Electro-Magnetic Acoustic Thickness Gauge

A1270

OPERATION MANUAL

Acoustic Control Systems Ltd.
Moscow 2016

Contents

Current Operation Manual (hereinafter referred to as "the operation manual") contains technical specifications, description, and operation principle of the A1270 Electro-Magnetic Acoustic Thickness Gauge (hereinafter referred to as “the thickness gauge" or "the instrument"), as well as information required for proper operation of the instrument.

Carefully read this operation manual before starting to work with the instrument.

Only the personnel familiar with general principles of the ultrasound waves propagation, having completed a corresponding training, and having read the operation documentation is allowed to work with the instrument.

The inspection tasks must be determined, the inspection schemes must be selected, the transducers must be chosen and inspection conditions for such materials must be evaluated, etc. for correct ultrasonic inspection.

During production of the instrument some modifications can be introduced to it due to constant improvement of its reliability and serviceability that do not affect the technical specifications of the instrument and thus are not described in the present operation manual.

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1 DESCRIPTION AND INSTRUMENT OPERATION

1.1 PURPOSE OF THE INSTRUMENT

1.1.1 Purpose and application range

The instrument is a general purpose hand-held ultrasound thickness gauge.

The instrument is designed for measurement of thickness of parts and walks of steel tubes and objects made of steel and metal alloys not using coupling fluids; ultrasonic thickness measurements of flat rolled stock; ultrasonic thickness measurements of the ship bottom without pretreatment of the surface; evaluation of anisotropy degree of the material.

The instrument can be used under the laboratory, field and workshop conditions in various industries.

The A-SCAN mode allows elimination of false readings, thus substantially increasing inspection reliability, express-searches for foreign inclusions and laminations, as well as getting true results of measuring through polymeric, varnish and paint and other types of insulated coating.

The instrument allows rotation of the image layout by 90^{o} rightwards and leftwards in the operation modes.

Measurement results can be recorded into the instrument's memory and further transferred to PC for procession, analysis and storage.

The instrument communicates with PC via the USB port.

1.1.2 Operating conditions

The instrument is designed to work under the following conditions:

– ambient air temperature range from -30 to +50 °C;

– relative air humidity up to 95 % at +35 °C.

1.2 TECHNICAL SPECIFICATIONS

Main technical specifications of the instrument are presented in Table 1.

Table 1

Parameter name	Value
Range of the thickness for measurement with the S3850 5.0A0D8ES transducer, mm	from 0.6 to 50.0
Limits of permissible absolute measurement error of thickness, where *H* is the thickness being measured	±(0.01·*H*+0.1)
Indication discreteness of thickness, mm: for thickness values up to 99.99 mm for thickness values from 100.0 mm	 0.01; 0.1 0.1
Setting range of ultrasound velocity, m/s	from 1 000 to 9 999
Setting range of operation frequencies, MHz	from 2.5 to 5.0
Power source	accumulator
Nominal voltage of accumulator, V	13.2
Period of continuous operation of the instrument powered by the accumulator under normal climatic conditions, no less than	9 h
Overall dimensions of the electronic unit, no more than	190×87×40 mm
Maximum weight of the electronic unit	900 g
Mean time between failures	18000 h
Average service life, no less than	5 years

1.3 DESIGN AND OPERATION

1.3.1 Design

The instrument represents an electronic unit (Figure 1) to which replaceable electromagnetic acoustic transducers (EMAT) shall be cable-connected. The upper and lower end faces of the instrument are enclosed with rubber plugs.

Figure 1

A color TFT display is located in the upper part of the face panel of the electronic unit. The display shows measurement results and operation information required for control over the instrument. The display provides a complete visual control over the measurement process via the color-coded indication.

A membrane keypad under the display allows control over the instrument.

The upper end face of the electronic unit bears a connector for EMAT, and the D16T calibration sample 5 mm thick made of aluminum alloy D16T. Propagation velocity of

ultrasound waves in the calibration sample is 3120 m/s. The sample is meant for adjustment of the instrument to the connected EMAT, as well as for prompt evaluation of the instrument performance (Figure 2).

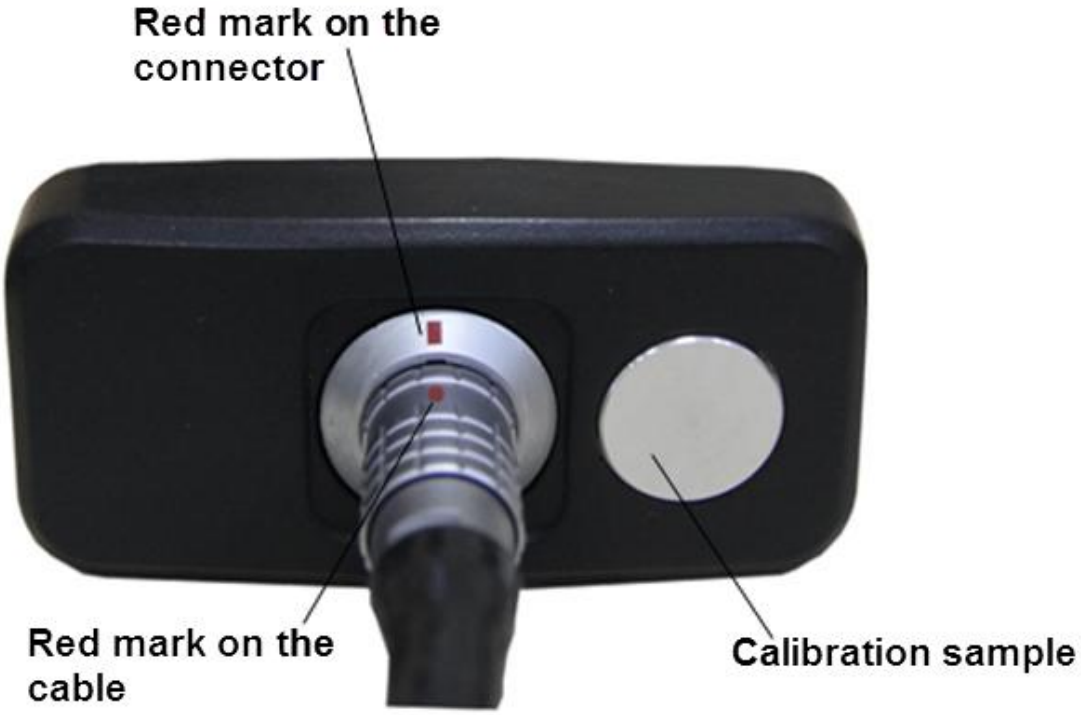


Figure 2

The lower end face of the electronic unit bears a brace for the belt, USB Micro B connector meant for connection of the USB communication cable to PC, and a connector for connection/disconnection of the power adapter to charge the built-in instrument's accumulator (Figure 3).

N o t e – Measurements are impossible during charging.

Figure 3

The "Micro B" connector of the USB cable shall be connected by the  symbol and/or the "B" letter facing upward (Figure 4).

Figure 4

1.3.2 Operation principle

Instrument's operation principle represents measurement of time of double traverse of ultrasonic waves through the object being inspected from one surface to another, which is further recalculated into the thickness value.

EMAT is used to emit the ultrasonic pulses into the object being inspected and receive the reflected pulses. EMAT shall be installed on the surface of the object being inspected in the place where the thickness shall be measured. EMAT has a pointed directional characteristic of irradiation direction and ultrasound reception, hence the thickness can be measured just below the installation place of the transducer. Provided the surface opposite to the surface with the EMAT installed has some cavities, the ultrasound pulses will be reflected from them and the thickness will be determined as the shortest distance from the external surface to these cavities.

1.3.3 Operation modes

The operation modes of the thickness gauge are as follows:

– in the measurement mode with a representation of the recorded results – MEMORY;

– in the measurement mode with a graphical representation of the signal – A-SCAN;

– in the mode so settings and selection of the measurement parameters – SETUP.

The instrument allows recording of the results into its memory when operated in any measurement mode.

In the MEMORY mode the thickness gauge allows prompt detection of thickness of the object being inspected; it allows the operator to view the recorded measurement results on the

display, edit the recordings doing additional measurements and record the data obtained into the correctable memory cells.

The A-SCAN mode allows elimination of false readings caused by presence of discontinuities in the material of the object being inspected. In this mode the signals are displayed in the form of A-SCAN, and measurement conditions and criteria are determined directly during the operation. Four measurement ways are possible: by the first signal exceeding the strobe threshold, by the maximum signal in the strobe, between two maximum signals in the strobe and ACF by the strobe. This mode as well allows viewing the selected sections of the signal, current parameters and settings, recording of the A-SCAN image together with the measurement result.

The SETUP mode allows adjustment of the required measurement conditions and parameters. A set of the editable parameters consists of the general parameters (common for all modes) and parameters proprietary for each separate measurement mode.

1.3.4 Display

In all operation modes the upper line on the instrument's display indicates information on the current operation mode of the instrument and its accumulator charge level. Table 2 lists the types of the icons of the operation mode tabs.

Table 2

Tab	Operation mode
	MEMORY
	A-SCAN
	SETUP

The icons of the measurement modes always go from left to right as follows: MEMORY–A-SCAN, at that an icon of the active mode is highlighted (Figure 5).

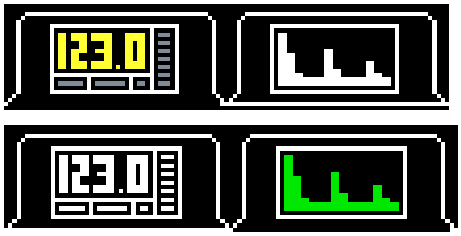


Figure 5

On entry into the SETUP mode its icon will be displayed instead of the icon of the previous mode, the parameters and settings of the mode will become editable (Figure 6).

Figure 6

In the MEMORY mode the characters informing on the presence of the signal and its level, as well as the measurement method are always indicated below, information on the measurement units and a digital value of the measurement result is present as well.

Table 3 presents a description of indicators of the acoustic contact and measurement method.

Table 3

Appearance of the indicator	Description
	Signal level is maximal, amplification of the receiving channel is set to the minimum value
	Signal level is average, amplification of the receiving channel is set to the average value
	Signal level is minimal, amplification of the receiving channel is set to the maximal value
	The signal is missing or it is insufficient for doing measurements
	No measurements
	Measurement using the ACF method
	Measurement using the threshold method

Display appearance of the thickness gauge in the MEMORY mode is presented in Figure 7.

