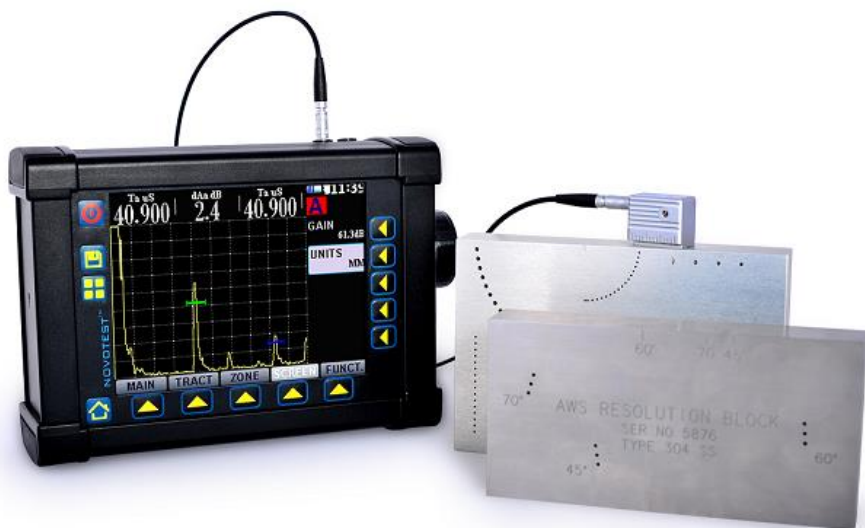




NOVOTEST

ULTRASONIC FLAW DETECTOR NOVOTEST UD1



Operating Manual

2015



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1. List of abbreviations used

The manual has the following abbreviations and symbols:

AFS – automatic signaling of defects;

TVG – time varied gain;

NDT – nondestructive testing;

CB – calibration block;

US – ultrasonic.

2. Introduction

2.1. Appointment of flaw detector

Flaw detector is designed for testing of products for the presence of defects such as discontinuity and homogeneity of materials, semi-finished products and welds for measuring depth and coordinates of defects, measure the thickness and sound velocity in the material.

Flaw detector implements shadow, echo and mirror-shadow testing methods. Flaw detector allows user to create, record and stored in nonvolatile memory temporary implementation of pulsed ultrasonic signals to subsequent transmitting to the PC for analysis and presentation in the form of a document. Integrated liquid crystal display (LCD) provides a mapping of ultrasonic signals in the form of A-scan, as well as images of cross sections of testing objects in the form of B-scans.

Flaw detector can be used in mechanical engineering, aerospace, metallurgy, mounting hardware, power equipment, as well as for the testing of transportation facilities.

2.2. Testing

For proper ultrasonic testing user must have testing methods for similar products and special requirements for ultrasonic testing. These requirements include: the definition of the task of testing, selection of suitable control techniques (testing schemes), the



selection of transducers, an assessment of the known conditions of control in such materials, the selection of the minimum size of the reflector for this type of product, reject level and so on.

2.3. Velocity of ultrasonic vibrations

Accuracy of measurement of thickness and position of defects depends on the correct setting of the ultrasonic velocity in the material. Velocity of ultrasound is dependent on the physical characteristics of the material and its temperature.

3. Operating Conditions

The device is designed to operate in the following environmental conditions:

- The temperature from -5 to +45 °C;
- Relative humidity to 95% at a maximum temperature of +35 °C.

The location of the flaw detector must be protected from direct exposure to dust, moisture and corrosive environments. The field strength of radio noise at the location of the flaw detector should not exceed the value of the infringing operation, i.e. creator of the flaw detector at the amplifier input voltage greater than half the maximum sensitivity. At high field strength of radio interference must be taken measures to shielding placements of flaw detector from the external electromagnetic field.

Operating position of the flaw detector may be any convenient for the user. To avoid moisture condensation inside the flaw detector when moving it from a cold to a warm place, it is necessary to sustain flaw detector for at least 4 hours before turning on in the premises.

4. Specifications

Operating Frequency Range	from 1 to 10,0 MHz
The range of measured time intervals (duration of scanning)	from 6 to 1000 μ s
Velocity range	1000 - 9999 m / s
The error of measurement of time intervals	not exceed $\pm 0,025 \mu$ s
Maximum permissible error of measurement of the amplitudes of the signals at the receiver input in the range from 0 to 110 dB	not exceed $\pm 0,5$ dB;
Testing gain range	125 dB
Averaging over the quantity of starts	from 1 to 16
Digitally reconfigurable bandpass filter with tunable center frequency of the filter from 1 Hz to 10 MHz	
The range of variation of temporal sensitivity adjustment (TVG)	40 dB
Number of control points TVG	15
The duration of the excitation pulse to the load	from 0,0 to 0,5 μ s
The amplitude of the excitation pulse to the 50 Ohm load, not less	100, 200, 300
Operating frequency range of the receiver on the level -3 dB	from 1 to 10 MHz
Deviation of the amplitudes of input signals in the range from 10 to 100% of the screen height not more than	1 dB
Scanning	from 1 to 1000 μ s
Delay of scanning	from 0 to 2000 μ s
Range of measurement of time intervals	from 0 to 1000 μ s
Setting a delay in the prism of the	from 0 to 15 μ s

probe	
Automatic signaling of defects (AFS)	dual-gate
Setting range of AFS gates	from 0 to 2000 μ s
Adjusting thresholds of AFS gates	from 0 to 100 %
Detection of signals	positive half-wave, radio mode
Dimensions (WxHxD)	195x135x55 mm;
Weight, not more	About 2kg (without batteries)
Mean time between failures	not less than - 3000 hours

Ultrasound probes used - ultrasonic piezoelectric transducers for pulse flaw detectors.

