner there is a semi-automatic procedure - CALIBRATION OF THE CORNER OF INPUT.

Before the entrance into a calibration mode in point «INPUT CORNER» it is necessary to establish passport value of the input converter corner.

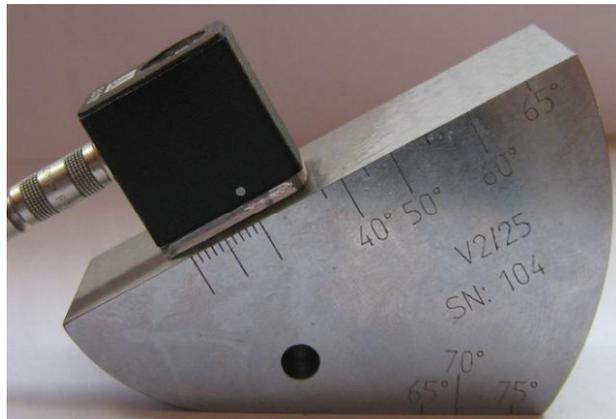
The input in this mode is carried out from the MENU mode by point selection «THE INPUT CORNER» and key pressing . Herewith the device remembers current configuration settings and a screen type. For calibration period the device will change some parameters of adjustment, in particular it will establish a zero delay, amplitude of a probing impulse and a number of other parameters. At the exit from procedure they will be restored. The signal in a calibration mode will be displayed as a mode of spatial bending around with the maximum size of the screen.

Calibration consists of two stages: definitions of in prism piezoelectric converter delay and calculation of an input corner of piezoelectric converter.

It is possible to leave a calibration mode only having passed both stages.

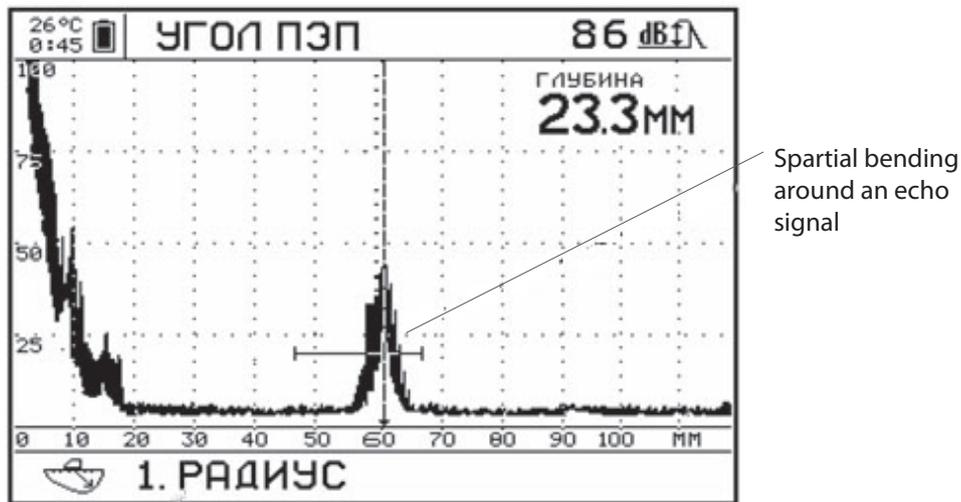
The calibration sample V2/25 is necessary for procedure carrying out.

On the first stage the delay in a converter prism is defined. For this purpose it is necessary to scan radial part (R50) of the sample V2/25 from a long side (picture 9).



Picture 9

Herewith the peak bending around from radial part is displayed on the screen (picture 10).



Picture 10

While regulating the attenuator, it is necessary to achieve the signal amplitude from radius surface of the sample at the level more than 25 % of the screen. If necessary it is possible to dump accumulates results by pressing a key  and repeat scanning again.

During the scanning the vertical cursor will automatically fix a maximum of this bending within the established strobe. Strobe movements are blocked, its position is chosen according to a zone in which the useful for measurements signals on the sample V2/25 can lie.

Having received a kind of signal comprehensible to measurements it is necessary to press a key . Herewith the device will settle calculation and will pass to the second stage - measurement of an input corner. Spatial bending will dump the previous accumulation; parameters of attenuator will change - decrease on 10 dB.

Further it is necessary to scan an aperture in the sample. If the corner of the calibrated converter is less or equal to 62 degrees then scanning is carried out on the big contact surface of sample V2/25 (picture 11).



Picture 11

At the big corners (except PIEZOELECTRIC CONVERTER 65° 2,5 MHz) scanning is conducted on a small contact surface of sample V2/25. Herewith with the help of attenuator must be achieved a situation when bending line will be above the strobe and “will not leave” the restriction.

Thus it is not necessary to displace PIEZOELECTRIC CONVERTER strongly from a corresponding corner match mark in order to avoid false measurements. For dump of the current data the key  is used.

Having received accumulation from a signal of an aperture press a key . The device will calculate the corner and deduce the total table with the calculated parameters. The calculated delay in micro seconds and an input corner in degrees will be displayed on the screen. To keep and establish these parameters, it is necessary to press , to cancel - . Herewith the device will restore former values of a delay and an input corner.

2.2.5 Adjustment of sensitivity

The detailed description of adjustment of sensitivity is shown in [7], [8].

Sensitivity adjustment is made for the purpose of reliable fixing signals maintenance from non-continuities which should be registered according to the given object of echo-signals amplitude control or of the equivalent area.

During the adjustment the following sensitivity levels are established:

Objectionable - sensitivity level on which the estimation of non-continuity admissibility on amplitude of the reflected signal found is made. It is determined by a used technique of control. It is possible to expose it by means of the first strobe (item 2.3.6.1)

Control (fixing level) - sensitivity level on which the fixing of non-continuities which are subjects of registration and the further estimation on extent, height, specific quantity, the form and orientation are made. A test objective level is below the rejection level on 6 db if supervising reference documents do not stipulate other. It can be settled by means of the second strobe.

Search - sensitivity level on which the search of defects by scanning the object in the set trajectory is made. The search level is below rejection minimum on 12 dB. It is exposed with the help of the attenuator.

Basic - the level of the sensitivity established on a signal from the chosen reflector in OBJECT OF CONTROL / REFERENCE BLOCK. Value of basic level can be established in corresponding point of the MENU - «BASIC LEVEL». During control on the flaw detector's screen the result will be displayed. It shows on how many decibels the accepted signal amplitude is more or less than the established basic level.

2.3 APPARATUS OPERATING MODES

2.3.1 MENU mode

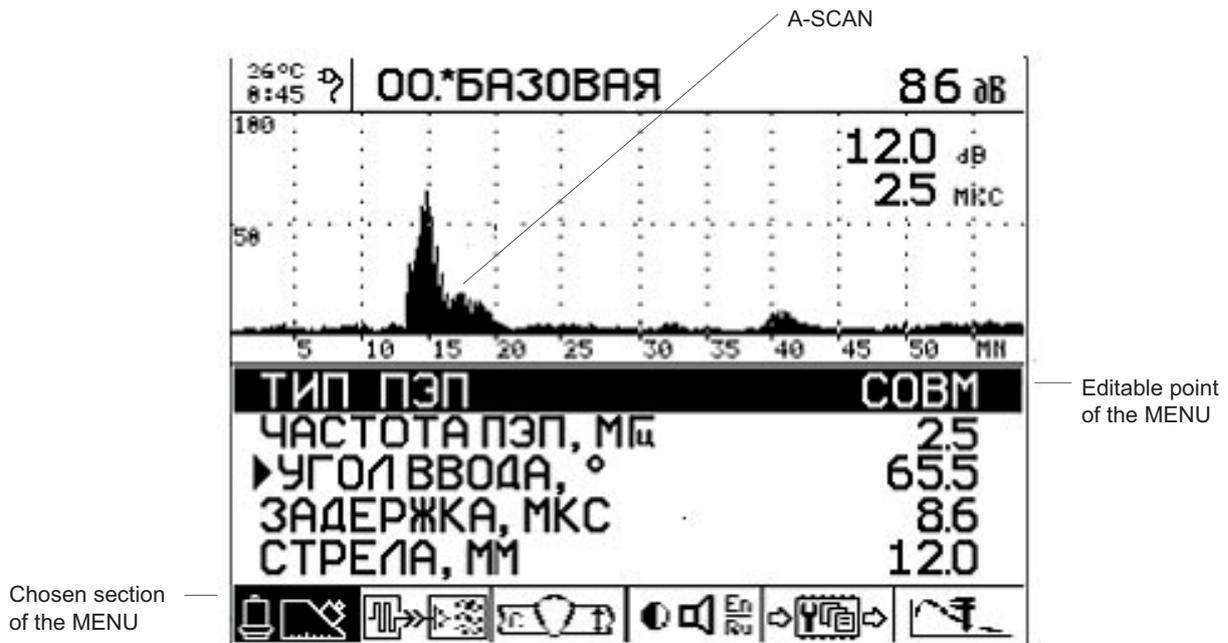
The MENU mode is made for installation of converter parameters and objects of control, for choosing the properties of a send-receive path, management of service options and operation performance with the device memory.