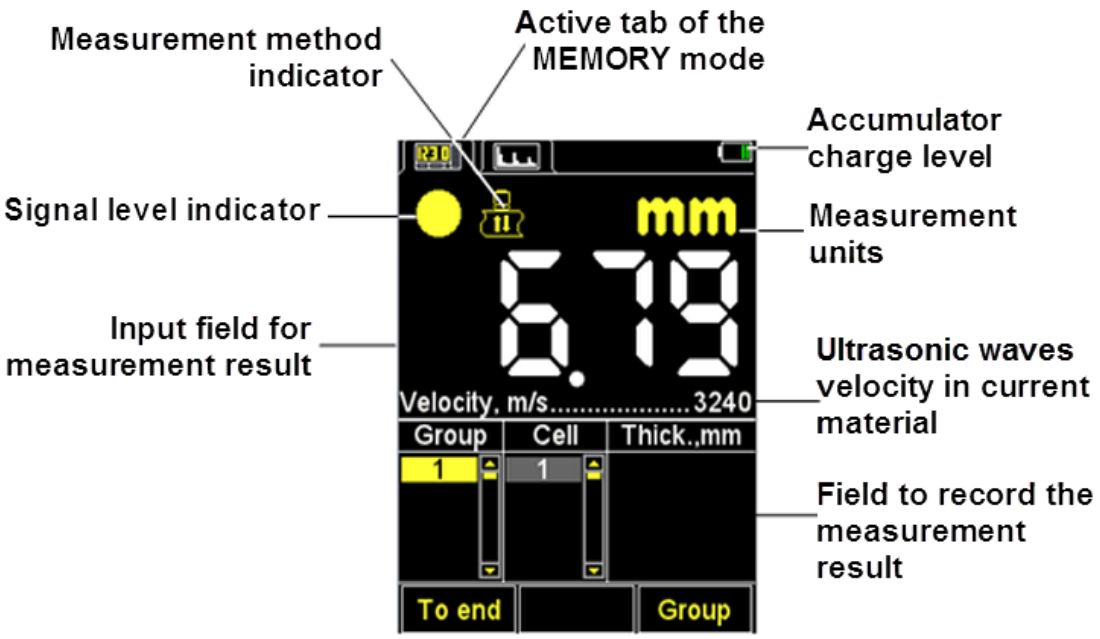

Measurement method indicator
Active tab of the MEMORY mode
Accumulator charge level
Signal level indicator
Measurement units
Input field for measurement result
Ultrasonic waves velocity in current material
Field to record the measurement result
mm
6.79
Velocity, m/s.....3240
Group
Cell
Thick.,mm
1
1
To end
Group

Figure 7

Display appearance of the thickness gauge in the A-SCAN mode is presented in Figure 8.

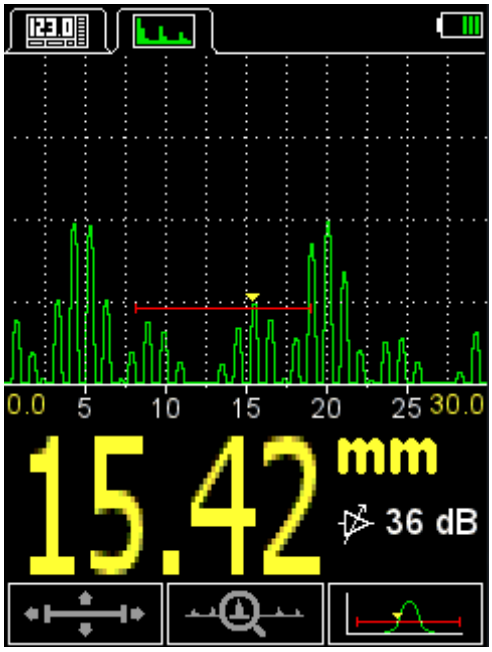


Figure 8

In the A-SCAN mode the display represents a graphic image of the echo-signal, digital value of the measurement result, information on the measurement units and signal amplification. The control icons are located in the lower part of the screen.

The instrument allows rotation of the image by 90^{o} rightwards and leftwards in the operation modes.

Display appearance changes depending on the selected image layout:

- vertical;
- horizontal left;
- horizontal right.

Instrument's display appearance in the A-SCAN mode with an enabled horizontal left display layout (orientation) is presented in Figure 9.

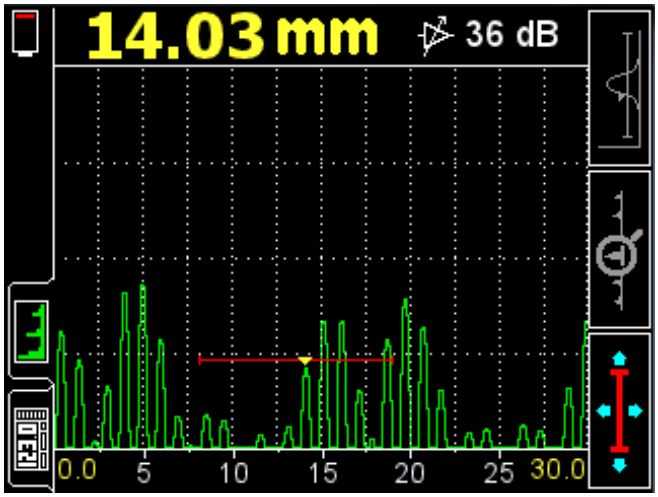


Figure 9

Display appearance of the thickness gauge in the A-SCAN mode with an enabled vertical layout (orientation) is presented in Figure 10.

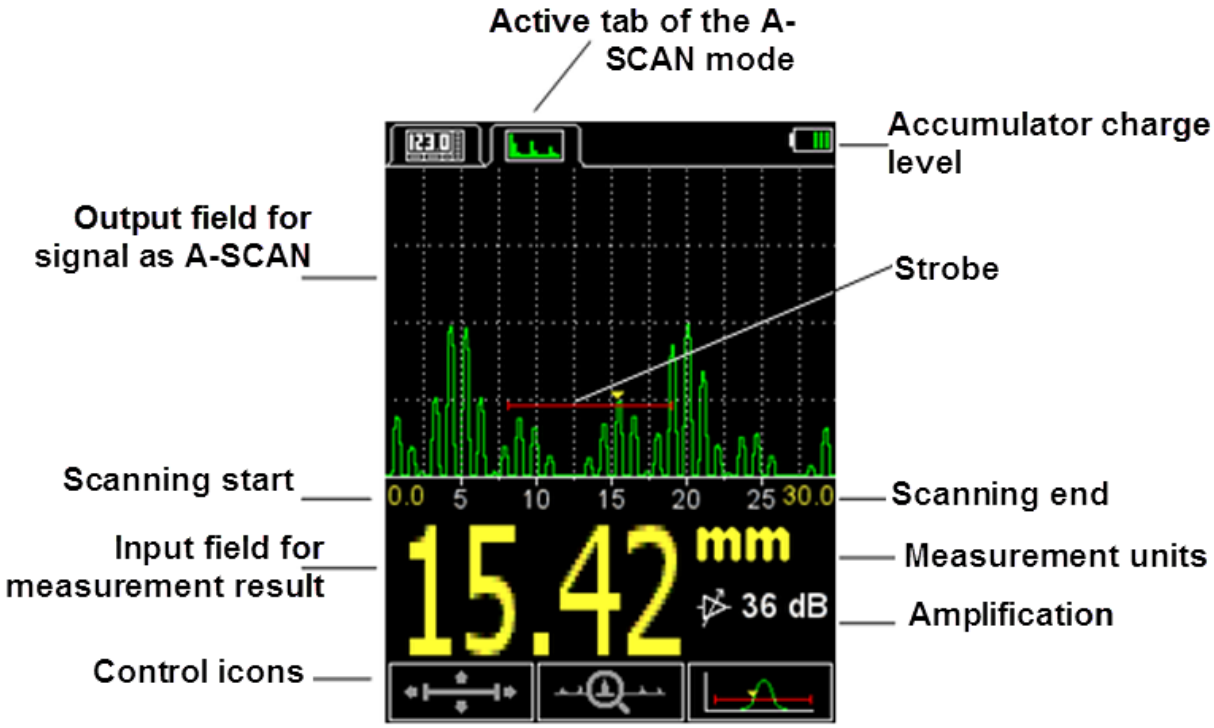


Figure 10

1.3.5 Keypad

Instrument's keypad (Figure 11) has 11 functional keys and the instrument On/Off key.

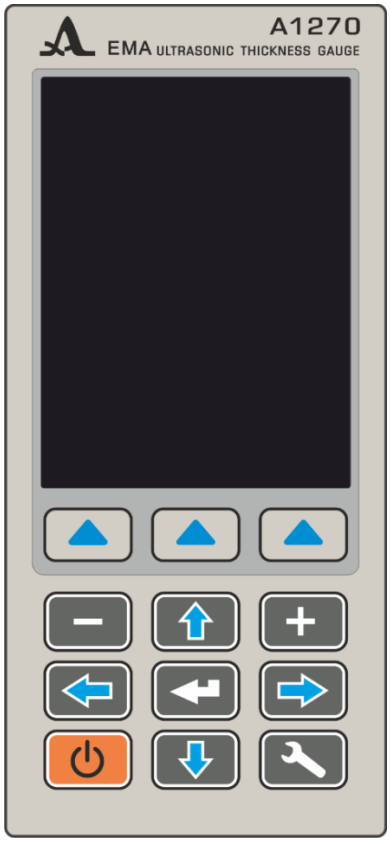


Figure 11

Main functions of the keys:

– Key  (ON / OFF) is used to switch On/Off the instrument.

ATTENTION: THE INSTRUMENT WILL BE AUTOMATICALLY SWITCHED OFF AFTER 10 MINUTES PASS FROM THE MOMENT ANY KEY IS PRESSED AND NO MEASURMENT PROCESSES ARE ACTIVE.

ATTENTION: IN 2 MINUTES THE DISPLAY BRIGHTNESS WILL AUTOMATICALLY BE SET TO THE MINIMAL LEVEL – 5%, PROVIDED NEITHER NO KEY IS PRESSED NOR MEASUREMENT PROCESS IS ACTIVE!

– Functional keys  (**F**) perform various functions depending on the selected operation mode of the instrument. Name of the current function is displayed under each key. The number of the functional keys in this operation manual are as follows, from left to right: **F1. F2**, **F3** (Figure 12).

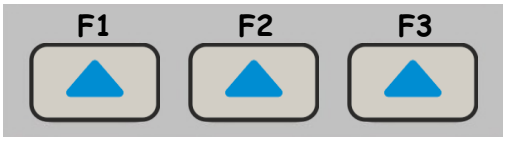


Figure 12

– The  key switches between the measurement modes and the SETUP mode, and vice versa.

– The  key (ENTER) depending on the operation mode and state of the thickness gauge can perform various functions.

– The  /  ,  /  and  /  keys are used to select and edit the active parameters. Their functions are similar for various instrument's operation modes and are self-explanatory hence their icons correspond to their functions.

2 PROPER USE

2.1 OPERATING RESTRICTIONS

The instrument is designed to be operated under conditions listed in paragraph **Ошибка! Источник ссылки не найден.**.

2.2 MAKING THE INSTRUMENT READY FOR OPERATION

2.2.1 Connecting the transducers

EMAT is used to determine the thickness of the object being inspected.

Two types of the transverse wave EMATs are used with the instrument - with a radial and linear polarization based on the pulsed electromagnet technology. In the basic delivery kit of the equipment is included EMAT S3850 5.0A0D8ES with the radial polarization and pulsed electromagnet.

EMAT S7392 3.0A0D10ES and S7394 2.5A0R10x10ES with permanent magnet can be connected to the instrument's electronic unit via a special connector.

The transducers shall be connected observing the markings on the cable and connector (Figure 2).

2.2.2 Switching On/Off the instrument

Press the key  manually to switch On the instrument.

The startup screen will be displaying the instrument's name and hardware version during several seconds (Figure 13).

Figure 13

The thickness gauge will automatically switch to the mode being active prior to the last shutdown with corresponding settings.

N o t e – If the same transducer which have been used prior to the last shutdown, is connected to the instrument, then the instrument will be immediately ready for operation. If another transducer is connected, then at first adjust the instrument for operation with it.

Press the  key manually to switch Off the instrument. The instrument as well will be automatically switched off after 10 minutes pass from the moment any key is pressed and if there are no active measurements.

All settings of the thickness gauge will be recorded upon switching off and if the accumulator goes dead.

2.2.3 Configuring and adjusting the instrument to the parameters of the EMAT being used

ATTENTION: PRIOR TO STARTING INSTRUMENT OPERATION AND IF THE TRANSDUCER IS CHANGED, THEN CONFIGURE AND ADJUST THE INSTRUMENT TO THE INDIVIDUAL PARAMETERS OF THE EMAT BEING USED!