The dimensions of the operating area of the screen is 115 x 86 mm.;
Electrical power is supplied from the following sources:

- AC power from 100 to 250 V, a frequency of (50 ± 1) MHz;
- 11,1 V, recommended capacity of at least 6,6 Ah.

5. Operating principle

Operating principle of flaw detector is based on the ultrasonic contact NDT method, which uses the properties of ultrasonic vibrations to reflect from the borders between materials with different acoustic impedance. The ultrasonic transducer emits ultrasonic impulse into the tested object. Reflected from the defects or the product surface the echo signals are received by the ultrasonic transducer. The resulting electrical signals are subject to amplification, digitization, processing and output to the display. Displays echoes received by the flaw detector is performing as scanning of type A (A-scan) as well as images of cross sections of tested objects in form of B-scan.

5.1. Electronic unit of flaw detector

Flaw detector makes the formation of electrical pulses to excite the piezoelectric transducer, gain derived from the piezoelectric transducer signals, processing and visualization of the formation and representation measurements in digital form, saving data in non-volatile memory and transfer it to PC.

The appearance of the electronic unit is shown on picture 6.1. Operation of flaw detector makes by keyboard. Visualization of signals and display of measurement results, the state of flaw detector and other information is shown on the LCD.

Connecting the probe is carried out by the coaxial cable through the connectors LEMO, which are located on top side of the devices body.

The device is powered by a three batteries type AA, or the included in set external charger connected to the mini-USB connector located on the bottom of the electronic unit of the flaw detector.

5.2. Probes

Flaw detector is designed to operate with the contact, dual element and separated ultrasonic transducers with an operating frequency in the range from 1 to 10.0 MHz.

The device uses a generator of bipolar sounding pulses with adjustable duration, which provides compatibility with both probes: have integrated terminating inductance and without them, allowing operation operate with most types of probes on the market.

Depending on the type of probe it is used two types of cables and, correspondingly, two ways to connect the probe:

- Ultrasonic transducers (type S) are connected via single cable LEMO-LEMO to the upper LEMO connector;
- Dual element transducers (type D) are connected by a double cable 2LEMO-2LEMO. Lower connector is used to connect the

receiver of the piezoelectric element, the upper - transmitter of the piezoelectric element.

6. Operation of the device

The basis of flaw detector operation is founded on the ability of ultrasonic vibrations spread into tested object and reflect from internal defects and object sides. The received signal is amplified and then converted into digital form processed by the microprocessor and the graphics and digitally displayed on the display.

Visualization of signals, display of measurement results, state of the flaw detector and other information are shown on the LCD. Exterior of the flaw detector is shown on picture 6.1.



Picture 6.1 Exterior of the flaw detector

6.1. Controls

Controls of the flaw detector presents as a keyboard.

The keyboard has 10 keys:



- switching on/off – press and hold for at least 3 seconds to turn on or off the device.



- Record the measurement result in devices memory



- return to the main menu of the flaw detector



- return to the main parameter group



- select the required parameter group




- select the parameter to change its values

The encoder is located on the side panel and has three functions:

- Select and change the value of the parameters;
- Selection of resolution of adjustments of selected parameter;
- Confirmation of the action during operation with devices memory.

To change the value of the selected parameter, turn the encoder clockwise (increase the selected parameter) or counterclockwise (to decrease the selected parameter).

To change the resolution of changing values of the selected parameter, as well as to confirm the action it is necessary to make pressing the encoder. Selected discreteness displays as one of the icons  near the variable parameter.

6.2. Preparing to work with the device

Read this instruction manual and follow its instructions.

Flaw detector must be protected from direct exposure to dust, moisture, corrosive environments, and must be sufficiently lit by light sources.

The field strength of the external interference at the location of the flaw detector must not exceed values that violate its performance. At high field strength of external interference must be taken to shielding placements of the flaw detector, as well as its power supply and connected cables.

When operating from AC power to the flaw detector must be supplied mains with voltage from 100 to 250 V and with frequency of (50 ± 1) Hz.

If in the power supply network arise switching noise in power supply network of the flaw detector must enable network filter.

To avoid moisture condensation inside the body, when moving from a cold environment to a warm, device must be hold in the warmth for 4 hours to dry completely.

At air temperatures below 10°C after switching on flaw detector must be warmed for at least 15 minutes.

Controls and indicator of the flaw detector located on the front panel, as shown in Picture 6.1.

Operating connectors are located at the top and side panels of the devices body.

WARNING! To prevent damage of connectors and cables - follow the instructions below!

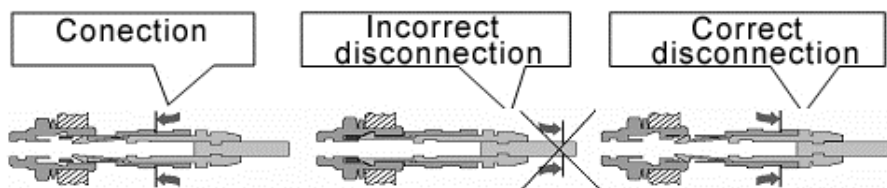
Used in the device connectors consist of two parts: the instrument socket and the cable plug (Pic. 6.2.).