The entrance into the MENU mode is possible only from the functional modes through unitary pressing a key , an exit - through repeated pressing of the same key. During the exit the device comes back into a previous operating mode (REVIEW, SEARCH, MAGNIFIER and B-SCAN).

The total number of parameters and the device options established in the MENU mode exceeds twenty. A combination of all these sets of parameters and options forms the device's configuration.

Creation and preservation of 99 various configurations in non-volatile memory of the device are provided. For their identification there is the procedure of individual name assignment. It helps to make the subsequent choice of a necessary configuration by its name.

On picture 12 there is the example of the MENU mode screen.



Picture 12

In the top line of the screen the name of active configuration is displayed. In the low line there is a pictograph menu. Above the pictograph menu there is a settings adjustment area (unto five points per each pictograph). And above the settings adjustment area there is the A-SCAN. Its observations help to control the propriety of settings chosen under the apparatus tuning.

The active line of parameters always presents in the MENU mode. Selection of the active line is made with the help of keys  and . The keys  and  change the parameter's value in the active line. In case of the active line fits with the definite executed by apparatus function then its activation is made with the help of the key . Such lines are marked with the triangle leftwards.

Settings and functions are conditionally divided into groups. For each group there is a special pictograph in the low line of the screen. The active group is displayed with inverted pictograph (black symbols on yellow background). The selection of group is made with the keys ,  and pictograph selection keys.

In the Table 11 there is a list of the MENU mode paragraphs, corresponding parameters and functions and ranges of their setting. Functional groups are indicated with conforming pictographs.

Table 11

Menu line	Parameters	Step	Comment
 Piezoelectric converter (PEC) parameters			
PEC type	Joint / Separate	-	PEC type setting
PEC frequency, MHz	0,5-15,0	0,1-2,0	Workiit frequency of PEC setting (for frequency more than 10 MHz the number of periods is 1,0)
Input corner, deg	0,0 - 90,0	0,5	Inclined PEC input angle setting. Entrance into the procedure of semi-automatic input corner and delay measurement.
Delay, mcs	0,00 - 99,98	0,02	Double time of signal passage in PEC protector (hardware time of delay)
Arrow, mm	0,0-49,9	0,1	Converter's arrow setting
 Characteristics of a taking-transferring path of the device			
Pulse, V	20/100/200		Probing pulse amplitude
Number of periods	0,5-5,0	0,5	Defines a form of a probing signal (for PEC frequency more than 10 MHz the number of periods is 1,0)
Poll frequency, Hz	10/25/50/100/200	-	Frequency of of probing signals following
Filter	ON / OFF	-	The strip digital filter on the central work frequency
B-SCAN temp, Hz	2,0-10,0	0,5	Frequency of automatic input of sections in a B-SCAN mode

Table 11 continuation

Menu line	Parameters	Step	Comment
 Object of control (OC) parameters and additional settings			
Velocity, m/s	1000- 15000	1	Ultrasonic fluctuations velocity in the OC
Thickness, mm	OFF/0,1 -499,9	0,1	Setting OC thickness
Basic level, dB	OFF/0-140	1	Level concerning which there is an amplitude redout of a signal in the field of the vertical cursor (at the included basic level)
Cut off, %	0-99	1	Cut off level under the signal screen displaying
Scale, X	mks / mm	-	Units of a horizontal scale marking
 Service settings			
Language	РУССКИЙ / ENGLISH	-	Language change
Sound	ON / OFF	-	Sound indication management
Cursor	ON / OFF	-	Management of cursor displaying
VIEW mode	TIME / DEPTH / SIGNAL	-	Choise of the parameter constantly shown on the screen in the REWIEW mode
 Operations with memory of the device			
Choice one option from 99	1 -99	1	Choice of a configuration from earlier written down in memory
Name editing		-	Editing of a configuration name
Number choice	1 -99	1	Number choice under which the current configuration will be written down

Table 11 continuation

Menu line	Parameters	Step	Comment
Data memory from 500	0-500	1	Installation of the total number counter of written down realisations Installation on 0 equivalents of memory clearing
Dump by time counters		-	Dump of the counter of an operating time from the accumulator
	Curves of DSG-diagram adjustment		
Piezo element diameter, mm	0.0 - 25,0	0,1	Piezo element diameter in converter
The equivalent area, sq. mm	0.0 - 25,0	0,1	Installation of the equivalent reflector area value
Basic signal on V2/25	0-200	1	Installation of basic signal level on sample V2/25 from aperture
Attenuation, dB/m	0,0 - 99.9	0,1	Installation of attenuation factor in a control object material
DSG-diagram search, dB	-12-0	1	Level of a DSG-diagram control search curve concerning rejection level

2.3.2 SEARCH mode

The most often used for the problems solution in flaw inspection mode is the SEARCH mode. On the screen of the flaw detector there are: the echo-signal, value of attenuator, results of measurements of coordinates and levels of signals. The key parameters established during adjustment are also displayed.

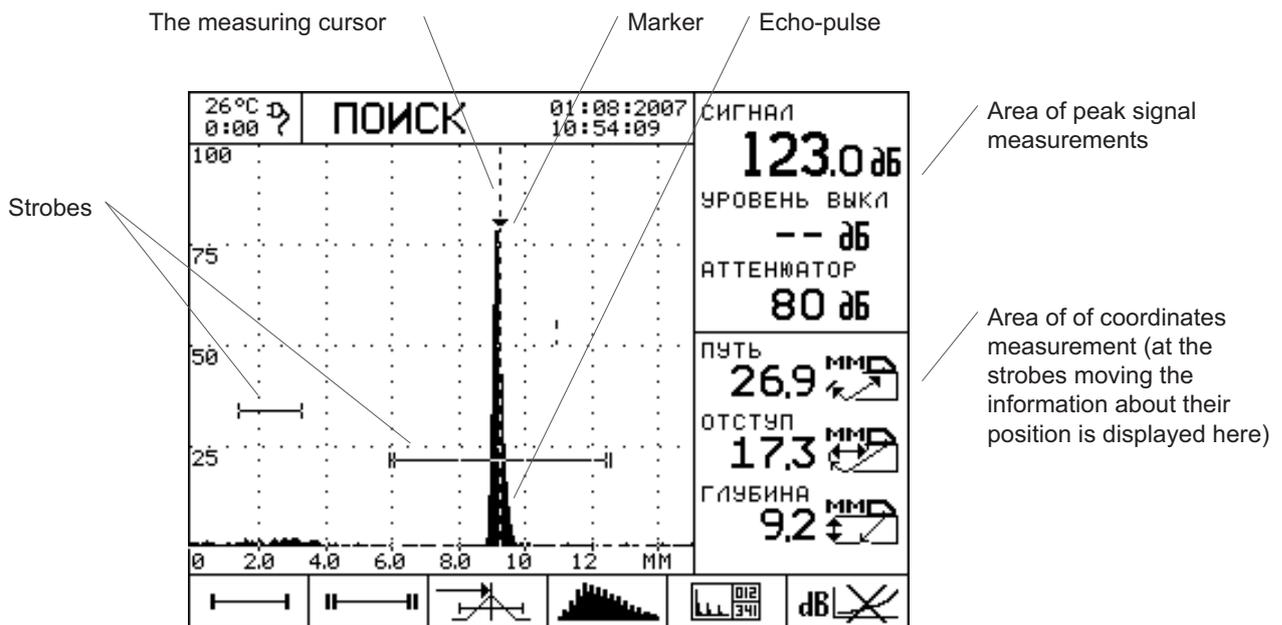
For registered signals there are possibilities of following measurements performance: time intervals of signals delay relatively with the beginning of a probing signal; distances to reflectors (for an echo-method) at known speed of ultrasonic fluctuations distributions; levels of amplitudes of signals. Measurements can be carried out both in automatic, and in manual modes.