Without this procedure the instrument will remain inoperative, any attempt to switch to any of the measurement modes will display the "Run probe test" warning message (Figure **Ошибка! Неизвестный аргумент ключа.**) on the screen.

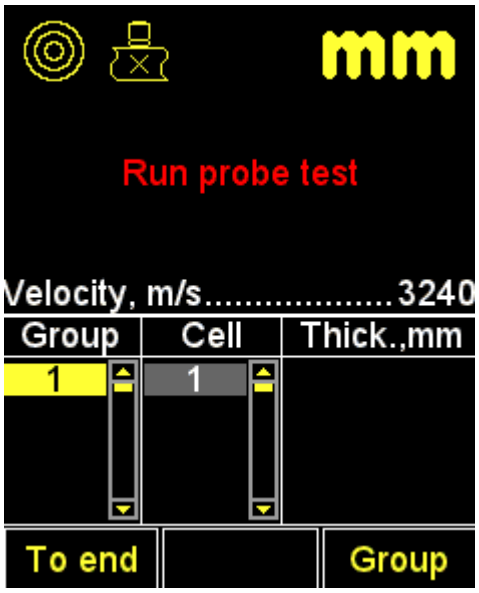


Figure 14

2.2.3.1 Selecting the transducer

Do the following to select the transducer:

– press the  key to enter the SETUP mode.

– By means of the keys  go to the Probe option and press the key **F3** (Open) or  to enter the transducers' (probes') library (Figure 15).

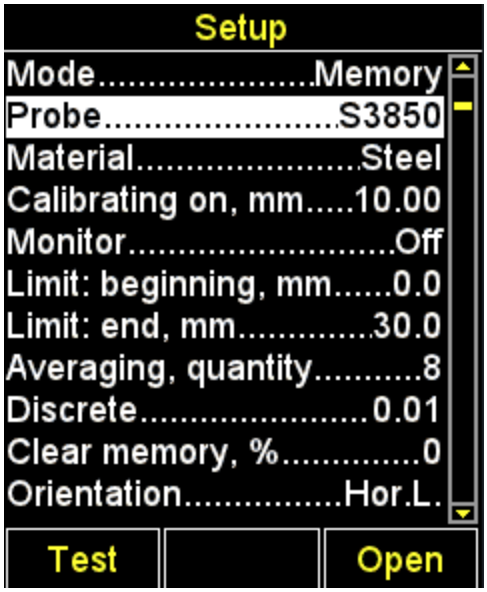


Figure 15

– By means of the keys  go to the line with the name of the connected probe (transducer) and press the key  to select it (Figure 16).

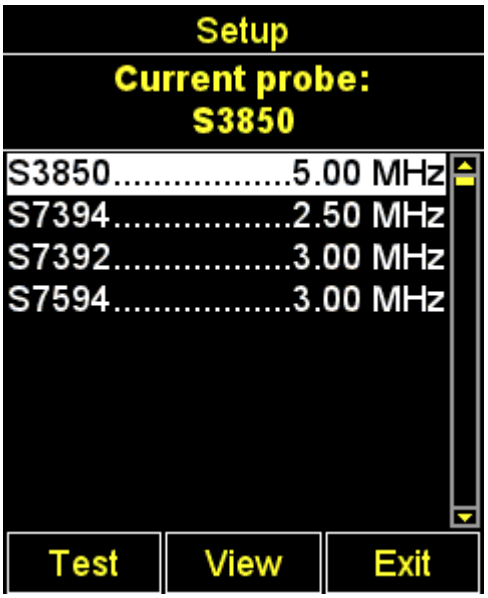


Figure 16

After the transducer is selected the probe testing process instrument's adjustment to its individual parameters will be started automatically.

2.2.3.2 Adjusting the instrument to the parameters of the transducer being used

The adjustment has two stages. At the first stage the instrument automatically analyses the characteristics of EMAT, at the second stage the instrument adjusts to them using a real echo-signal from the calibration sample built in the instrument.

Do the following to adjust the instrument to the individual parameters of EMAT being used:

– Enter the SETUP mode.

– Select the "Probe" line and press the **F1** key (Test). The screen will display the message: "**PROBE ZEROING** - Take the probe in hand, and press ENTER".

– Not letting EMAT to contact the calibration sample, press the  key.

The screen will display the "Testing in process – Please wait…" message.

Wait for the "Testing process – Place the probe on zeroing sample and press ENTER" to appear on the screen.

– Install EMAT on the calibration sample of the instrument and press the key  .

The screen will display the "Testing in process – Please wait…" message.

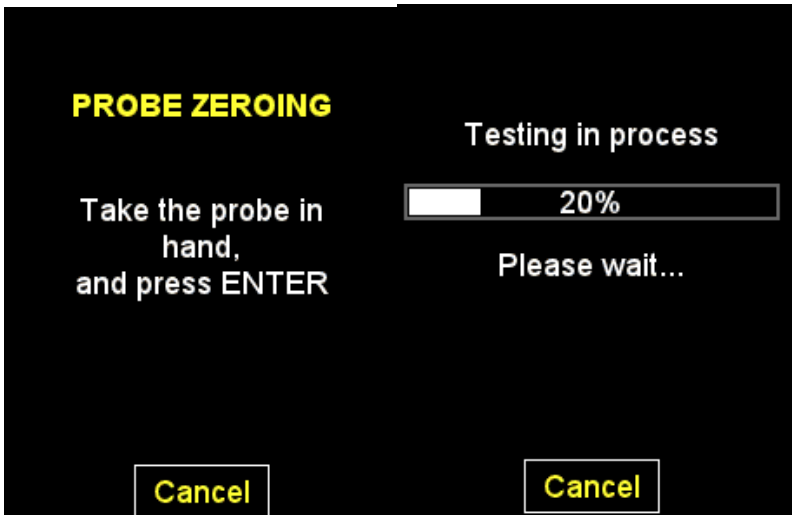
– Upon completion of the testing the message will be displayed informing on the results: a positive result with an indication of the thickness value of the calibration sample, or a negative result with the "Testing failed" message.

– Remove the transducer from the calibration sample.

– Press the key **F2** (OK). If the test result is positive, the instrument will switch into the measurement mode, if the test result is negative, the instrument will return to the main window of the SETUP mode.

At any step the testing procedure can be cancelled by pressing the **F2** key (Cancel), in that case the instrument will return to the main window of the SETUP mode.

Figure 17 presents a sequence of the screen layouts of the instrument during adjustment with a positive result.



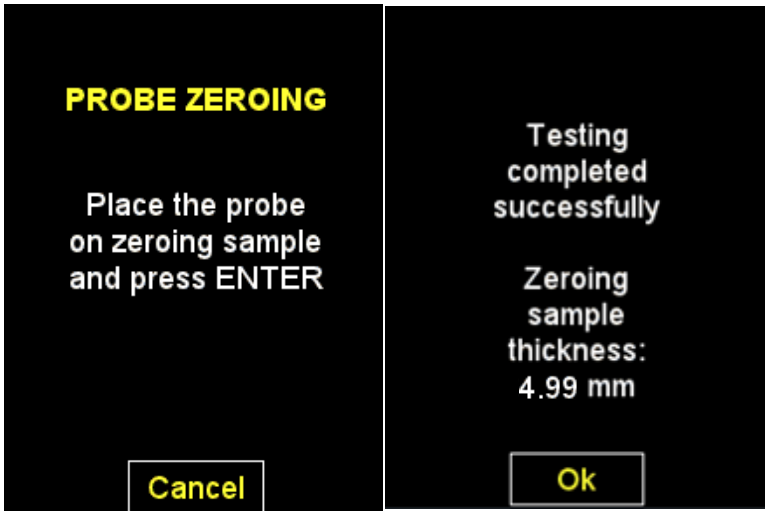


Figure 17

2.3 WORKING WITH THE INSTRUMENT

2.3.1 Working with the instrument

During inspection a temperature dependence of the ultrasound propagation velocity in chilled or heated materials. For the best measurement results the instrument must be adjusted to the ultrasound velocity by the calibration sample with the same temperature as of the temperature of the object being inspected.

2.3.2 SETUP mode

The SETUP mode includes a list of the editable parameters, EMAT testing procedures and procedure of velocity calibration with the sample, transfer of the data to PC, viewing the transducers' library, and operation with the materials' library.

All settings of the instrument will be saved after it is switched Off or the accumulator goes dead.

Screen appearance in the SETUP mode is presented in Figure 18.

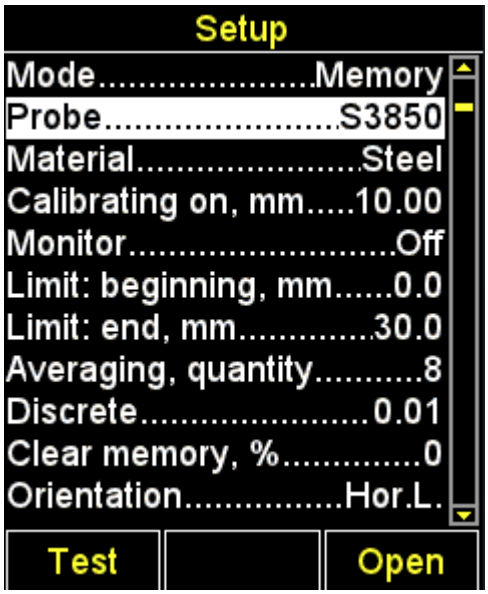


Figure 18

The keys being active in any of the menus of the SETUP mode:

 - scrolling the active line through the menu options, transition is carried out cyclically in both directions. The parameter highlighted by the active line becomes available for selection or editing;

 - decrease/increase the digital value of the selected parameter.

Menu options of the SETUP mode are common for all measurement modes, their corresponding parameters (in the metric measurement system) and functions are presented in Table 4.

Table 4

Menu option (parameter)	Parameter value	Description
Mode	Memory / A-SCAN	Selects the measurement mode
Probe	Name of EMAT	Enters the transducers' library. Starts the testing procedure of EMAT
Material	Name of the material	Enters the materials' library
Calibrating on, mm	from 2 to 80	Sets the sample's thickness. Starts the procedure of velocity calibration with the sample
Averaging, quantity	1 / 2 / 4 / 8 / 16	Increasing of the averaging value improves the noise/signal ratio by repeated summation of the signal in time
Discrete	0.01 / 0.1	Setting the result display discreteness
Orientation	Hor.L. / Vert / Hor.R.	Selects an orientation (layout) of the A-SCAN image on the display
Sound	On / Off	Control over the sound indication
Vibration	On / Off	Control over the vibration indication
Language	Russian / English	Selecting the interface language
Meas.unit	mm / inches	Selecting the measurement unit system

Menu option (parameter)	Parameter value	Description
Brightness, %	From 20 to 100	Setting the display brightness level

Additional menu options of the SETUP-MEMORY mode and their corresponding parameters (in the metric measurement system) and functions are presented in Table 5.

Table 5

Menu option (parameter)	Parameter value	Description
Monitor	Off / Outside/ Inside	Off – switching Off of the Monitor. Inside / Outside – Sets a criterion of the sound alarm respond if the measurement result is within the set limits (inside) or beyond them (outside)
Limit: beginning, mm	from 0 to 150	Sets the lower limit of actuation of the Monitor
Limit: end, mm	from 1.1 to 300	Sets the upper limit of actuation of the Monitor
Clear memory, %	from 0 to 100	Indication of the volume of the memory being used. Starts the procedure of deletion of the measurement results from the memory

Additional menu options of the SETUP - A-SCAN mode, their corresponding parameters (in the metric measurement system) and functions are presented in Table 6.