Picture 6.2. Connector used in the device

A method of connecting and disconnecting the plug and socket shown on Picture 6.2.1. When connecting user must ensure that the points of red color (if any) are plotted on the plug and the socket are jumped together.

CAUTION: When disconnecting the plug from the socket, hold its body in the dotted area. Do not pull the cable!!




Picture 6.2.1 Manipulations with LEMO connectors

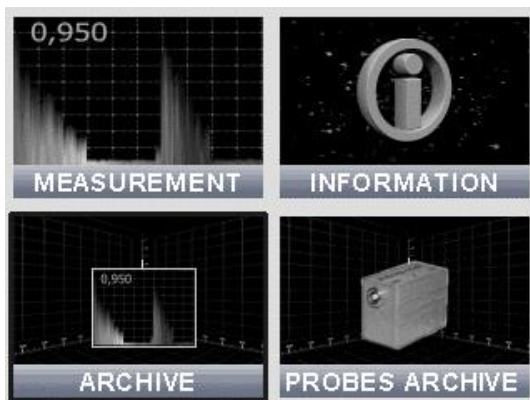
6.3. Turning on the flaw detector

If operation will be carried out by an external power supply, it is necessary to connect the power supply unit of the flaw detector to the power connector, located on the down side of the device's body. Operation of the device is possible during battery charging.

Before switching on the flaw detector, connect the transducer. Connect the power adapter supplied with the flaw detector to the corresponding connector. If you connect the battery and power supply, the flaw detector is powered from the power supply; if the power supply is disconnected, the flaw detector automatically goes to battery supply.

To enable (disable) flaw detector press  and hold it for at least 3 seconds to short beep.

When you turn on the device screen of main menu is displayed.



Picture 6.3. Main menu of the flaw detector.

The main menu of flaw detector is consists of four sections:

- Measurement;
- Information;
- Archive;
- Probes archive.

6.4. Connecting the transducer to the flaw detector

Combined probe is connected to the upper connector on the top panel of flaw detector than set "Tract" - "Probe" parameter "Type" - "Combined".

Dual element transducers are connectig as follows: emitting plate of dual probe is connecting to the upper connector, and the receiving plate is connecting to the lower connector on body of the flaw

detector by inserting the cable connectors until its click. Set "TRACT" - "PROBE" parameter "TYPE" - "DUAL".

6.5. The main modes of operation of the flaw detector

"**MEASUREMENT**" mode - goes to the measurement;

"**ARCHIVE**" mode - displays all stored measurement results and settings;

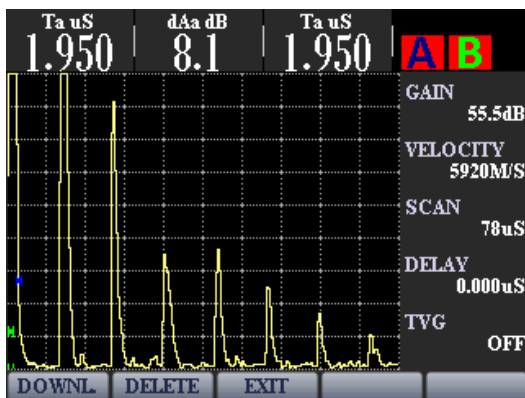
"**PROBES ARCHIVE**" mode - contains a list of saved probe with individual settings;

"**INFORMATION**" mode - display information about the device.

To select the required mode - scroll encoder and confirm your selection by pressing the encoder.

6.5.1 "MEASUREMENT" mode

"Measurement" mode is the main mode (Pic. 6.5.1), designed for ultrasonic testing.



Picture 6.5.1 "Measurement" mode



All parameters for configuring the measuring part of flaw detector divided into groups, depending on the selected group user gets access to the various parameters.

Group	Parameters				
Main	Gain	Velocity	Scan	Delay	
Generator*	Gain	Detector	Frequency of the filter	Filter	Cut
Probe*	Gain	Level	Width+	Width-	
Zones	Type	Delay	Angle	Arrow	Frequency
Zone*	Zone	Level	Start	Width	Signal
Display	Zone	Measurement	Control	Search	
Block 1*	Gain	Units			
Block 2*	Parameter 1	Parameter 2	Parameter 3		
Block 3*	Parameter 1	Parameter 2	Parameter 3		
Time*	Parameter 1	Parameter 2	Parameter 3		
Functions	Hours	Minutes	Day	Month	Year
TVG	Gain	Envelope	B-scan	Averaging	
DGS1*	TVG	Cleaning	Point	Position	+dB
DGS2*	DGS	Point	Position	dB	

* - group of parameters for access to which is necessary to press combination of buttons.