The automatic mode - when one or two strobes are active. Measurement of the amplitude value of the point which exceeds the level of a strobe and

having the maximum amplitude in a strobe is carried out there. If a signal is below a strobe it's fixing and measurement is not made.

The measurement mode when strobes are disconnected is called manual. Signal measurement is made by cursor moving with the help of keys  and .

Variant of the screen image of device for the given mode is displayed on picture 13.



Picture 13

The device screen in a SEARCH mode is divided on a two vertical areas. In the left area the signal is displayed, and in the right numerical values of parameters are deduced.

The horizontal axis of graphic signal displaying area corresponds to time or distance and has, accordingly, a marking either in micro seconds, or in millimeters. Changing the development range in a SEARCH mode is carried out with the help of keys  .

The vertical axis corresponds to amplitude of signals in the linear scale and is marked in percentage of the full size of the screen.

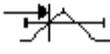
Management of the amplitude scale of displayed signals is carried out by means of attenuator value changes with the keys   and by choosing the amplitude of a probing signal (through the options in a MENU mode).

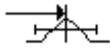
The device allows representing the signals in not detected (oscillographic) kind and in detected kind (A-scan). For detected kind it is possible to choose filled contour, the blank contour or bending line.

Except a signal, in graphic area the vertical line of the measuring cursor and strobes in the form of horizontal pieces with terminators are displayed.

By means of the cursor measurement of the ultrasonic signal passage time and also amplitude of a signal are carried out. Cursor installation is carried out automatically at the included strobe or by manual cursor moving with the keys  .

The way of automatic cursor operation depends on the chosen supervisory regime:

 - on a forward front of an echo-signal;

 - on an echo-signal maximum.

The strobe is used for automation coordinates measurements of defects and levels of the reflected signals in interesting intervals of time. At the moment an echo-signal hit the strobe time interval and when the amplitude of signal excess the level of a strobe threshold the automatic installation of the cursor to the place of operation and indication of the measured parameters are made. In addition the fact of excess is displayed by a sound notice and alarm of light-emitting diodes. Switching on the strobe and choice of a zone of operation is carried out in the pictographs area STROBE MANAGEMENT.

By pressing a key of a pictographs choice  which is situated under the strobe picture the pictograph of strobe edition appears.

Besides the cursor the marker in the form of a painted triangle is displayed on the screen. It is always established automatically on the maximum value of signal amplitude within a strobe.

In the right area of the screen the measured parameters are displayed. They are received in a point of current vertical cursor position: the value of a signal in dB (with the switched off basic level) or a deviation from the basic level established in the device; way, space, depth, time.

At switching on the adjustment mode of a strobe in the right bottom window the value of the strobe time interval beginning, its length and threshold level are displayed instead of a way, space and depth.

In the bottom part of the screen the pictographs which allow operating strobe position are located. They also can manage a choice of the measuring cursor operation way, switching of signals displaying mode and working window type, switching on time adjustment of sensitivity functions and work with DGS- diagrams. The more detailed way of adjustment and work with SWEPT GAIN functions and DGS-diagrams is described below.

In table 12 the description of pictographs in SEARCH, REVIEW and MAGNIFIER modes is displayed.

Table 12

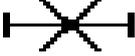
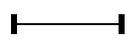
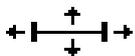
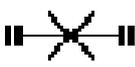
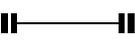
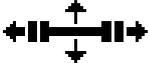
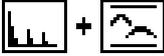
Pictograph	Appointment
Strobe 1 management	
	Strobe 1 is OFF. There is no automatic changing
	Strobe 1 is ON. DSG-diagram operation at threshold excess
	<p style="text-align: center;">STROBE 1 SETTING</p> Strobe position, level and length settings. Entrance with a key  . Exit through the same key. Active keys:   -left strobe edge position;   -strobe length,   - strobe level.
Strobe 2 management	
	Strobe 2 is OFF. There is no automatic changing.
	Strobe 2 is ON. DSG-diagram operation at threshold excess

Table 12 continuation

Pictograph	Appointment
	<p style="text-align: center;">STROBE 2 SETTING</p> <p>Strobe position, level and length settings. Entrance with a key .</p> <p>Exit through the same key. Active keys:   - left strobe edge position;   -strobe length,   - strobe level.</p>
Way of automatic signal parameter measurement	
	With the installation given the time (depth) will be measured from the moment of a probing impulse till the moment when the signal has exceeded level in the strobe, the amplitude is measured in a maximum point
	With the installation given the time (depth) will be measured from the moment of a probing impulse till the maximum level of the strobe, the amplitude is measured in the same point
Management of signal representation way	
	The detected signal is displayed in the form of a planimetric line
	The detected signal is displayed in the filled type
	The signal is presented in not detected type
	Spatial bending construction around the detected signal
Modes changing	
	SEARCH mode
	VIEW mode
	MAGNIFIER mode

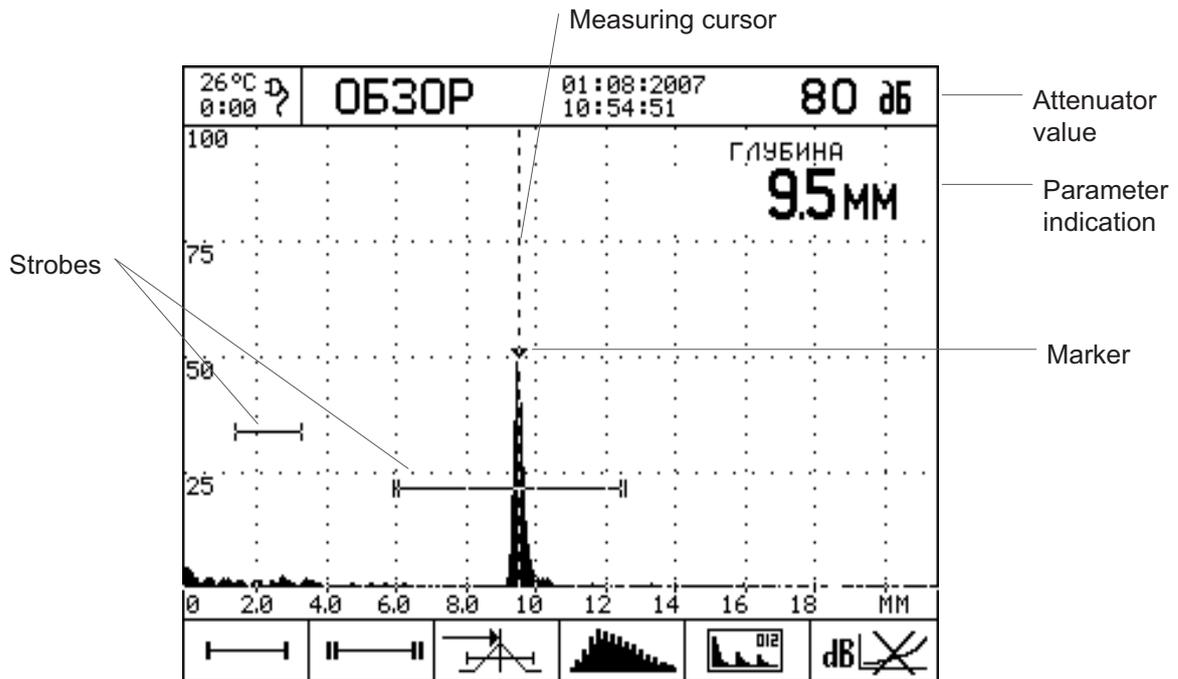
Pictograph	Appointment
	B-SCAN mode
Work with a swept gain	
	Swept gain is OFF
	Swept gain is ON
	Swept gain characteristic editing. The signal and additional swept gain characteristic are included in logarithmic scale. Creation and removal of knots, Installation of knots level in dB. Enter with the key  exit with the key  Active keys:  -enter and removal of knots   -Cursor installation in a central point.   -central point level installation.  -setting of swept gain default parameters.
Work with DSG-diagram	
	The mode with DSG-diagram curve construction is ON
	The mode with DSG-diagram curve construction is ON, but it cannot be calculated for the parameters specified