Table 6

Menu option (parameter)	Parameter value	Description
Scan start, mm	from 0 to 295	Sets start of the scanning
Scan end, mm	from 5 to 300	Sets end of the scanning
Gate: beginning, mm	from 0 to 300	Setting the lower boundary of the strobe
Gate: end, mm	from 0 to 300	Setting the upper boundary of the strobe

Menu option (parameter)	Parameter value	Description
Amplification, dB	from 0 to 40	Amplification setting
A-Scan image	Filling / Contour	Selects the appearance type of the signal in the A-SCAN mode

2.3.2.1 The MODE option

Select the measurement mode:

– MEMORY - with display of the measurement results stored in the memory on the instrument's screen;

– A-SCAN – with display of the signal in the form of A-Scan on the screen.

Active keys:

F1 (Memory) - selects the MEMORY mode;

F3 (A-Scan) - selects the A-SCAN mode;

 - sequential switching between the modes.

Screen appearance of the MODE option is presented in Figure 19.

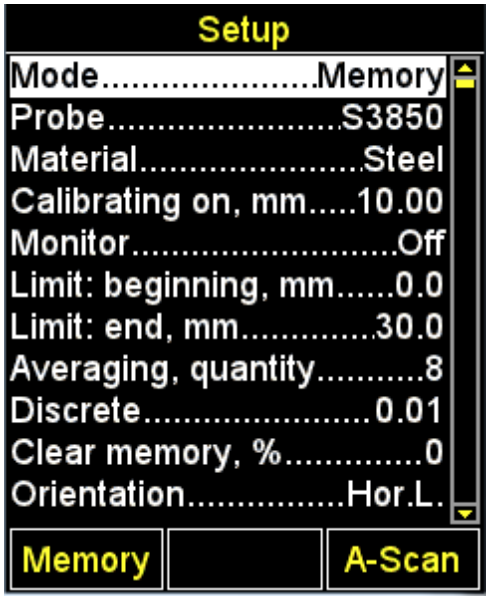


Figure 19

2.3.2.2 Probe option

– Enters the transducers' library.

Active keys:

F1 (Test) - starts the testing procedure of EMAT adjustment of the instrument to the selected transducer;

F3 (Open) or  - enters the transducers' library.

Screen appearance of the Probe option is presented in Figure 20.

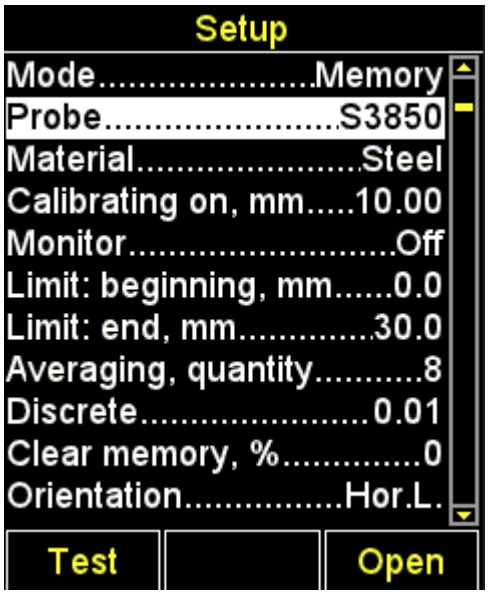


Figure 20

– Viewing the transducers' library.

The window header will show information on the EMAT being currently used - "Current probe:".

ATTENTION: USERS ARE PROHIBITED TO ADD THE TRANSDUCERS (PROBES) TO THE LIBRARY AND EDIT THE LIBRARY INDEPENDENTLY!

Active keys:

F1 (Test) – starts the procedure of adjustment of the instrument to the individual parameters of EMAT.

F2 (View) – provides viewing of detailed information on the transducer. The screen will display information on the name, type and frequency of EMAT.

F3 (Exit) – returns to the main window of the SETUP mode.

 - selects the transducer from the list, at that the testing procedure of EMAT adjustment to the instrument's parameters will be started automatically. Detailed description of the procedure is given in paragraph 2.2.3.2.

Upon exiting the library, the instrument will remember the line being active last and will set it upon the next library entry. Upon switching Off the instrument information on the active line of the library will be zeroed.

Figure 21 shows the appearance of the instrument's screen when viewing the transducers' libraries.

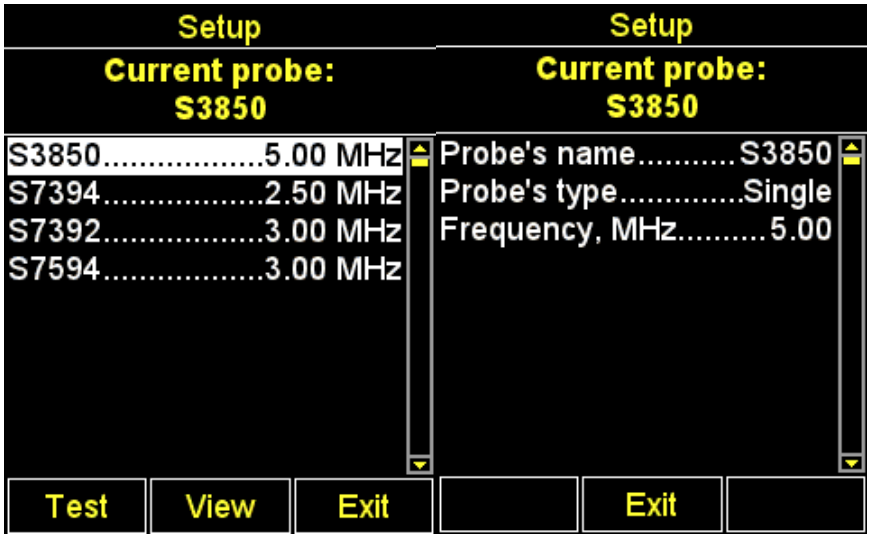


Figure 21

2.3.2.3 MATERIAL option

– Enters the materials' library.

Active keys:

F2 (Open) or  - enters the materials' library, to record new materials into the memory and edit the existing ones, and to select the material for operation.

Screen appearance of the MATERIAL option is presented in Figure 22.

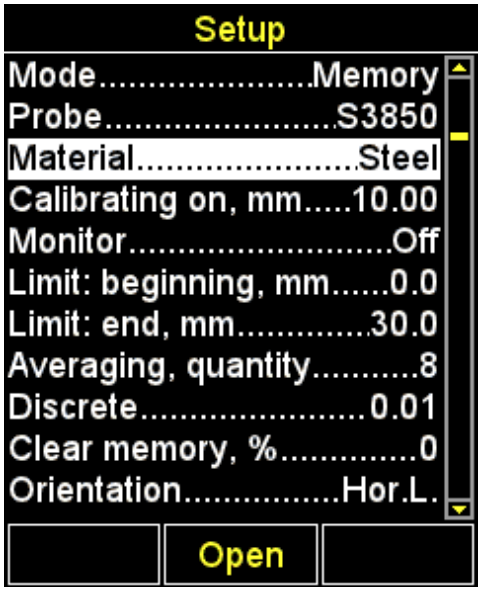


Figure 22

– Working with the materials' library.

Instrument's memory can information on 64 material types.

The window header shows information on the material currently used (current) and ultrasound velocity in it.

Creating new material.

The NEW menu option is listed the first in the menu, and then the following go: the names and propagation velocity of ultrasound waves in the material types recorded in the instrument's memory (Figure 23).

Figure 23

Active keys:

F1 (Create) - opens the editor of the material name (Figure 24).

F3 (Exit) - returns to the main window of the SETUP mode.

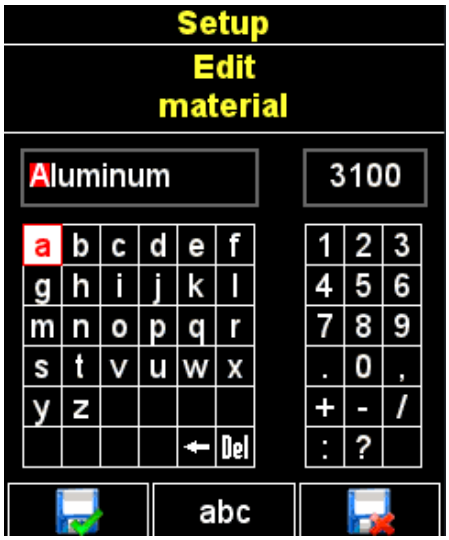


Figure 24

Active keys:

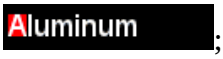
F1 () – Exits the editor saving the changes.

F2 (XXX) – Switching between the characters in the letter table: абв – Russian low-case characters, АБВ – Russian upper-case characters, abc – English low-case characters, ABC – English upper-case characters.

F3 () – Exits the editor saving the changes.

When the material is created or the existing material recorded in the instrument's memory is being edited, the screen will show a current name of the material with an inverse active character in the material field name, propagation velocity of ultrasound waves in the material and tables with the available characters.

Do the following to change the name of the material:

– By means of the keys  select the character to be deleted or changed in the line of the material name, for example **"A"** –  ;

– use the **F2** key to select the language and character case;

– By means of the keys  ,  ,  and  select a new character in the tables of the characters, for example **"B"** –  , deletion operation of the highlighted character –  or a character prior to the highlighted one –  , and press the key  .

Do the following to change the ultrasound propagation velocity in the material:

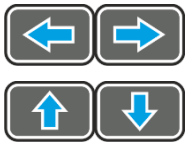
– By means of the keys  or  move the cursor into the velocity value field. When the velocity value becomes editable it will change its color from white  to red  and the value will start decreasing or increasing depending on the key which was used.

– By means of the keys  or  set the required velocity value of ultrasound  ;

– Press the key  , the velocity value will change its color to white, and the first character of the material name will become active  .

Table 7 contains description of the purpose of some keys when working in the material name editor.

Table 7

Key	Purpose
	Scrolling through the characters' table
	Selects a character to be edited in the material field name. Changes the velocity value

Key	Purpose
	Substitutes the active character with the character from the table. The next character will be active after substitution
F1 ()	Exits the editor saving the changes
F2 (XXX)	Switching between the characters in the letter table, where XXX: абв – Russian low-case characters АБВ – Russian upper-case characters abc – English low-case characters ABC – English upper-case characters
F3 ()	Exits the editor saving the changes

Editing information on the material.

Active keys:

F1 (Edit) - switches to the edit mode of information on the selected material. Editing process is similar to above-described creation of information on the material.

F2 (Delete) - deletes the material from the instrument's memory.

F3 (Exit) - returns to the main window of the SETUP mode.

 - selects the material for operation and returns to the main window of the SETUP mode.

Upon exiting the library, the instrument will remember the line being active last and will set it upon the next library entry. Upon switching Off the instrument the information on the active line of the library will be zeroed.

Screen appearance of the materials' library is presented in Figure 25.

Figure 25

Upon pressing the key **F2** (Delete) the following message will be displayed: "Remove material?" (Figure 26). You can confirm deletion by pressing **F1** (Yes), or cancel it by pressing **F3** (No).

Figure 26

2.3.2.4 The CALIBRATING ON Option

The CALIBRATING ON option is meant for determination of the ultrasound wave velocity in the material of known thickness.

Calibration sample thickness can be set within the interval from 2 to 80 mm

Screen appearance of the instrument of the CALIBRATING ON option is presented in Figure 27.

Active keys:

F1 (–) or  – decreases the thickness value of the calibration sample.

F2 (Run) - starts the procedure of velocity calibration with the sample.

F2 (+) or  – decreases the thickness value of the calibration sample.