Generator - double-click on the button TRACT

Probe - double-click on the button TRACT

Zone - double-click on the button ZONE

Block1 - double-click on the button DISPLAY

Block2 - double-click on the button DISPLAY

Block 3 - double-click on the button DISPLAY

Time - double-click on the button DISPLAY

TVG - double-click on the button TRACT or ZONE

DGS1 - double-click on the button ZONE

DGS2 - double-click on the button ZONE

Description of parameters of flaw detector

Groups	Parameters	Description
Main	GAIN	Setting of gain of received path from 0 to 115 dB, in steps of 0.1, 1 dB.
	VELOCITY	Display the set velocity of ultrasonic vibrations in the tested material. Adjustment range from 1000 to 9999 m / s. Accuracy of the measurement the depth, coordinates of defects and thickness are depends on the accuracy of the velocity settings.
	SCALE	The duration of scanning - depth sounding along the beam. Adjustment range from 1 to 1000 μ s. Flaw detector processed only signals that are under scanning.
	DELAY	The "Delay" specifies the time delay relative to the start of scanning of the probe pulse. Setting range from 0 to 1000 μ s.
Tract	GAIN	Setting of gain of received path from 0 to 115 dB at 0.1, 1 dB
	DETECTOR	Selecting the type of visualization of the signal. Can take two values: the MODULE and RADIO.
	F.FILT	Selecting the central operating frequency of receiver path (selection of



		frequency range receiver path). It can take values from 1 MHz to 10 MHz.
	FILTER	Turn on / off frequency filter.
Zones	ZONE	Selecting gate. Takes the values: A or B.
	LEVEL	The threshold level of the selected control gate. Is given in % of the screen height, can take values from 0 to 100% of the screen height.
	START	Coordinate of the beginning of the selected gate. It can take values from 0 to the maximum value of scanning.
	WIDTH	The width of the selected control gate along the beam. It can take values from 0 to the maximum value of scanning. The total value of the start and the width of the gate can not exceed the value of the maximum scanning.
	SIGNAL	Turn on / off sound signal (available for the extended version of the flaw detector)
	Display	GAIN
UNITS		Selecting the display unit parameter settings. Has two values: μ s and mm.
Functions	GAIN	Setting of gain of received path from 0 to 115 dB at 0.1, 1 dB.
	PEAK	Turn on / off fixing the maximum amplitude of the echo.
	B-scan	Turn on / off display of a scanning-type B-scan.
	AVG.	Number of echoes which are averaged

		result.
Generator	GAIN	Setting of gain of received path from 0 to 115 dB at 0.1, 1 dB.
	LEVEL	Setting the level of the generator excitation. Can take values 100V, 200 V, 300V.
	WIDTH +	Adjust the width of the positive halfwave of the signal
	WIDTH -	Adjust the width of the negative halfwave of the signal
Probe	TYPE	Setting the type of the connected ultrasonic transducer. Has two values: combined and dual.
	DELAY	Setting a delay in the prism of transducer
	ANGLE	The angle of entry of the ultrasonic vibrations to the connected transducer.
	ARROW	Allows to set an arrow of transducer (set from 0 to 90 mm).
	FREQ.	Setting the operating frequency of the ultrasonic transducer. Has a range from 1 MHz to 10 MHz.
Zone	ZONE	Selecting gate. Takes the values: A or B.
	MEAS.	A method for determining the time of arrival of the signal in the tested gate: "by the peak" - on the state of the maximum signal in the control gate; "by the flank" - on the first crossing of the signal with the threshold in the control gate.
	CONTR.	Setting the control area. The maximum

		value of 20 dB, but can not exceed the value of the search gate.
	SEARCH	Setting the level of the search area. The maximum value is 20 dB.
Block 1	PARAM.1	Allows to select the measured values in the first of three blocks. **
	PARAM.2	Allows to select the measured values in the first of three blocks. **
	PARAM.3	Allows to select the measured values in the first of three blocks. **
Block 2	PARAM.1	Allows to select the measured values in the second of three blocks. **
	PARAM.2	Allows to select the measured values in the second of three blocks. **
	PARAM.3	Allows to select the measured values in the second of three blocks. **
Block 3	PARAM.1	Allows to select the measured values in the third of three blocks. **
	PARAM.2	Allows to select the measured values in the third of three blocks. **
	PARAM.3	Allows to select the measured values in the third of three blocks. **
TIME	HOURS	Setting hours
	MINUTES	Setting minutes
	DAY	Setting day
	MONTH	Setting month
	YEAR	Setting year
TVG	TVG	Turn on / off TVG.
	CLEAR	Allows to reset the TVG.
	POINT	Select point TVG and display the total number of points. The maximum number of points TVG - 15.

	POS.	Displays coordinates of the position of the current point of TVG. The distance between two neighboring points is not less than 3 microseconds.
	+dB	Gain of the current point TVG. The total value of all the points of the TVG not more 40 dB, accuracy of setting 0.1 dB.
DGS1	DGS	Turn on / off DGS.
	POINT	Select Point TVG and display the total number of points. The maximum number of points TVG - 15.
	POS.	Displays coordinates of the position of the current point of TVG. The distance between two neighboring points is not less than 3 microseconds.
	dB	Gain of the current point DGS. The total value of all the points of the DGS not more 40 dB, accuracy of setting 0.1 dB.
DGS2	DGS	Turn on / off DGS.
	A REF.	Allows to set the level / amplitude of the reference signal
	mm ²	Allows to set the value of the equivalent area of the reflector

** - Measured values of the received ultrasonic vibration signals:

Ta – time value signal in the gate A, shown in microseconds.

Tb – time value signal in the gate B, shown in microseconds.

Ta-b – the difference between the time values between the signals A and B in gate.

Aa – value of signal amplitude in gate A.

Ab – value of signal amplitude in gate B.

Aa-b – the difference between the amplitudes of the signal in the A and B gates.

Xba – the distance from the front edge of the signal in gate A.