2.3.3 REVIEW mode

In the REVIEW mode the A-scan of a signal with the maximum size on the screen is displayed, and the digital measuring information is minimized. That is convenient during the general ultrasonic signals form analysis.

Controls in the REVIEW mode and in the menu of pictographs are similar to the SEARCH mode.

The device screen in the REVIEW mode is divided into the top information area, the menu of pictographs in the bottom part and the central graphic area for signals displaying (picture 14).



Picture 14

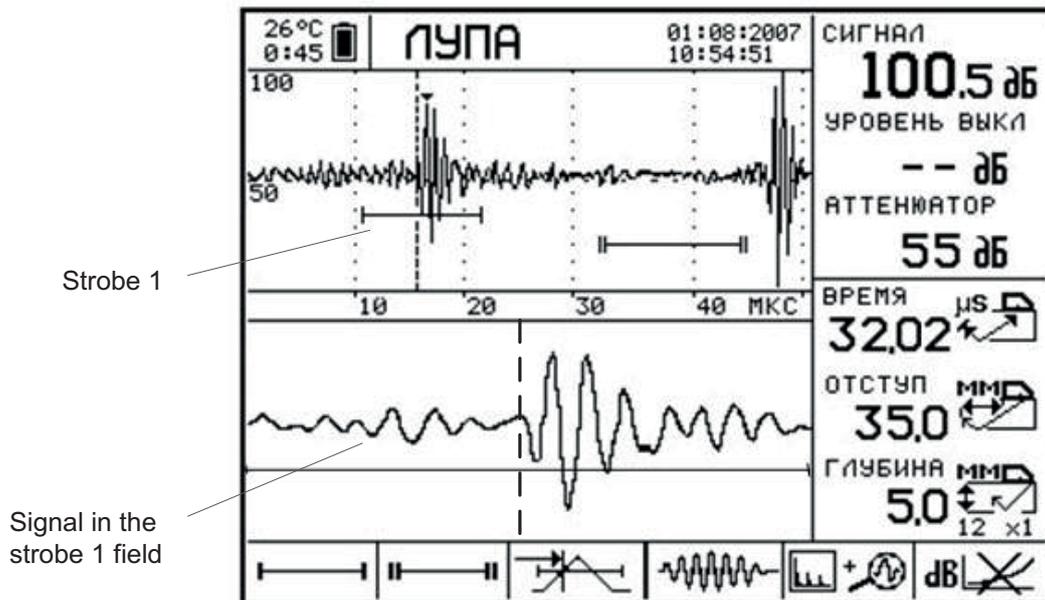
In the top line along with the official information and the name of a current operating mode the value of attenuator in dB is displayed.

In the central graphic area on the right above the basic measuring parameter is displayed. The parameter choice is carried out in the MENU mode, in a group of service options  $\frac{E_0}{R_U}$, point - «IN THE REVIEW MODE».

2.3.4 MAGNIFIER mode

Appointment of the MAGNIFIER mode, its functionality, controls and the pictographs menu are similar to SEARCH and REVIEW modes.

Distinctive features of the MAGNIFIER mode are simultaneously representation on the screen of two signal images (picture 15) and measurement of ultrasonic signal passage time or a way with the raised accuracy to 0,01 (at three signs in the measured value of time (way) integer part - accuracy to 0,1).



Picture 15

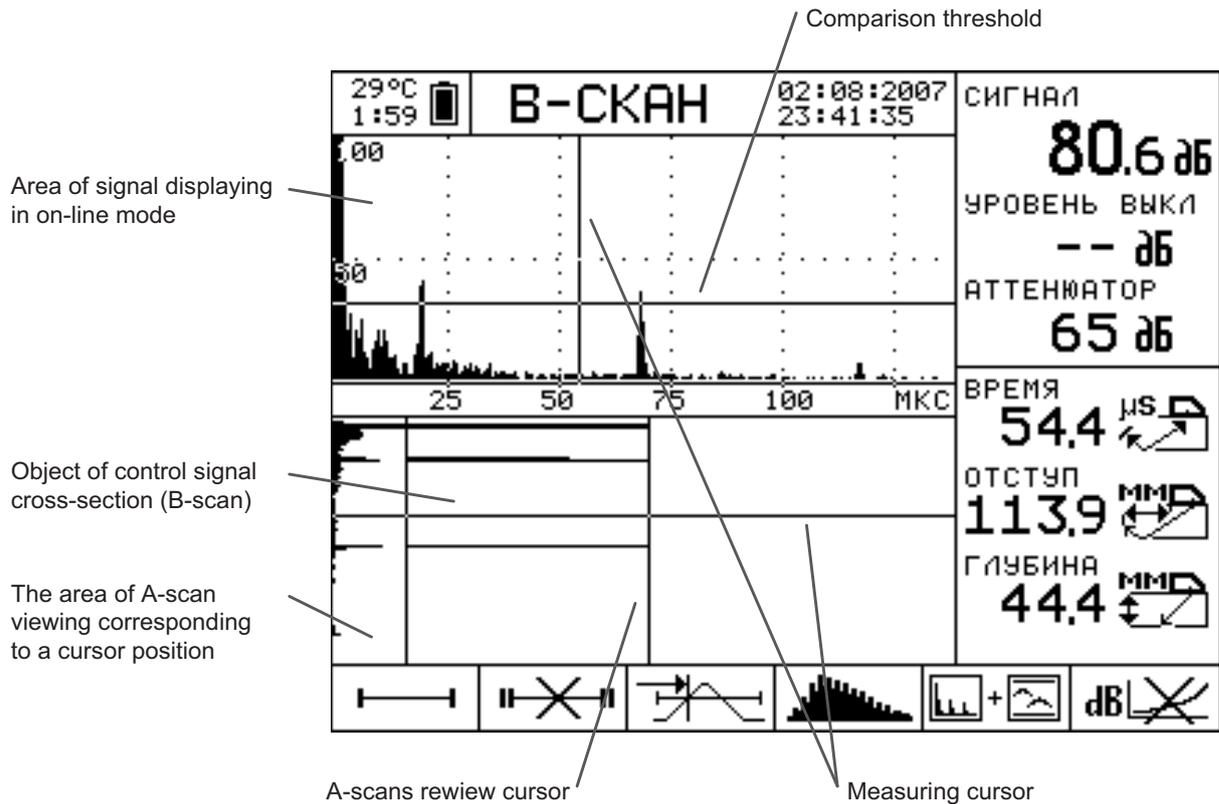
In the bottom graphic window the stretched time interval corresponding to a strobe 1 is displayed.