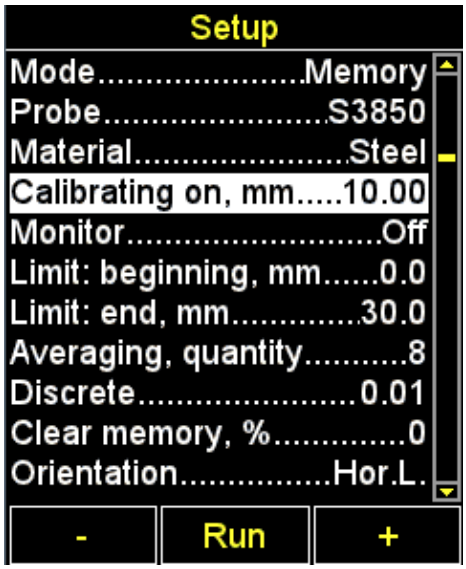


Figure 27

Setting the thickness of the calibration sample and a procedure of the velocity calibration with the sample.

Do the following to calibrate the velocity:

– Set the thickness of the sample.

– Start the procedure of velocity calibration with the sample.

– The screen will display the "Put the probe on calibrating sample and press ENTER" message.

– Apply some coupling liquid onto the sample.

– Place EMAT on the sample and press  .

– The screen will display the "Data acquisition on the sample thickness of XX.XX mm", message, where XX.XX is the set thickness of the sample.

– Current velocity measurement result will be displayed on the screen. After performing all measurements, the screen will display the velocity value and the "Save result?" message.

Figure 28 shows a sequence of the screen layouts (orientation) of the instrument during the calibration procedure.

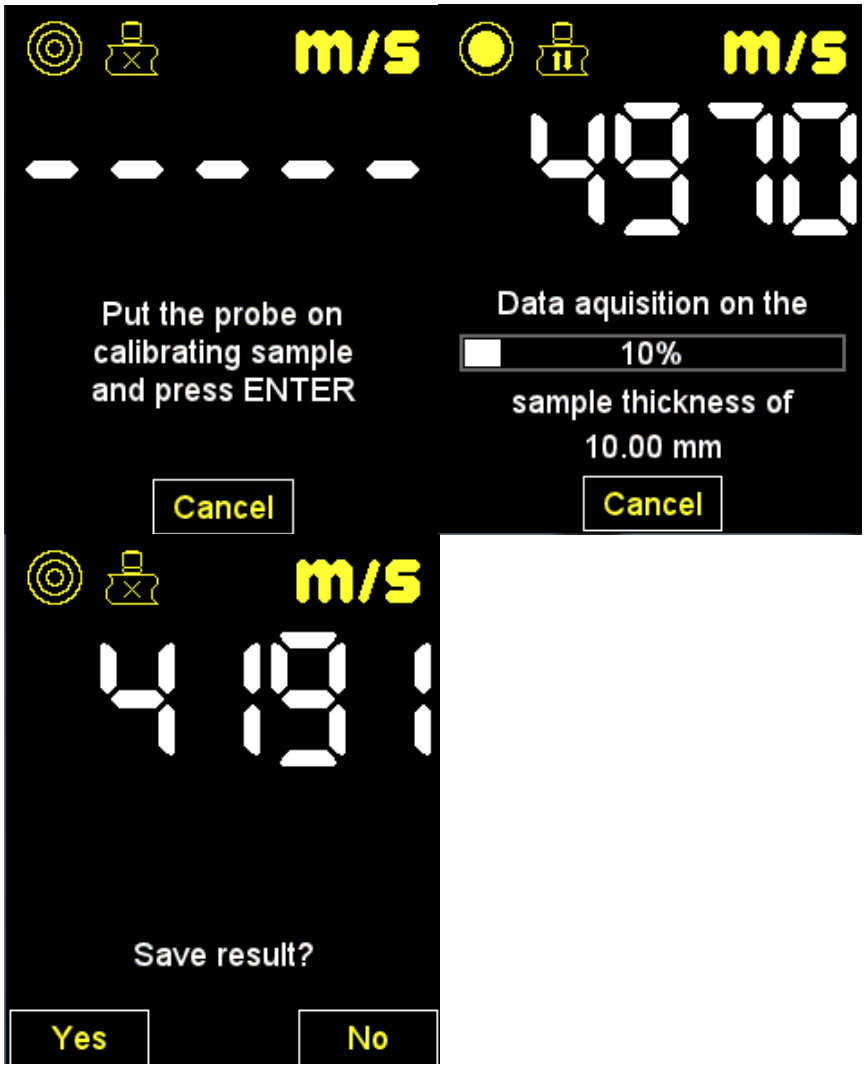


Figure 28

Saving the velocity value obtained during calibration.

Active keys:

F1 (Yes) - saving the obtained velocity value for the material existing in the library which shall be selected from the list of the materials, (Figure 29) or for the new material: select the "New" option, set the name of the material and press the key **F1** (Save) (Figure 30).

F3 (No) - exits not saving the result.

Figure 29

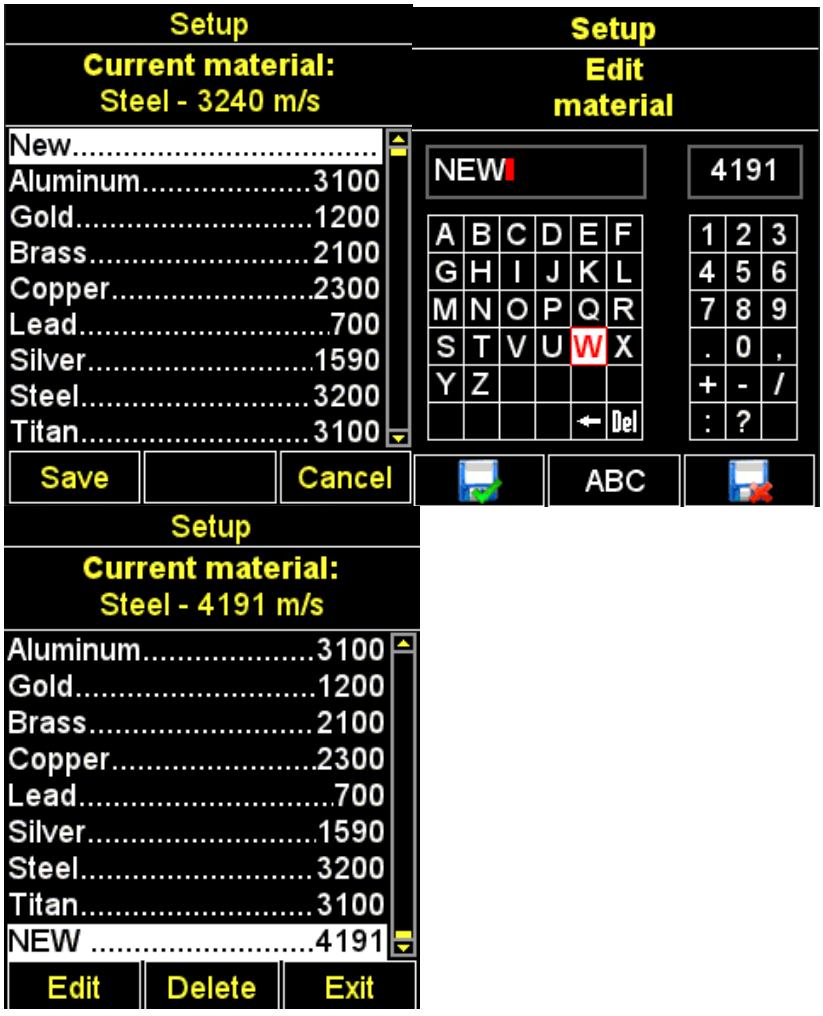


Figure 30

2.3.2.5 Monitor option (only for the MEMORY mode)

Setting the actuation conditions for color, sound and vibro-alarms during measurements.

Selecting the actuation condition:

INSIDE - the measurement result is within the specified range;

OUTSIDE - the measurement result is out of the specified range;

OFF - Monitor is Off.

Screen appearance of the instrument's Monitor option is presented in Figure 31.

Active keys:

F1 (Inside) - selecting the actuation condition INSIDE;

F2 (Off) - Monitor is Off;

F3 (Outside) - selecting the actuation condition OUTSIDE;

 - switching between the INSIDE / OFF / OUTSIDE options.

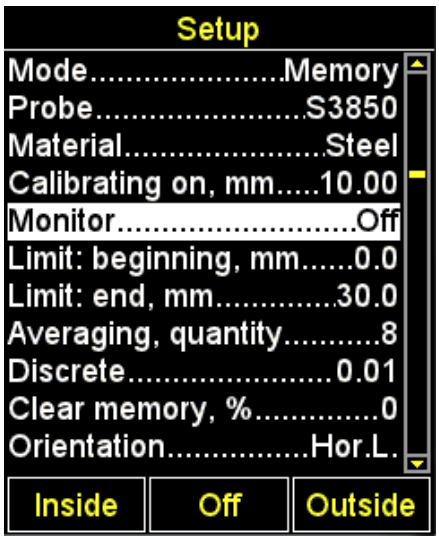


Figure 31

2.3.2.6 The LIMIT: BEGINNING option (only for the MEMORY mode)

Sets the lower limit of actuation of the Monitor.

Permissible values vary from 0 to 150 mm.

Screen appearance of the instrument's LIMIT: beginning option is presented in Figure 32.

Active keys:

F1 (–) or  – decreases the value of the lower actuation limit of the Monitor.

F2 (+) or  – increases the value of the lower actuation limit of the Monitor.

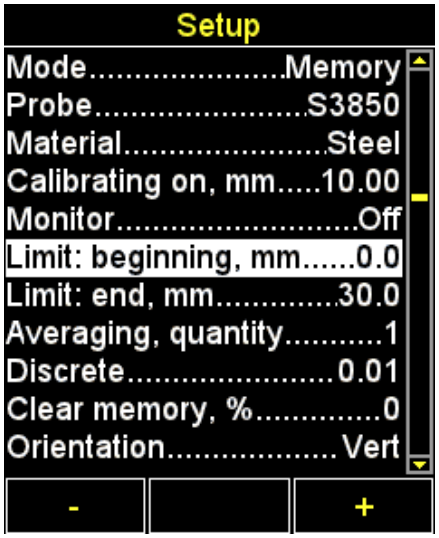


Figure 32

2.3.2.7 The LIMIT: end (only for the MEMORY mode)

Sets the upper limit of actuation of the Monitor.

Permissible values vary from 1 to 300 mm.

Screen appearance of the instrument's LIMIT: end option is presented in Figure 33.

Active keys:

F1 (–) or  – decreases the value of the upper actuation limit of the Monitor.

F2 (+) or  – increases the value of the upper actuation limit of the Monitor.

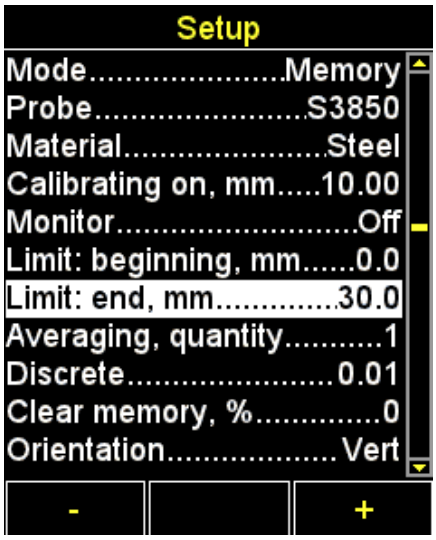


Figure 33

2.3.2.8 The AVERAGING, QUANTITY option

Setting the value of signal averaging.

Permissible values: 1. 2, 4, 8, 16.

Screen appearance of the instrument's AVERAGING, QUANTITY option is presented in Figure 35.

Active keys:

F1 (–) or  – decreases the averaging value.

F2 (+) or  – increases the averaging value.