Xbb – the distance from the front edge of the signal in gate B.

Xipa – the distance from the input signal in the gate A.

Xipb – the distance from the input signal in the gate B.

Ya – coordinate of signal depth in the gate A.

Yb – coordinate of signal depth in the gate B.

Ya-b – the difference between the values of the coordinate signals depth A and B.

Sa – equivalent area signal in gate A.

Sb – equivalent area signal in gate B.

La – distance to the reflector along the beam in the gate A.

Lb - distance to the reflector along the beam in the gate B.

dAa – value of the signal level (dB) from the gate A to the maximum signal.

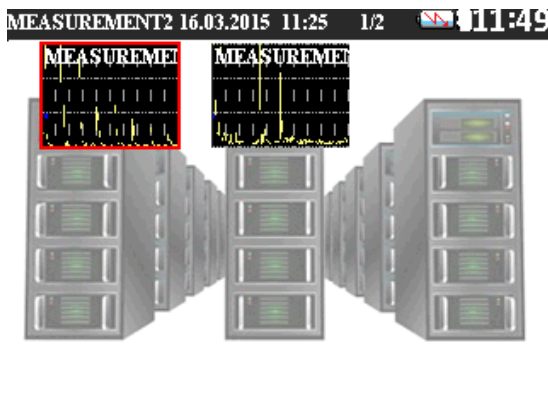
dAb – value of the signal level (dB) from the gate B to the maximum signal.

La - Lb - the difference between the values of the distance to the reflector along the beam in gates A and B.

For measurement values (except Ta-b, Aa-b, Ya-b and La - Lb) it is necessary to combine control gates A or B with the signal in which it is planned to carry out measurements. To determine the Ta-b, Aa-b, Ya-b and La - Lb is necessary to set control gates A and B on two adjacent echoes.

6.5.2. "ARCHIVE" mode

This mode allows user to view all previously stored results of testing and download the selected file to continue working with the required settings (Pic. 6.5.2).



Picture 6.5.2 "ARCHIVE" mode

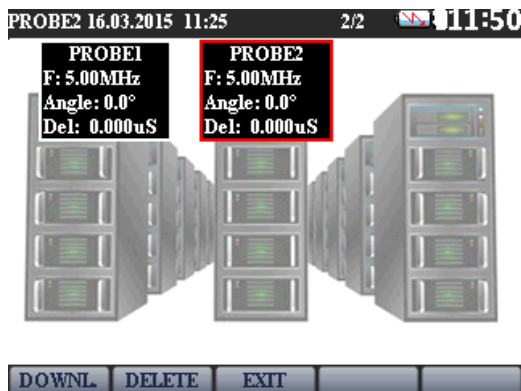
Previously stored results are presented in a list and sorted by creation date.

To select the file need to scrolling encoder, to confirm the selection press the encoder. Device offers the following steps:

Actions	Description
Download	Downloading all the settings for measurements with previously saved settings
Delete	Allows to delete the selected file.
Exit	Back to list of all files

6.5.3. "PROBES ARCHIVE" mode

This option allows user to view all the previously saved settings of ultrasonic transducers and, if necessary, download the selected file to proceed with the setup.



Picture 6.5.3 "PROBES ARCHIVE" mode

Device offers the following steps:

Actions	Description
Download	Downloading all the settings for measurements with previously saved settings
Delete	Allows to delete the selected file.
Exit	Back to list of all files

7. Basic settings of flaw detector

7.1. Initial setup of the device

7.1.1. Selection of A-scan mode

To select the display mode of the signal as A-scan in the menu "TRACT" select the "DETECTOR " and set one of available options: "MODULE" or "RADIO". Typically, the main mode of A-scan is the "MODULE".

7.1.2. Selection of basic units

The main flaw detectors units can be μs or mm.

To select the required units it is necessary in the group of parameters "DISPLAY" set the required value of the "UNITS".

7.2. Setting the transducer parameters

Accuracy of measurement is depending on the correctness settings of transducer parameters when working with flaw depends. Flaw detector allows you to work with both combined and dual element transducers.

7.2.1. Selecting the type of transducer

To select the type of the transducer in the parameter group "PROBE" set the required value of the "TYPE": "SINGL" or "DUAL".

7.2.2. Setting the frequency of transducer

To set the frequency of transducer in the group of parameters "PROBE" set the required value of the parameter "FREQ".

7.2.3. Setting the input angle of transducer

To set the input angle of transducer in the group of parameters "PROBE" set required value of the parameter "ANGLE".

7.2.4. Setting delay in the transducers prism

Typically, during the ultrasonic testing piezoceramic plates are not in contact with the tested object, and are protected by a layer of protective material (protector) or (in the case of angle-beam transducer) is mounted on a corner prism.

For correct calculation of the coordinates, it is necessary to compensate the moving time of ultrasonic vibrations through the protector / prism.

7.2.5. Installation of transducers arrow

During testing with angle-beam transducer coordinates is calculated from the output point of the beam. In order to be able to take a

measurement from the front face of transducer must be set arrow of probe. To install arrow of transducer in the group of parameters "PROBE" set the required value of the "ARROW".

7.3. Setting the display of signal

7.3.1. Setting the gain

To adjust the gain in parameter group "MAIN" select "GAIN" and set the required gain value.

7.3.2. Setting the duration of the scanning

To adjust the duration of the scanning in the group of parameters "MAIN" set required value of the parameter "SCAN".