Presence of the window given allows to estimate the form of a part time realization symbol being in limits of a strobe 1 in more details.

2.3.5 B-SCAN mode

The B-scan is intended for formation of measurements results in the form of control object cross-section image (B-scan) at manual uniform scanning by the converter along one line.

The corresponding screenshot of the device is resulted in picture 16.



Picture 16

The screen structure is similar to the MAGNIFIER mode. In the top graphic window there is A-scan in a real time mode, and in bottom window there is a B-scan. The right part of the screen is intended for measurements results displaying.

The A-scan displayed scale is set up preliminary in modes SEARCH, REVIEW or MAGNIFIER with the help of attenuator and development parameters. Threshold comparison level is defined by level of the first strobe. Direct management of strengthening and a range of viewing depth in B-scan mode are impossible. In the same window the measuring cursor and a horizontal line of a comparison threshold are displayed.

B-scan formation in the bottom graphic window is carried out by periodic and consecutive record of A-scans from the top window.

The record occurs at single or long pressing a  key. The B-scan written is saved at any switching of operating modes before device switching off. To write down a new B-scan it is necessary to press a key , the previous value is thus erased. The frequency of A-scans record is established in menu point «B-SCAN RATE». At excess of the B-scan sizes over the sizes of displayed area the B-scan input stops.

The section image is formed in the binary image type on which black color marks the areas of a comparison threshold signal excess and other places remain light.

The section received can be additionally analyzed by changing of a comparison threshold by means of  and  keys. The keys  and  move the cursor and allow to see the separate written down A-scans in the left part of the bottom window. By means of keys  and  it is possible to move the measuring cursor and to write down indications of coordinates.

2.3.6 Auxiliary modes and functions

2.3.6.1 Strobes adjustment

Strobes are used for installation of control zones, sensitivity levels, operation of ASD system, coordinates of defects measurement and signals amplitudes from reflectors in interesting intervals.

In the device there is a possibility of work with two strobes.

If a signal exceeds a strobe level, the cursor automatically is established on a point, where there was an excess (or on a maximum). Corresponding parameters of the cursor in the given point are displayed on the screen and the sound and light alarm is on. The strobe beginning and also its length are connected with depth and can be regulated with the step of tenth shares of millimeter depending on the established control object parameters.

In case when a strobe is situated outside of a displayed on the screen range at the right border there is the index which allows defining the level of a strobe threshold (a single arrow for the first and double for the second strobe).

ATTENTION: WHEN THE SIGNAL AMPLITUDE EXCEEDS THE STROBE LEVEL WHICH IS OUT OF THE RANGE DISPLAYED ON THE SCREEN THE OPERATION MONITOR WORKS. CURSOR AND MARKER ARE NOT DISPLAYED!

So that it is possible to pass to the strobe management it is necessary to activate this mode with a corresponding pictographs choice key.

Switching on / off the chosen strobe is carried out with the key . For the position and the size of a strobe editing the following keys are used:

-   - strobe moving across;
-   - adjustment of a strobe duration;
-   - adjustment of a strobe level.

Editing is possible only with the strobe ON.

In the right bottom window of the screen the information about the strobe beginning, its length and level is displayed (from up to down on picture 17).



Picture 17

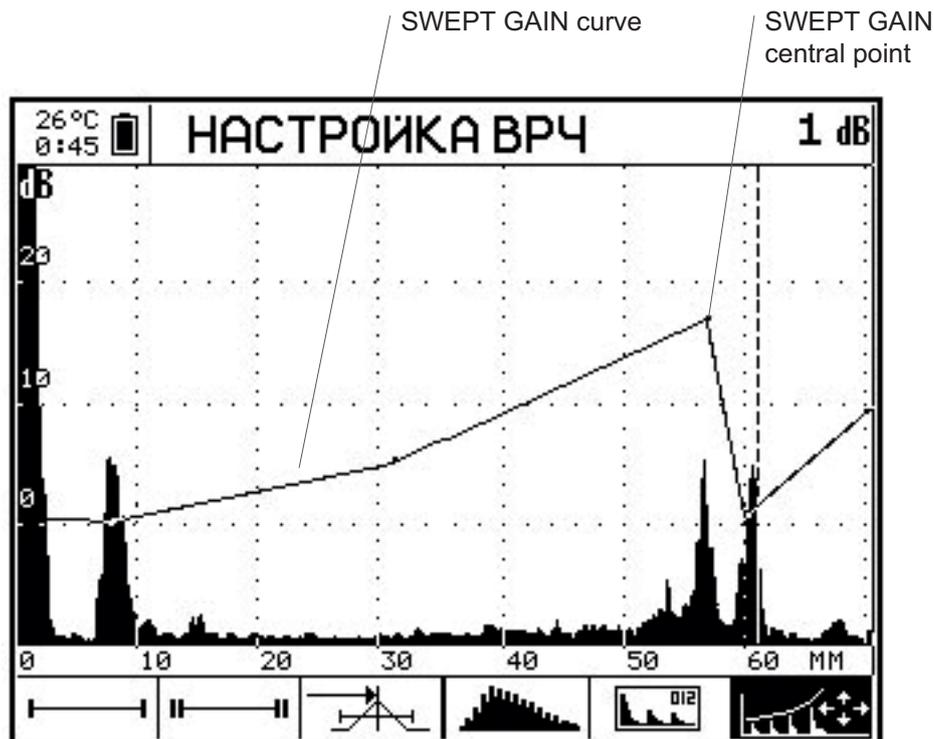
The strobe beginning is set on the left border of a control zone, the strobe end - on the right border of a control zone; strobe level is adjusted on rejection or a test level. The exit from the strobe editing is carried out by a corresponding key of a pictograph choosing.

2.3.6.2 SWEPT GAIN adjustment

The detailed description of SWEPT GAIN adjustment (time adjustment of sensitivity) is resulted in [7] and [8].

In flaw detector, for correction of signals with distance easing effect, use of SWEPT GAIN function is provided.

For SWEPT GAIN editing modes SEARCH, REVIEW and MAGNIFIER it is necessary to make active the last pictograph, and choose , then press a key . At transition into the SWEPT GAIN editor the pictograph is changed for . The screen also changes. On the screen the time realization of echo signal and SWEPT GAIN characteristic are displayed as linearly-broken function in logarithmic scale. It has 32 system points (picture 18). The maximum depth of a point adjustment is 30 db.



Picture 18

The vertical axis of the screen is graduated in decibels and corresponds to level of strengthening correction in a device path. Level of strengthening for the corrected knot is displayed in the right top corner of the screen. Change of SWEPT GAIN characteristic is applied to displayed realization of a signal that allows selection of demanded function operatively. Dependence of transfer factor between central points is interpolated on exponential law.

For SWEPT GAIN adjustment it is necessary to have the control sample of material in which the size of threshold reflectors is set - near and far (for this purpose notches on which the search for signals of the direct and unitary reflected beam are usually used).

Adjustment procedure:

- In operation mode SEARCH or REVIEW establish the development so that signals on the screen from all defects in a prospective zone of control could be displayed.
- Pass into a editing of SWEPT GAIN function mode.
- Catch maximum signal from a near reflector. Then with the keys   establish the time cursor on this place and create a new central point with a key .

– Repeat the procedure of a central point installation for the distant reflector.

– With the keys   correct the position of again created central points so that amplitudes from a near and far reflector were established at one level.

The exit from a SWEPT GAIN editing mode is carried out with a corresponding key of a pictographs choice.