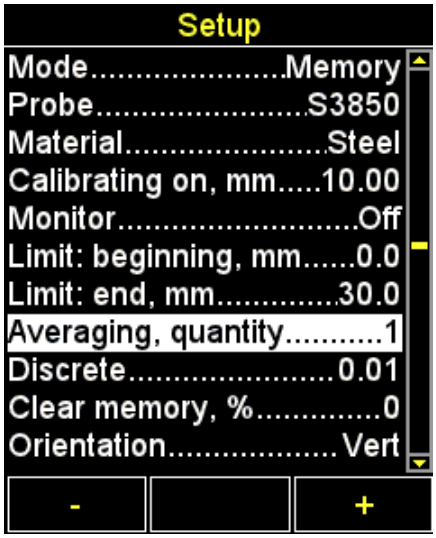


Figure 34

2.3.2.9 The DISCRETE option

Setting the discreteness of display of the image on the screen.

Screen appearance of the instrument's DISCRETE option (for the metric measurement system) is presented in Figure 35.

Active keys:

F1 (0.1) - setting the display of the measurement results with one decimal place;

F3 (0.01) - setting the display of the measurement results with two decimal places;

 - switching between the discreteness values from 0.1 и 0.01.

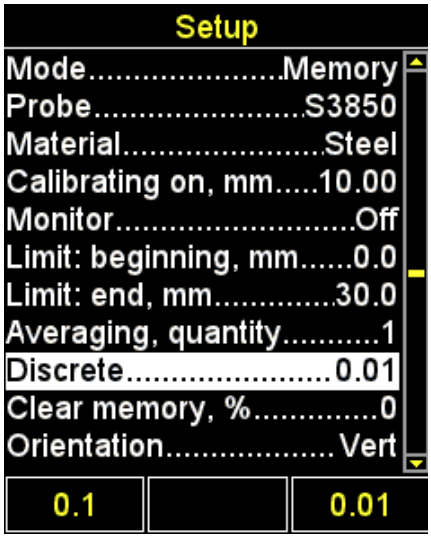


Figure 35

2.3.2.10 The CLEAR MEMORY option (only for the MEMORY mode)

Deleting the measurement results from the memory.

The filling percentage of the memory with the measurement results is specified as an option parameter.

Screen appearance of the instrument's CLEAR MEMORY option is presented in Figure 36.

Active keys:

F2 (Run) or  - starts the procedure of memory cleaning.

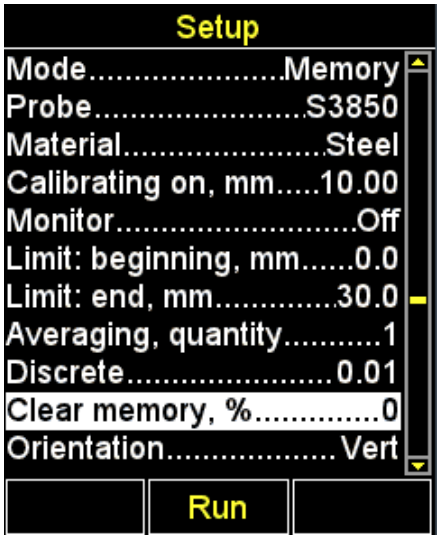


Figure 36

Upon start of the memory cleaning procedure the screen will display the "Saved data will be deleted. Continue?" message (Figure 37).

Active keys:

F1 (Yes) - confirms deletion of the data.

F3 (No) - cancels data deletion.

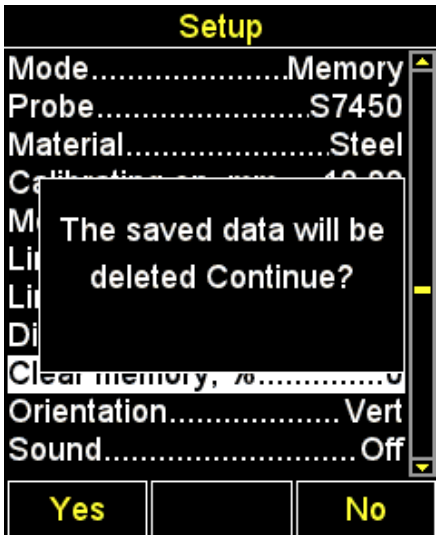


Figure 37

2.3.2.11 The SCAN BEGINNING (only for the A-SCAN mode)

The SCAN BEGINNING option is meant for setting the beginning (start) of the display area of A-Scan on the screen.

Value of the scan beginning can be set within the range from 0 to 150 mm.

Screen appearance of the instrument's SCAN BEGINNING option is presented in Figure 38.

Active keys:

F1 (–) or  – decreases the value of the scan beginning.

F2 (+) or  – increases the value of the scan beginning.

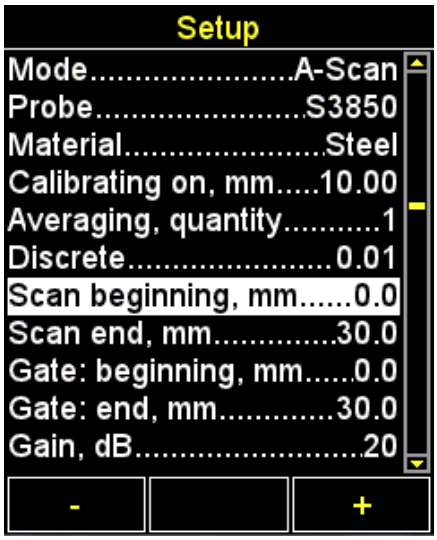


Figure 38

2.3.2.12 The SCAN END option (only for the A-SCAN mode)

The SCAN END option is meant for setting the end of the display area of A-Scan on the screen.

Value of the scanning (scan) end can be set within the range from 5 to 300 mm.

Screen appearance of the instrument's SCAN END option is presented in Figure 39.

Active keys:

F1 (–) or  – decreases the value of the scanning (scan) end.

F2 (+) or  – increases the value of the scanning (scan) end.

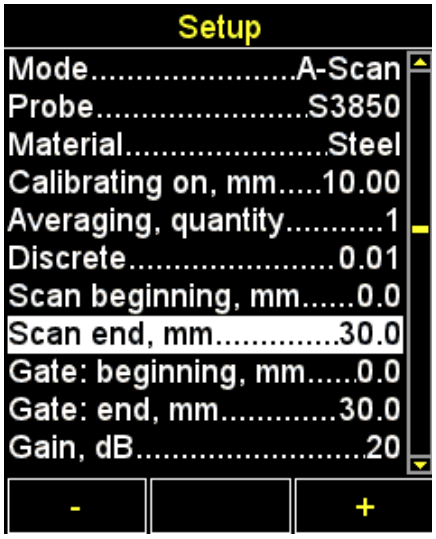


Figure 39

2.3.2.13 The GATE:BEGINNING (only for the A-SCAN mode)

The GATE:BEGINNING option is meant for setting the lower boundary of the strobe.

Value can be set within the range from 0 to 150 mm.

Screen appearance of the instrument's GATE:BEGINNING option is presented in Figure 40.

Active keys:

F1 (–) or  – decreases the value of the lower boundary of the strobe (gate).

F2 (+) or  – increases the value of the lower boundary of the strobe (gate).

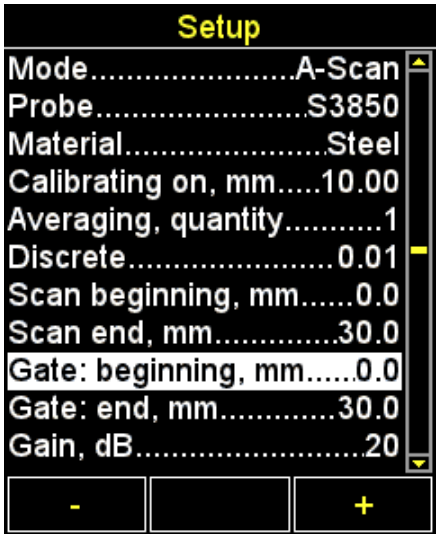


Figure 40

2.3.2.14 The Gate: end option (only for the A-SCAN mode)

The Gate: end option is meant for setting the upper boundary of the strobe.

Value of the gate end (end of the strobe) can be set within the range from 1 to 300 mm.

Screen appearance of the instrument's Gate: end option is presented in Figure 41.

Active keys:

F1 (–) or  – decreases the value of the upper boundary of the strobe.

F2 (+) or  – increases the value of the upper boundary of the strobe.

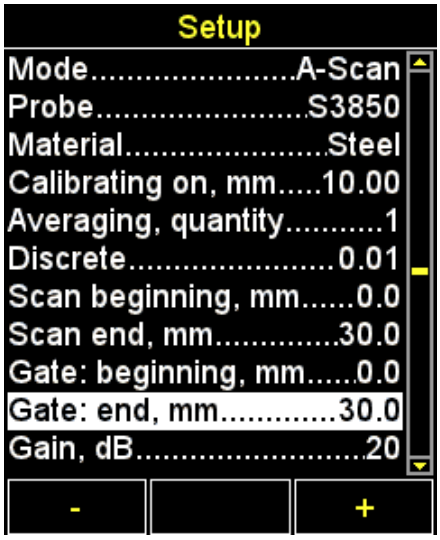


Figure 41

2.3.2.15 The Amplification option (only for the A-SCAN mode)

The Amplification option is meant for setting the amplification value of the instrument's receiving channel.

The amplification value can be set within the range from 0 to 80 dB.

Screen appearance of the instrument's Amplification option is presented in Figure 42.

Active keys:

F1 (–) or  – decreases the amplification value.

F2 (+) or  – increases the amplification value.

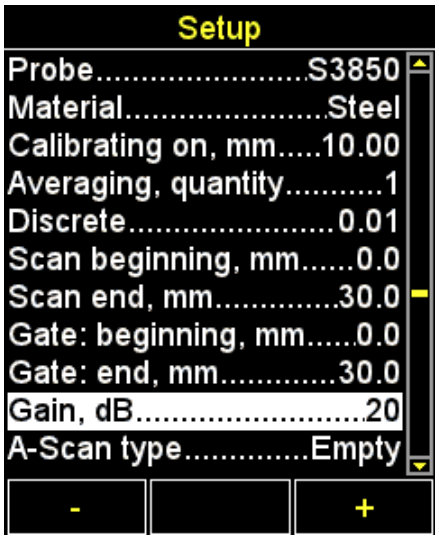


Figure 42

2.3.2.16 The A-SCAN TYPE option (only for the A-SCAN mode)

Selecting the appearance type of the signal display in the A-SCAN mode and when viewing the recorded A-Scans in the MEMORY mode – FILLING / CONTOUR.

Screen appearance of the instrument's A-SCAN TYPE option is presented in Figure 43.

Active keys:

F1 (Filling) - the detected signal is displayed in the filled form.

F3 (Contour) - the detected signal is displayed as a contour line.

 - switching between the signal display types.

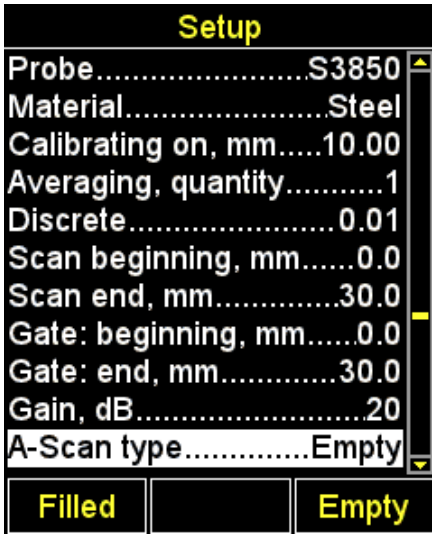


Figure 43

2.3.2.17 The ORIENTATION option

Selecting the image orientation type – Hor.R. / Vert / Hor.L.