7.3.3. Setting the scanning delay

To adjust duration of delay in parameter group "MAIN" set the required value of the parameter "DELAY".

7.3.4. Setting cut-off of signal

In some cases it is convenient to use cut-off signal on the vertical axis to enhance the perceptual quality of the signal. This method allows to remove from the screen of the flaw detector noise, as well as other small amplitude signals, preventing the identification of useful signals.

To set the cut-off signal, in parameter group "MAIN" set the required value of the "DELAY". The cut-off is a percentage of the screen height.

7.3.5. Envelope of the signal mode

In some cases it may be necessary to detect the maximum of signal, and get an envelope signal during scanning of reflectors.

To activate the envelope in group settings "FUNCTIONS" set the required value of the "ENVELOPE": "ON" or "OFF".

7.4. Setting of the flaw detector for measurements

7.4.1. Basic settings of control areas (Gates)

Flaw detector has two independent gates - A and B. Configure of gates is basic operation, that allow configure the flaw detector for measuring the signal amplitudes, the depth of the reflector, thickness measurements etc.

For each of the control gates can be set independently:

- The level of the gate as a percentage of the screen height of the flaw detector;
- The start coordinates of the control gate;
- The width of the control gate (gate length);
- Signal (audio alarm when signal cross the control gate).

7.4.1.1. Setting the level of the control gate

To adjust the control gate level in a group of parameters "ZONE" in parameter "ZONES" set required strobe (A or B) and change the parameter "LEVEL" to set required value.

7.4.1.2. Setting start of control gate

To set the start of the control gate in a group of parameters "ZONES" in parameter "GATES" set required strobe (A or B) and change the parameter "Start" to set the required value.

7.4.1.3. Setting the width of the control gate

To adjust the width of the control gate in a group of parameters "ZONES" in parameter "ZONE" set required strobe (A or B) and change the parameter "WIDTH" to set required value.

7.4.1.4. Enable sound alarm

To enable / disable the sound alarm when the level crossing control gate in the parameter group "ZONES" in the parameter "ZONE" set required strobe (A or B) and change the parameter "SIGNAL" to enable or disable the alarm.

7.4.1.5. Setting additional levels of control in the area

In flaw detector is possible to set additional levels in the control area: control and search. Additional levels are set in dB relative to the main level of the control gate independently for each control gate.

To set additional levels of control in parameter group "ZONE" set the required parameters "CONTROL" and "SEARCH" for the required control gate.

On the display of the device will appear additional levels of control and search control gate below basic level area.

7.4.2. Setting the display of the measured parameters

7.4.2.1. Basic principles of the display of the measured parameters

All parameters measured by flaw detector, can be displayed in a special area on the display.

Area with a display parameter consists of three blocks separated vertically. In each of these blocks can be displayed one to three of the measured parameters.

7.4.2.2. Installation of the displayed parameters

To adjust the output to the screen of the flaw detector measured parameters of ultrasonic impulse in the group of parameters "DISPLAY" select any of the three blocks "BLOCK 1", "BLOCK 2" or "BLOCK 3" and set the measured value in the line "PARAM.1", "PARAM.2", "PARAM.3" displayed in the selected block. If set "OFF" for the string "PARAM. 1", "PARAM. 2", "PARAM. 3", area of the screen corresponded this line will remain blank.

In one block can be displayed one to three parameters. If selected only one parameter for display, it will be displayed in large font (recommended for displaying the main parameter being measured). If display two or three parameters in a block, font will be reduced (recommended for the secondary display of measured values).

7.5. Setting the sound velocity in the tested object

To properly coordinate measuring defects and measuring the thickness of the tested object it is necessary to set the speed of propagation of ultrasonic vibrations in the material of tested object.

To set the velocity of ultrasonic vibrations in the tested object in the group of parameters "MAIN" select "VELOCITY" and set the required value.

7.6. The display mode signal as B-Scan

Presentation the results of ultrasonic testing in the form of a cross-section of the tested object, perpendicular to the surface and parallel to the direction input sounding. To estimate the amplitude of the echo signals amplitude there is correlation between echo signals and color of images. The right side of the display of measurement results presented color scheme estimates the amplitude echo signal, where blue is the smallest and red is the highest echo signal amplitude.

When operating in any of the possible types of scanning user is able to adjust all the parameters required for optimum performance and ease visualization of the received echoes. When changing scanning type A to type B (and vice versa), all settings remain saved.

7.7. Measurement mode with averaging of signal

In some cases, during testing materials with high damping, when controlling of large tested objects and operating at high scanning duration, noise amplitude can be compared with the amplitude of the useful signal and on the background of strong noise useful signal is difficult to detect.

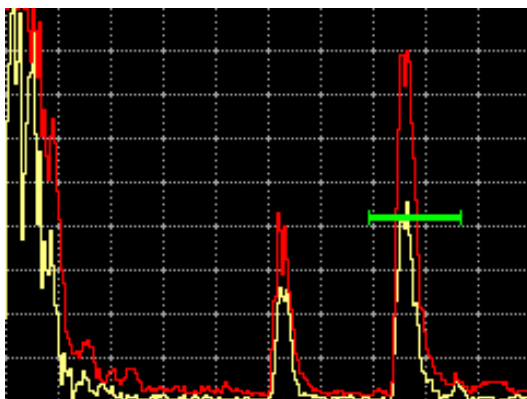
For these cases, in the device is implemented the averaging mode, which can be done by 2, 4, 8 and 16 signals. To activate the averaging in the group of parameters "Functions" select and activate the parameter "AVG." and set required number of averaging.