2.3.6.3 Adjustment of DGS-diagram

Adjustment and use details are set in [7] and [8].

In the A1214 EXPERT device there is a function of automatic DSG-diagram calculation procedure for the combined converters. By using of DSG-diagrams it is possible to adjust sensitivity of control and automatically count the equivalent defect area.

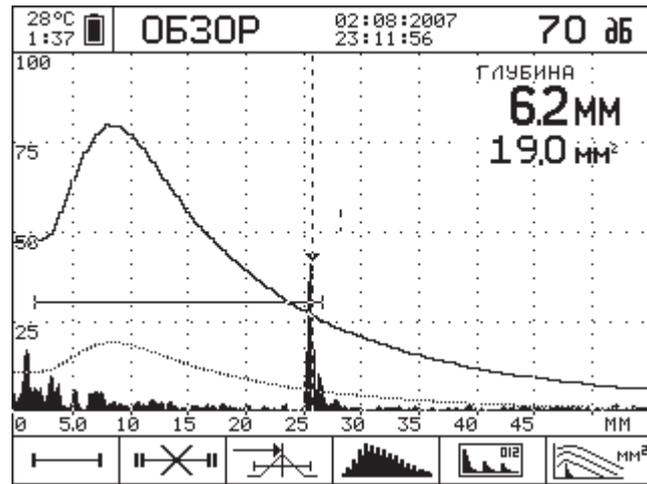
Switching on the DGS-diagram mode:

– With the choice key activate the sixth pictograph;

– With the key  choose the pictograph .

ATTENTION: DGS-DIAGRAM IS ONLY ACTIVE IN THE SEARCH AND REVIEW MODES!

If parameters have been set correctly then on the device screen after calculation (“Running” indicator of calculation conditions) two curves are displayed. They correspond to REJECTION and SEARCH levels (picture 19).



Picture 19

Examination level curve is depicted by degraded contrast line and acceptance level curve – by solid line.

If the parameters for calculation are incorrect instead of pictogram  the pictogram  will be depicted.

For correct construction of DGS-diagrams set the parameters in MENU mode, the parameter group marked by pictogram  within the limits outlined in table 13.

ATTENTION: THESE PARAMETERS ARE AVAILABLE FOR EDITING ONLY WHEN DGS MODE IS SWITCHED ON. IF DGS MODE IS SWITCHED OFF THESE OPTIONS OF THE MENU ARE UNAVAILABLE AND DEPICTED WITH DEGRADED CONTRAST!

Table 13

Menu bar	Range	Index	Note
	DGS curve setting		
PE DIAMETER, MM	0 - 25	0,1	PEP piezoelectric element diameter
EQUIVALENT AREA, SQ. MM	0 - 25	0,1	Flat bottom hole equivalent area corresponding to the acceptance level (examination line DGS curve)

Menu bar	Range	Index	Note
REFERENCE SIGNAL ON V2	0 - 200	1	Setting the reference signal of the reference level on block V2/25 from the hole (5 mm diameter)
ATTENUATION, dB/m	0 - 99,9	1	Setting of attenuation coefficient in OK material
DGS EXAMINATION, dB	-12 - 0	1	DGS examination curve level in respect to the acceptance level

PE DIAMETER – piezoelectric element diameter specified in PEP passport or measured diameter.

EQUIVALENT AREA – flat bottom hole acceptance equivalent area value sets the acceptance level DGS curve. Specified in ultrasonic control methods.

REFERENCE SIGNAL ON V2 – set in accordance with calibration block V2/25. The signal level in dB is determined depending on the value of the acceptance angle of transducer from the parallel hole with diameter of 5 mm:

- by large area of contact of V2/25 if the acceptance angle is 62 degree or less;
- by small area of contact of V2/25 if the acceptance angle is over 62 degree.

ATTENUATION – the attenuation coefficient is specified in the ultrasonic monitoring methods.

DGS EXAMINATION – value in dB corresponding to the examination (recording) level in relation to the acceptance level.

In addition the following parameters of MENU mode are used in calculations: PEP FREQUENCY, ACCEPTANCE ANGLE, DELAY, SPEED (US speed in OK). If any parameter included into DGS-diagram calculation is changed it is automatically recalculated. The calculation status indicator is depicted in the display in MENU mode. If the calculation parameters are set incorrectly the display reads «DGS CALCULATION IMPOSSIBLE. CHANGE PARAMETERS». If such a situation occurs check the set parameters.

If DGS curve examination (recording) level signal amplitude is exceeded and the signal is in the pulse gate interval the monitor activates. The unit display in EXAMINATION mode depicts the value of the flaw equivalent area and the value of the signal amplitude (with «+» or «-») in

relation to the acceptance level, namely:

- «+» - the signal exceeds the acceptance level by this value;
- «-» - the signal is lower than the acceptance level by this value.

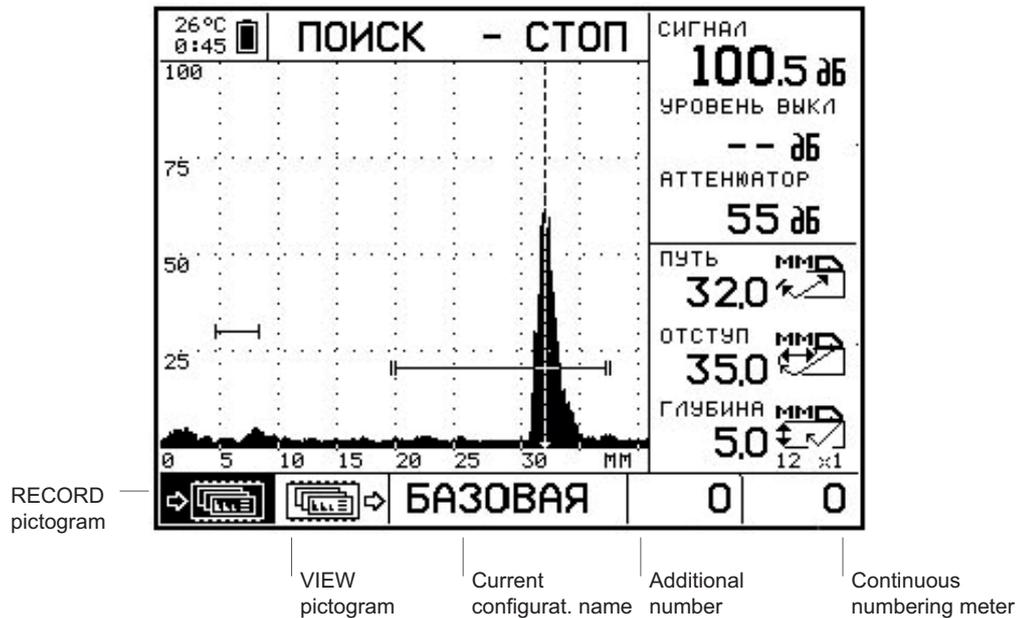
In SCAN mode at DGS-diagram construction the display depicts the parameter chosen in the unit MENU option «IN SCAN MODE» and the value of the flaw equivalent area.

DGS mode is switched on by pressing button  with active sixth window of the pictogram.

2.3.6.4 STOP mode

STOP mode is intended for stopping (freezing) the signal realization on the display and their recording to the memory and also for viewing earlier recorded realizations with all their accompanying parameters and testing conditions.

You can access STOP mode by pressing  button once when working in EXAMINATION, SCAN or ZOOM modes. A variant of the screen in STOP mode is shown on Picture 20.



Picture 20

This mode pictogram function is described in table 14.

Table 14

Pictogram variant	Function
	Records realization at pressing the key 
	Allows viewing earlier recorded realizations with the help of the key  
Configuration name	The name of the configuration into which the realization is recorded
Additional number	Automatically or manually assigned number
Continuous numbering meter	Recorder realization sequence number

If  pictogram is active the recording is made into the unit memory. To carry out recording press . An open number is assigned to each recorded realization. Users can assign an additional number to each realization. This number is automatically increased with each frame recording. To change it activate the area of additional number with keys  .