Screen appearance of the instrument's ORIENTATION option is presented in Figure 43.

Active keys:

F1 (Hor.L.) – horizontal left.

F2 (Vert) – vertical.

F3 (Hor.R.) – horizontal right.

 - switching into the mode of automatic image orientation change depending on the instrument's position.

Figure 44

2.3.2.18 The SOUND option

Switching On/Off the sound indication of the instrument.

For convenient operation of the thickness gauge the main events of the thickness gauge during measurements, adjustment and key pressing are accompanied by sound indication. The sound indication as well is used for auditory monitoring of reception of ultrasonic signals. The sound signals inform the operator on the current processes not influencing the measurement results.

Screen appearance of the instrument's SOUND option is presented in Figure 45.

Active keys:

F1 (On) - switching On the sound indication.

F3 (Off) - switching Off the sound indication;

 - switching On/Off the sound indication.

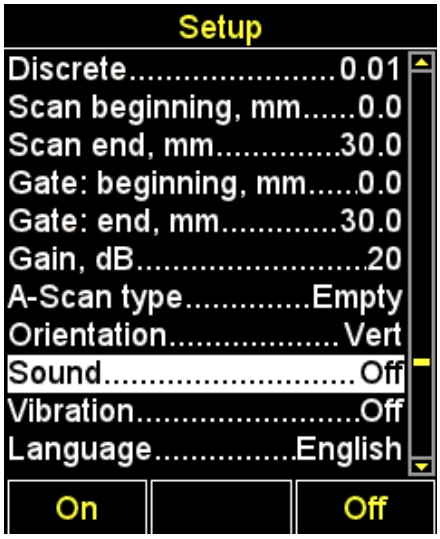


Figure 45

2.3.2.19 The VIBRATION option

Switching On/Off the instrument's vibration indication.

For convenient operation of the thickness gauge the main events of the thickness gauge during measurements, adjustment and key pressing are accompanied by vibration indication. The vibration indication as well informs the operator on the current processes not influencing the measurement results.

Screen appearance of the instrument's VIBRATION option is presented in Figure 46.

Active keys:

F1 (On) - switching On the vibration indication.

F3 (Off) - switching Off the vibration indication;

 - Switching On/Off the vibration indication.

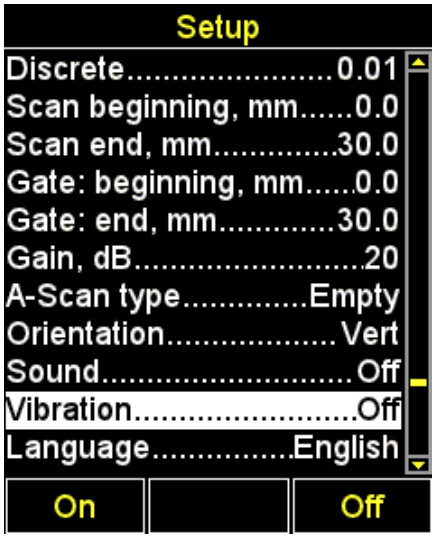


Figure 46

2.3.2.20 The LANGUAGE option

Switching between the instrument's interface languages:

– Russian;

– English;

– German;

– French;

– Italian;

– Portuguese;

– Spanish;

– Chinese.

Screen appearance of the instrument's LANGUAGE option is presented in Figure 47.

Active keys:

F1 (←) – selects the language by scrolling to the left;

F2 (Russian) – current language;

F3 (→) – selects the language by scrolling to the right;

 - sequential switching of the available interface languages.

Figure 47

2.3.2.21 The MEASURING UNITS option

Selects the measurement unit system - MM / INCHES.

Screen appearance of the instrument's MEASURING UNITS option is presented in Figure 48.

Active keys:

F1 (mm) - the metric measurement units. The thickness is displayed in mm, the velocity is displayed in в m/s.

F3 (inches) - the British measurement units. The thickness is displayed in inches; the velocity is displayed in inch/microsecond;

 - switching between the measurement unit systems.

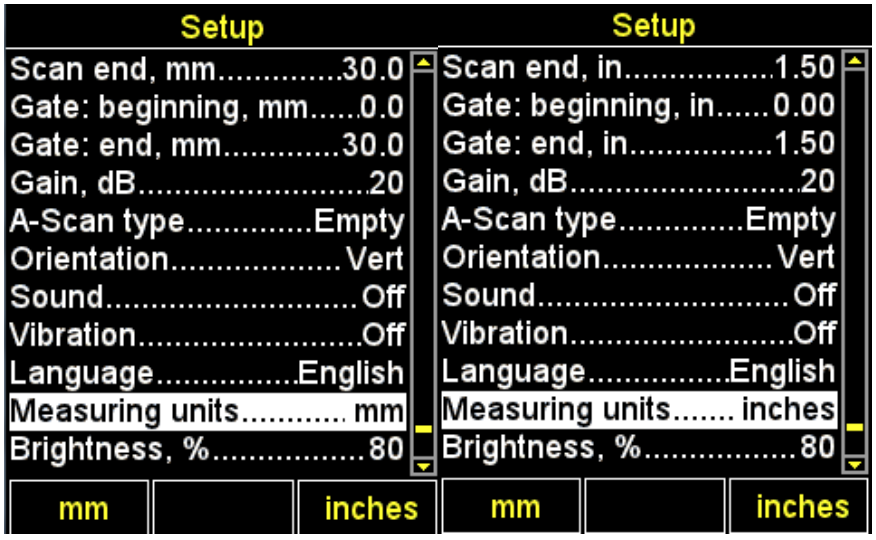


Figure 48

2.3.2.22 The BRIGHTNESS option

Setting the screen brightness within the range from 20 to 100 %.

Screen appearance of the instrument's BRIGHTNESS option is presented in Figure 49.

Active keys:

F1 (–) or  - decreases the screen brightness.

F3 (+) or  - increases the screen brightness.

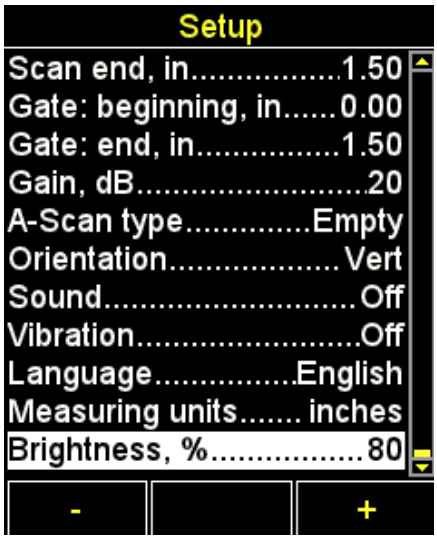


Figure 49

2.3.3 The MEMORY mode

In the MEMORY mode the screen is split into two parts: the upper part shows information on measurement (thickness, signal level, measurement method, velocity of ultrasound wave in the current material), the lower part shows information on the previously recorded results (groups, cells of the groups and thickness measurement results) (Figure 50).

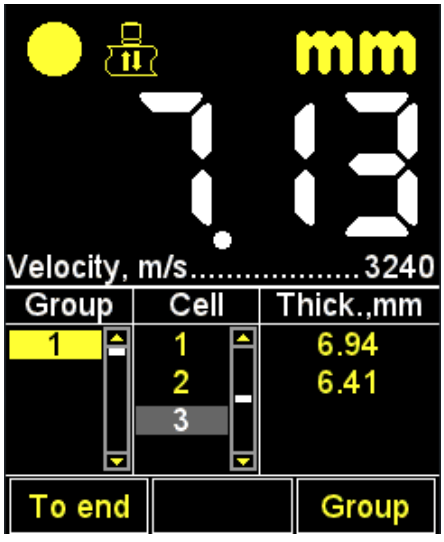


Figure 50

To perform the measurements, install EMAT on the object being inspected. The acoustic contact level indicator and the measurement method indicator will be displayed in the upper left corner.

If the sound indication is enabled in the menu of the Monitor, the changes of the readings will be accompanied by the quick sound signals.

Screen appearance if the actuation condition is Monitor-INSIDE or the Monitor-OUTSIDE is presented in Figure 51 (the measurement result is displayed in red if the Monitor's actuation condition is met, or in white if the Monitor's actuation condition is not met).

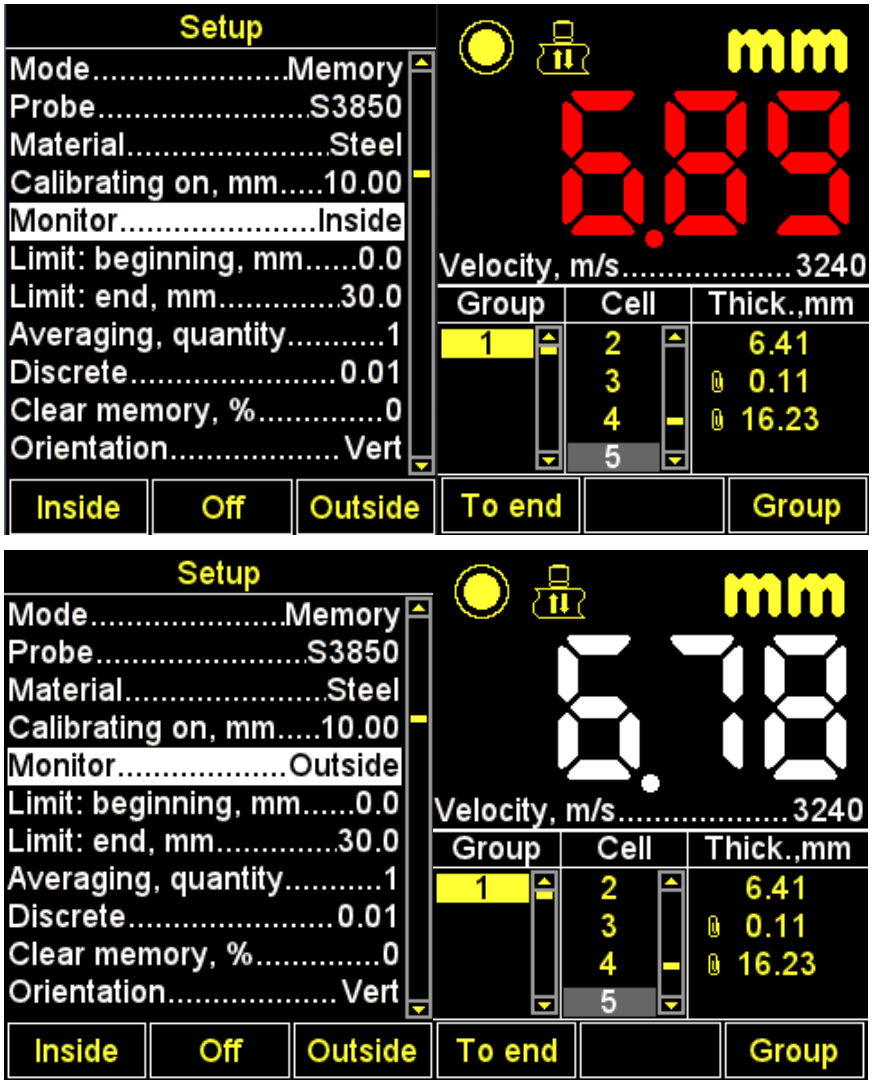


Figure 51

Active keys:

 - changes the velocity of ultrasound waves in the material.

If sound signals are emitted and the readings are changing on the screen, then fix the position of EMAT during 2-3 seconds and wait for stable readings.