Caution, when the averaging mode activated it is reduced frequency of refreshing of signal on the display.

7.8. Measurement mode with signal accumulation


In some cases it may be necessary to detect the maximum of signal, and get an envelope of signal during scanning.

To activate the envelope mode in group settings "FUNCTIONS" select the "ENVELOPE" and set the required parameter - on or off.



8. Device memory

8.1. Saving the results of test and device settings

To save the current settings, in measurement mode press the "SAVE" key , on the devices display image will be fixed (frozen). Select "MEAS." if you want to save device settings or "PROBE" if you want to save probes settings.

8.2. Downloading the configuration settings of the device or transducers from the archive

To load a previously saved device settings (configuration) or transducer settings go to main menu and select "ARCHIVE" or "PROBES ARCHIVE".

9. Calibration of the flaw detector

9.1. Measuring of prism delay for direct transducer

During operation with the direct transducer abrasion occurs with prism, it cause to changes of delay of the signal in transducer. Given that the propagation of time in the prism transducer significantly affect the accuracy of calculation of the coordinates of the reflectors it is very important to accurately measure the delay in the prism and periodically update this parameter.

Measurement of prism delay of direct transducer made using a standard sample SO-2.

To measure delays in the prism of transducer it is necessary to get a first reflected signal (the first ground signal) on a standard sample SO-2 on the side of 59 mm and put this signal into one of the control gates, for example gate A.

Configure the display of the measured parameters - display the value of the propagation time along the beam or propagation time required for the control gate, in this example - L_a and T_a accordingly.

Time of propagation of ultrasonic vibrations in the prism of direct transducer in microseconds equals:

$$2t = t_1 - 20 \mu s,$$

where t_1 - the time between excitation pulse and the echo from the surface of the standard sample SO-2 at the side 59 mm with transducer position corresponding to the maximum amplitude of the echo signal, for this example - the value L_a or T_a ;



20 μs - the propagation time of the ultrasonic vibration in the standard sample on the side of 59 mm.

9.2. Measuring of prism delay for angle-beam transducer

During operation with the angle-beam transducer abrasion occurs with prism, it cause to changes of angle and delay of the signal in transducer. Given that the propagation of time in the prism transducer significantly affect the accuracy of calculation of the coordinates of the reflectors it is very important to accurately measure the delay in the prism and periodically update this parameter.

Measurement of prism delay of angle-beam transducer made using a standard sample SO-3.

To measure delay in the prism it is necessary to get the reflected signal from the radiused surface at the standard sample SO-3 and put this signal into one of the control gates, for example gate A.

Configure the display of the measured parameters - display the value of the propagation time along the beam for the required control gate, in this example - L_a .

Time of propagation of ultrasonic vibrations in the prism of angle-beam transducer in microseconds equals:

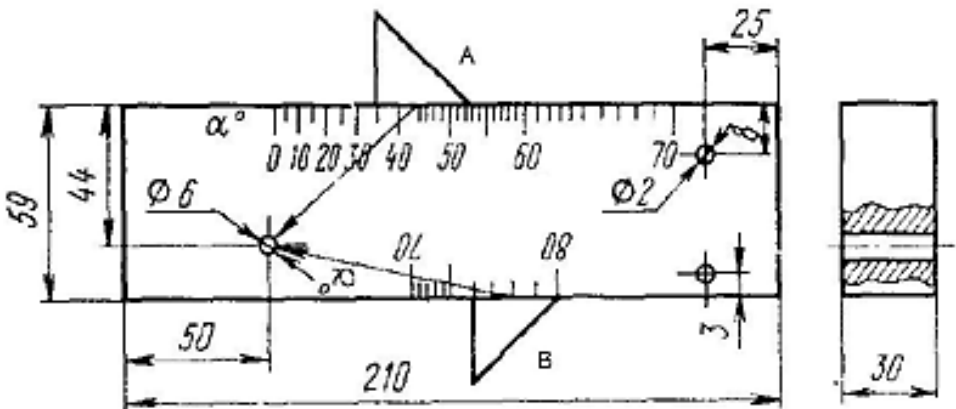
$$2t = t_1 - 33,7 \mu\text{s},$$

where t_1 - the total time between the excitation pulse and the echo signal from the concave cylindrical surface in the standard sample SO-3 when the transducer is installed in a position corresponding to the maximum amplitude of the echo signal, for this example - the value L_a ;

33,7 μs - the propagation time of the ultrasonic vibration in the standard sample, calculated for the parameters: the radius of the sample - 55 mm, the propagation velocity of the transverse wave in the material sample - 3,26 mm/ μs .

9.3. Measurement of input angle of transducer

Measuring of the input angle of the beam of angle-beam transducer in position A or B in Picture 10.3. Moving of angle-beam transducer near these positions user seek maximum of the echo signal from the reflector (cylindrical hole $\varnothing 6$ mm. located at a depth of 44 mm or 15 mm for the various positions of probes). Value of the angle is specified on the marks of the corner scale opposite the output point of ultrasonic beam.