Before recording the user can manually measure the vertical cursor movement amplitude with keys  .

ATTENTION: IF THE CURSOR IS MOVED MANUALLY BEFORE ACCESSING STOP MODE THE PARAMETERS ARE CHANGED AND REFLECT THE NEW POSITION OF THE CURSOR!

With active reading pictogram  with the help of keys   the icons of earlier recorded realizations are searched through and depicted.

STOP mode is exited by single time pressing of  key or automatically after recording the data.

2.3.6.5 Computer communication mode

The computer communication mode is used for:

- transferring data recorded to the unit memory to PC;
- viewing the unit signals on PC screen in the real time mode;
- configuration recording from PC to the unit and backwards;
- ultrasonic test protocol drawing up.

The unit is connected with PC with the help of the cable for USB connection: multipin connector LEMO is plugged into the unit and USB plug – into PC. Connection is shown on Picture 21.



Picture 21

Before connecting the unit to PC switch the unit off. At connecting to computer the unit automatically switches onto the computer control mode. The unit screen reads «COMPUTER COMMUNICATION MODE».

ADM program is used for documenting the control results. This program allows:

- reading the frames recorded to the unit, saving them to the hard disk and printing;
- creating, editing, reading and recording configurations to the unit and computer hard disk;
- controlling the unit from the computer in the real time mode (computer flaw detector);
- creating, editing, saving to PC and printing the ultrasonic test protocols with the use of data recorded to the unit.

ADM program possibilities detailed description and the order of its operation is given in «ADM program user manual». The program distributive and user manual are on the CD included into the unit distribution kit.

2.4 MEASURING

Measuring process detailed description is given in [7] and [8].

Further is short description of measuring.

For manual testing in addition to the flaw detector and transducers you need blocks for equipment setting and testing and contact liquid.

Unsound and exfoliating scale, rust or contamination of an item surface affect ultrasound penetration into OK material. Therefore, before carrying out measurements on such surface you should clean it of formation, wipe the surface, remove catalytic fines and cover the surface with contact liquid.

Cleaning of rough corroded surfaces of items in addition to finer measurements allows prolonging the ultrasonic transducers' operating life. It is especially important for PC transducers.

Requirements to allowed waviness and surface preparation are specified in standard technical documentation for testing certain types of items.

Changes are made in EXAMINATION, VIEW and ZOOM modes.

The unit has two measuring modes: manual and automatic. In the manual mode the time, depth and amplitude are measured in the cursor and signal cross point. And the measurement accuracy in time and depth depends on the signal compression and stretch ratios. In the automatic mode the accuracy does not depend on the compression and stretch ratios, therefore it is recommended to carry out measuring in the automatic mode.

Gates and corresponding automatic operation algorithm are used for fixing a measurement point: by front or maximal signal.

ATTENTION: CURSOR CAN BE SWITCHED OFF, I.E. MADE INVISIBLE, IN MENU MODE, IN THIS CASE MEASUREMENTS ARE MADE BY INVISIBLE CURSOR WHICH IN THE MAXIMAL SIGNAL OPERATION MODE $\sim^{\wedge}\pm$ COINCIDES WITH THE MARKER (MEASUREMENTS ARE MADE BY THE MARKER)!

In addition the automatic operation is indicated by a sound signal and red LED on the unit front panel.

2.4.1 Measuring of time and coordinates

Measuring of the reflector (flaw) occurrence coordinates includes two main operations:

- determination of the position of the transducer corresponding to the maximum of the echo signal from the reflector in OK;
- fixing of the unit readings – time of ultrasound signal movement from PEP to the reflector and backwards or the reflector position coordinates in millimeters.

MENU mode option «SCALE X» contains three variants of depicting the sweep (horizontal axes) which choice determines the type of coordinates depiction:

VARIANT 1. «SCALE X MCS» - the horizontal axes is marked in microseconds in accordance with the ultrasonic wave beam.

In the mode of working by the straight PEP the TIME of the ultrasonic signal movement from PEP to the reflector and backwards and the DEPTH of the reflector occurrence are depicted;

In the mode of working by the angle PEP the following parameters are depicted:

- TIME – the time of the ultrasonic signal movement from PEP to the reflector and backwards;
- OFFSET – the distance between the reflector front edge and the probe by the scanning surface – X coordinate. For correct measurement of the OFFSET in MENU mode set PEP arrow;
- DEPTH – the reflector occurrence depth (Y coordinate).

VARIANT 2. «SCALE X MM» - the horizontal axes is marked in millimeters in accordance with the ultrasonic wave beam.

In the mode of working by the straight PEP the PATH by the beam and the DEPTH to the reflector which coincide are depicted.

In the mode of working by the angle PEP: the PATH by the beam from PEP to the reflector, OFFSET and DEPTH are depicted analogue with variant 1.

VARIANT 3. «SCALE X by depth MM» - the horizontal axes is marked in millimeters of OK thickness.

In the mode of working by the straight PEP the PATH by the beam and the DEPTH to the reflector which coincide are depicted.

In the mode of working by the angle PEP: the PATH by the beam from PEP to the reflector, OFFSET and DEPTH are depicted analogue with variant 1.

The variant of depicting the reflector coordinates for angle PEP in EXAMINATION and ZOOM modes depending on «SCALE X» parameter choice in MENU mode are shown on Picture 22.

«SCALE X MM»,
«SCALE BY DEPTH MM»



«SCALE X MCS»



Picture 22

In VIEW mode at changing coordinates and time the parameter chosen in option «IN VIEW MODE» of the unit MENU and does not depend on the variant of the unit sweep scale depiction is depicted.

OK thickness can be set in MENU mode option «THICKNESS, MM». In this case the unit shows the beam with which we are working (straight (0), once-reflected (x1), twice-reflected (x2), etc.) and calculates the real value of the discontinuity occurrence depth irrespective of the beam with which we are working.

2.4.2 Measuring of the signal amplitudes

Irrespective of the chosen type of the signal amplitude measuring, manual or automatic, the measured parameters of the signal are induced in the flaw detector display right area (Picture 23).



Picture 23

In the first option SIGNAL the measured signal amplitude is depicted.

In the second option LEVEL the reference level state is depicted. If the reference level is switched on its value is depicted in decibels and the measured signal amplitude is calculated from the reference level (Picture 24).



The amplitude of sensed signal from the reflector is 0.5 dB over the set reference level of 90 dB

Picture 24

Attenuator value is depicted in the third option. Attenuator is echo signals calibrated reducer. With its help the signal size on the screen can be regulated so that it is possible to watch the signal. Using its calibrated values it is possible to compare amplitudes of different signals on the screen, adjust them for one and the same level, for example, for the standard level of 50% of the vertical scale.

The attenuator is controlled by keys  . To reduce the signal amplitude press and hold key  in this case the attenuation in the attenuator grows which is depicted in the screen by the attenuator value growth. To increase the signal amplitude use key .

Note – In some other Russian and foreign flaw detectors instead of the attenuator value the values of signal increase in decibels are depicted, they grow with the signal amplitude growth in the screen.

Attenuator is also used for readjusting the flaw detector from one sensitivity level to another. For example, in order to set the examination sensitivity level which is 6 dB lower than the recording level (i.e. examination sensitivity is higher than the test sensitivity) reduce the attenuator value by 6 dB with the help of key .

2.5 USE OF SETTINGS DEPOSITORY

The unit settings depository is in MENU mode, group of parameters .

The unit contains the notion of «current» configuration. It is the configuration which parameters can be edited. The current configuration parameters are used for work in all modes. When the unit is switched off all parameters of the current configuration are saved. When the unit is switched on it starts operating using these very parameters. In VIEW, EXAMINATION, ZOOM and B-SCAN modes the main parameters of the current configuration can be viewed by pressing key . An information window will appear in the unit screen (Picture 25).