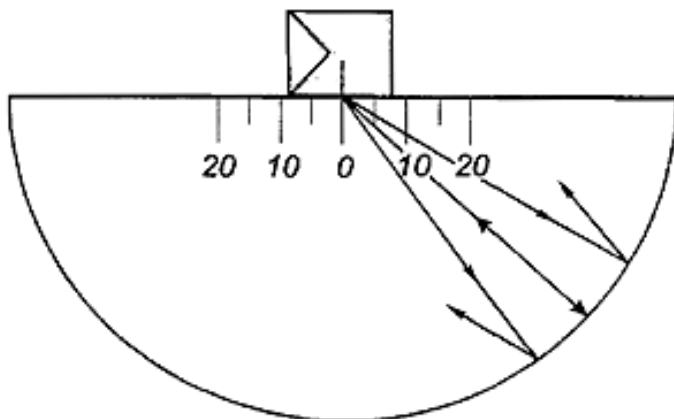


Picture 10.3 Standard sample SO-2

9.4. Measurement of transducers arrow

To find output point 0 of ultrasonic beam of angle-beam transducer put probe on central mark "0" (Pic. 10.4) and with small movements find position corresponding to the maximum echo signal. Output point is located exactly above the center mark of the sample.

Arrow of transducer in millimeters defined as the distance from the output point of the ultrasonic beam to the end of the transducer body in the direction of sounding (measured along the lateral scale is marked in millimeters).



Picture 10.4 Standard sample SO-3

9.5. Measurement the velocity of ultrasonic vibrations in the tested object

Measurement the velocity of ultrasound can be performed directly on the tested object or with the samples made from the same material.

Before the measurement of ultrasonic velocity in the material of the tested object it is necessary to make setting of the transducers (set the correct delay value in the prism and set the angle for the angle-beam transducer) described above.

Select the place on the product (or on sample of the same material) in which can be made thickness measurement of the sample using appropriate transducer. Set the control gate, adjust the display the thickness of tested object. Mechanically with satisfying accuracy make measurement of real thickness at the point of control.

Measurement (setting) of the ultrasonic velocity in the material of tested object (or a sample of similar material) is produced by adjusting the value of the parameter "VELOCITY" in the "Main" to align the measured values of the thickness of the object (sample) with the real (obtained by measuring the mechanical method).

9.6. Calculations of the equivalent area of the reflector

α – input angle of ultrasonic vibrations in the material;

v – velocity in the material;

f – frequency of transducer;

R – radius of lateral drilling;

x – depth of the defect;

r – length of the passage of ultrasonic vibrations to the defect along the beam;

$\lambda = v/f$ – the length of the wave in the material;

r_0 – the length of near gate of transducer;

$\pi = 3,1415$ – constant;

S_p – effective area of transducer;

L_{pr} – length of the path in the prism;

v_{pr} – velocity of ultrasonic vibrations in a prism.

$$L_{pr} = \frac{T_{pr} \cdot v_{pr}}{2} \cdot \frac{v_{pr}}{v} \quad (*)$$

$$r = L_{pr} + x/\cos[\alpha]$$

$$r_0 = \frac{S}{\lambda \cdot \pi}$$

Equivalent area of the reflector:

for lateral drilling

$$s = \lambda \cdot \sqrt{\frac{R \cdot r}{4}}$$

to the plane (angle)

$$s = \frac{r \cdot \lambda}{2}$$

10. Maintenance

Maintenance of flaw detector is carrying out for preventive maintenance to ensure the normal operation of flaw detector during its using. Recommended periods for the following types of maintenance operation:

- visual inspection - every month;
- exterior cleaning - after each exploitation.

At visual inspection of the external state of flaw detector is recommended to check the absence of chips and cracks, clarity of the controls, mounting parts on the device. Dust on the body of the device cleared by soft cloth or brush.

11. Precautions and trouble shouting

11.1. Use the device with care. Any wrong using may result in the violation of the present technical specifications and thus, lead to the manufacturer warranty cessation.

11.2. Always check the integrity of the cables, information processing unit and transducers. Provide immediate replacement of the damaged parts by the original ones. These operations must be performed by skilled personnel.

11.3. Do not expose the device to aggressive chemical medium.

11.4. Do not leave the device at the direct sun rays.

11.5. Do not sink the device into any liquids. If the device gets wet, take the battery out and leave for 24 hours to get dry.

12. Manufacturer's guarantee and service maintenance

12.1. In case when device (information processing unit), supplied by the Seller within one year since the delivery date used properly, appear defective, the Seller shall repair or replace them or supply new parts therefore and send them to the Buyer. The other parts of the device (transducers, batteries, charger, bag etc.) warranty does not cover. The Buyer must prepay any shipping charges, taxes, or duties related to transportation of the product to the service location, and Seller pays return shipping and associated costs. In addition, the Buyer shall be responsible for insuring any product shipped or returned to an authorized service location, and the Buyer shall bear risk of loss during shipping to the service location, and Seller all risks during delivery to the Buyer. In order to exercise its rights the Buyer shall inform the Seller as soon as possible after the date when such defect appeared.

12.2. Prepare technically grounded reclamation document and send it together with the hardness tester to the guarantee service or to the manufacturer at the address:

Scientific and Technical Centre

"Industrial Devices and Technologies" Ltd

5, Spasskaya street, Novomoskovsk, 51200, Ukraine

Phone: +38-067-593-59-77

Fax: +38-0562-355-880

Mail: sales@novotest.biz

12.3. Postwarranty maintenance is performed by the manufacturer service centre upon the customer request.