01. П121-2. 5-65	
ЧАСТОТА ПЭП, МГц	25
УГОЛ ВВОДА, °	65.0
ЗАДЕРЖКА, МКС	9.00
СТРЕЛА, ММ	15.0
ТИП ПЭП	СОВМ
ИМПУЛЬС, В	100
ЧИСЛО ПЕРИОДОВ	1.0
ФИЛЬТР	ВЫКЛ
ОПОРНЫЙ УРОВЕНЬ, дБ	0
ЭКВ. ПЛОЩАДЬ, кв. мм	10.0
СКОРОСТЬ, м/с	3250

Picture 25

2.5.1 Reading of configuration from depository

In order to use an earlier used configuration load its parameters into the current configuration. After loading the name of the configuration from which the loading was carried out will be depicted in the menu in the upper part of the screen. If any parameter of the current configuration is changed in comparison with the initial configuration the asterisk is added to the name.

A configuration can be chosen from the depository in three ways.

Way 1 – in MENU mode. Choose the configuration in menu option «CHOOSE SETTINGS OUT OF 99» with the help of keys  .

Way 2 - in VIEW, EXAMINATION, ZOOM and B-SCAD modes by the configuration number and name without viewing parameters. To choose a configuration hold key  and press keys  . The chosen configuration number and name are depicted in the screen upper area.

The chosen configuration is loaded when you release key .

Way 3 - in VIEW, EXAMINATION, ZOOM and B-SCAD modes with viewing parameters. In these modes when you for a long time hold key  the information window (Picture 25) depicting the values of the main settings of the current configuration appears. Holding key  choose the configuration with necessary parameters with the help of keys   simultaneously viewing the parameters of browsed configurations in the information window.

2.5.2 Creating and saving new configurations

To create a new configuration with necessary parameters insert these parameters into the current configuration, if necessary edit the configuration name and save to the memory under any number from 1 to 99.

The name is edited in the option «EDIT NAME». To do it select pictogram  corresponding to the section «OPERATIONS WITH UNIT MEMORY» in menu mode. Put the cursor on the option «EDIT NAME» and press key . The configuration name will be highlighted in the upper area (Picture 26).



Picture 26

Editing procedure is carried out the following way:   - choice of letter position,   - choice of a symbol (letter, digit). The editing mode is exited by pressing key .

To save a prepared configuration to the memory select option «COPY FROM CURRENT B». Select the configuration number and press key .

To avoid saving a configuration by mistake the window «SAVE» appears. Confirm or refuse the configuration saving by the key  or . If you press key  the configuration will be saved which is shown in the «scrolling» status flag.

3 MAINTENANCE

3.1 UTILITY POWER AND ENERGY CONSUMPTION

3.1.1 Power supply energy control

During the flaw detector operation the built-in discharging controller controls the power source discharge degree. In the display the discharge degree is induced in form of battery in the upper left corner. Fully filled in symbol means fully charged accumulator. In proportion to discharging the symbol is cleaned. At the accumulator charge critical level the unit automatically switches off saving all settings and recorded information.

The unit consumption and accordingly the period of operation depend on several factors:

- emission pulse repetition frequency;
- number of periods;
- emission pulses amplitude;
- display brightness.

Therefore, it is rather hard to estimate remaining time of operation. For approximate estimation of the unit time of operation with certain parameters you can use the built-in hour meter. The meter counts the unit time of operation from the last charging or meter reset. When the charging unit is connected the meter is reset. When the charging unit is connected the unit is not fed by the accumulator and the meter is in reset state. The meter is manually reset with the help of the function «RESET METER» in MENU mode.

3.1.2 Accumulator preburning

Accumulator elements have memory effect manifested by the accumulator capacity decrease during its exploitation. To neutralize the memory effect it is necessary to periodically fully discharge accumulators. For this purpose the recharger has the preburning mode. When you press the recharger red button it starts to discharge the accumulator (yellow LED flashes on and off). The recharger can switch onto the preburning mode only from the charging mode (yellow LED burns) or when the charge is finished (green LED burns). When the accumulator is fully discharged the recharger automatically switches onto charging mode. Depending on the accumulator state the time of its charging may vary. The time of charge-discharge cycle is not over 14 hours.

3.2 PERIODIC MAINTENANCE

In process of exploitation it is recommended to periodically clean the flaw detector case from dirt and dust with cleaners for plastic objects. In case of the indicator protection glass contamination it is recommended to wipe it with a soft tissue wetted with plastic glass cleanser. In case of contamination the keypad can be wiped with alcohol. In case you have no special cleaners the flaw detector can be cleaned with soapy water.

If connectors are contaminated with dirt or foreign particles it should be cleaned with the help of a soft brush.

It is recommended to preburn the accumulator once a month.

3.3 POTENTIAL PROBLEMS

Table 15 contains the description of typical problem which the flaw detector which users can amend himself.

Table 15

Problem description	Possible reasons	Troubleshooting
At switching on the unit the switching on indicator flashes but the unit does not switch on	Not fully discharged capacitors in the unit circuit which is in the way of standard switching on	Pause for 1-2 min and switch the unit on again
Absence of any symbols in the indicator after pressing a button 	Accumulator is discharged	Use line supply or charge the accumulator

In case of any problems or questions on the flaw detector use contact the firm representatives on the phones specified in the unit passport.

4 STORAGE

The flaw detector should be stored in the bag included into the unit distribution kit. The storage conditions -1 correspond to GOST 15150-69.

The units should be stored on a shelf.

Units placement in storage should allow their free movement and access to them.

The distance between the storage walls, floor and units should be at least 100 mm.

The distance between the storage heating devices and units should be at least 0.5 m.

The storage premises should be free of current-conducting dust, aggressive gases and fumes admixtures causing the unit material corrosion.

5 TRANSPORTATION

The flaw detector should be transported in the bag included into the unit distribution kit.

The transportation conditions in part of climate influence should correspond to the storage conditions 5 corresponding to GOST 15150-69.

Packed units can be transported for any distance and by any transport with no limitation of speed.

Packed units should be fastened in carrying vehicles and in case of open carrying devices – protected from rain and water.

Packed units placement and fastening in vehicles should provide their stability and exclude possible impacts on each other and the vehicle walls.

Units transportation conditions should correspond to the requirements of specifications, rules and norms for each type of vehicle.

In case of transportation by air packed units should be placed into sealed and heated compartments.

After transporting in temperatures other than the exploitation temperature before exploiting the unit should be kept in normal climate conditions for at least 2 hours.

ATTACHMENT A

(for reference)

Recommended literature on ultrasonic monitoring

- [1] GOST 14782-86 Non-destructive monitoring. Weld-in connections. Ultrasonic methods.
- [2] Non-destructive monitoring and diagnostics: Reference book under the editorship of Kyuev V.V.
- [3] Non-destructive monitoring: Reference book. Volume 3: Ultrasonic monitoring / Ermolov I.N., Lange Yu.V.
- [4] Ultrasonic monitoring: Textbook for experts of the first and second skill level / Ermolov I.N., Ermolov M.I.
- [5] Welled-in connection ultrasonic monitoring methods / Shcherbincki V.G.
- [6] Ultrasonic flaw detection in power plant engineering: Tutorial / Kretov E.F.
- [7] Guidelines for ultrasonic flaw detectors A1212 MASTER and A1214 EXPERT usage/ Voronkov V.A., Voronkov I.V.
- [8] Guide for ultrasonic flaw detectors A1212 MASTER and A1214 EXPERT setting and exploitation / Kaplan N.M., Samokrutov A.A.





Ultrasonic flaw detector A1214 EXPERT

Users guide

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