ATTENTION: WHEN EMAT IS REMOVED FROM THE OBJECT BEING INSPECTED, THE MEASUREMENT RESULT WILL IMMEDIATELY CHANGE TO THE HORIZONTAL STROKES!

 - saves the current result.

N o t e – The result will be recorded into the first free cell of the last existing group.

You can correct the value recorded into the instrument's memory according to the instructions given in paragraph 2.3.3.3.

2.3.3.1 Adding new/deleting the last group

Upon pressing the key **F3** the instrument's screen will display the "Add new or remove the last group?" message (Figure 52).

Active keys:

F1 (–) - deletes the last group.

F2 (Cancel) - exits the procedure.

F3 (+) - adds a new group provided that the last existing group is not empty.

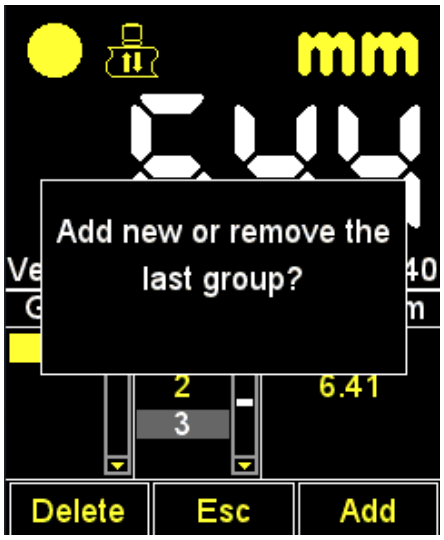


Figure 52

2.3.3.2 Saving the result

Measurement results are stored in the instrument's memory in the cells. The cells are organized into the groups. The groups and cells in the groups are identified by the sequence number numbers. The groups and cells in each group are numbered starting with "1".

Maximum quantity of the cells in the group is 500.

Maximum quantity of the groups is 100.

A corresponding explanatory text will be displayed by the instrument when the maximum quantity of the cells is reached in the group.

In practice recording the results into small groups can be more convenient (by several tens of values). You can create a new group when required (paragraph 2.3.3.1). If required, you can go back to any existing group and continue recording of the results into it.

2.3.3.3 Viewing and adjusting the measurement results

Any result recorded into the instrument's memory can be viewed and corrected if there are any doubts about its reliability. To correct the result, you have to conduct another measurement in the same point and re-record the low-quality value.

Key is used to enter the mode of viewing and editing of the results. Upon pressing the key, the character (Figure 53) will appear on the screen.

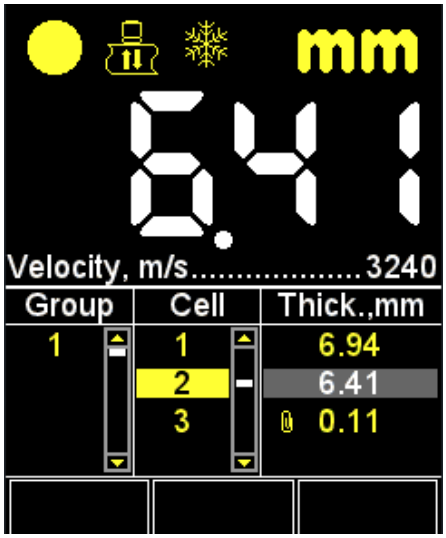


Figure 53

Key is used to return to the MEMORY mode.

Use the keys to view the recorded results. Scrolling through the measurement results is executed sequentially by the group cells, according to the selected view direction. When the last/first cell in the group is reached, the scrolling will switch to the next/previous group of the results correspondingly.

Do the following to correct the result:

– By means of the keys go to the cell with the result you want to correct;

– press the key , at that the character will disappear.

N o t e – In practice the result remains in the instrument's memory up to the moment a new value will be recorded to the selected cell. To go back to the view mode not changing the value recorded in the cell, press the key.

– perform the measurement and press the key when the result is satisfactory to record it into the cell selected to be corrected. Upon recording the instrument will automatically return to the view mode.

2.3.4 The A-SCAN mode

Thickness measurement in the A-SCAN mode represents an analysis of the image shape of the echo-signal obtained, a selection of the analysis interval and criteria for calculation of propagation time of the ultrasound impulses through the material of the object from one surface

to another one. This time is recalculated into the thickness value of the inspected object using the propagation velocity of ultrasound pulses in the material.

In the A-SCAN mode when working with the vertical orientation the screen is split into two parts: the upper part shows the signal in the form of A-Scan, and the lower part shoes the digital values of parameters and control icons (Figure 54).

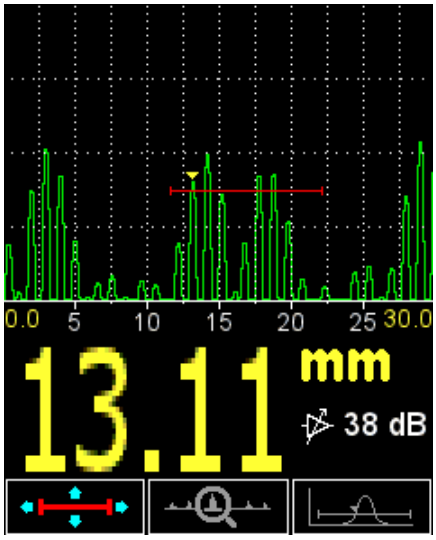
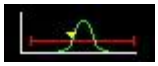
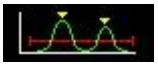
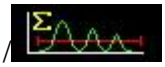


Figure 54

Main active keys:

F1 () – controls over the size and position of the strobe.

F2 () – controls over the signal display.

F3 ( /  /  / ) – selects the measurement method: by the maximal value in the strobe / by the first exceeding of the strobe by the signal / between two maximum values of the signal/ ACF by the strobe.

 - saving the measurement result.

N o t e – The result will be recorded into the first empty cell of the last existing group created in the MEMORY mode. To select the group and to view the recorded value, go to the MEMORY mode.

Table 8 contains description of the purposes of the keys for the first active icon.

Table 8

Key	Purpose
	Changes the length of the strobe relative to its left boundary
	Vertical movement of the strobe

	Horizontal movement of the strobe

Table 9 contains description of the purposes of the keys for the second active icon.

Table 9

Key	Purpose
	Changing the scanning length
	Changing the amplification value
	Horizontal scrolling of the signal on the screen

Table 1 0 contains description of the purposes of the keys for the third active icon.

Table 10

Key	Purpose
	Changing the amplification value

2.3.4.1 Saving the A-Scan

Upon pressing the  key the screen will display the message to be confirmed: "Save current A-Scan?" (Figure 55)

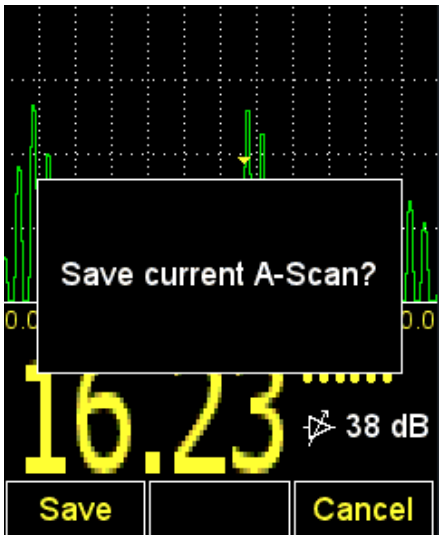


Figure 55

N o t e – The result will be recorded into the first empty cell of the last existing group created in the MEMORY mode. To select the group and to view the recorded value, go to the MEMORY mode.

Active keys:

F1 (Save) - saving the digital value of the measurement result and its A-Scan.

F3 (Cancel) - cancels saving.

2.3.4.2 Viewing the saved A-Scans

To view the saved A-Scans and their corresponding measurement results, go to the MEMORY mode. Data with the A-Scans saved in the measurement result column are specified by the  character. This character goes before the result value (Figure 56).

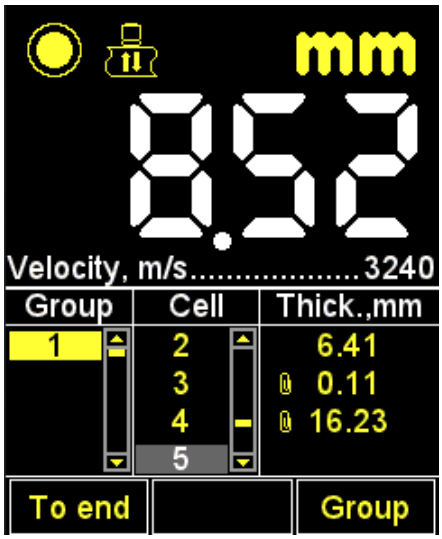


Figure 56

Press the  key to enter the view mode and press the **F2** key (A-Scan) (Figure 57).

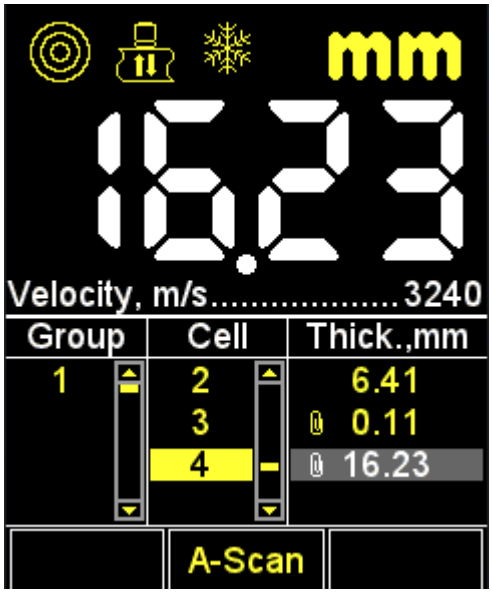


Figure 57

The A-Scan saved for the selected result will be displayed in the upper part of the screen (Figure 58).

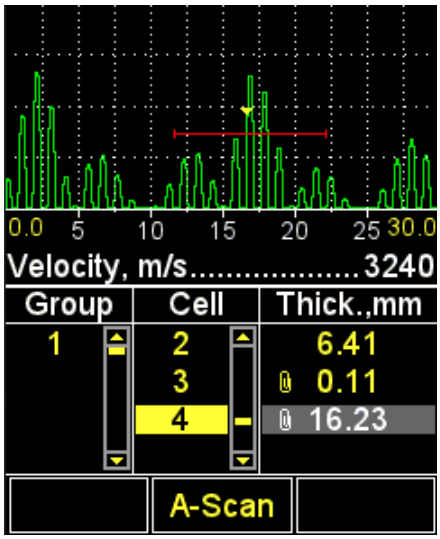


Figure 58

To return to the view mode of the results, press the **F2** (A-Scan) key.

The value recorded into the instrument's memory in the A-SCAN mode can be corrected in the MEMORY mode according to the instructions given in paragraph 2.3.3.3.

ATTENTION: DURING CORRECTION OF THE DIGITAL VALUE THE GRAPHIC IMAGE OF THE SIGNAL (A-SCAN) WILL BE LOST!

2.4 DOING MEASUREMENTS

Prior to thickness measurement select a transducer from the library, adjust the instrument and chose the material for measurement. If the set propagation velocity in the material defers from the real one, then configure the velocity manually or perform the calibration.

The accuracy of the settings directly influences the measurement accuracy. You can use the instrument's library of materials if the evaluation measurements are allowed.

If accurate results are required, then take the sample made of the same material as the object being inspected, and adjust the velocity using this sample. You have to adjust the velocity with the EMAT you will use for measurements. A plane parallel sample with smooth surfaces will be the best. Note that the highest thickness value of the sample (within the available range) and the best quality of its surface possible allow the best adjustment of the instrument to the ultrasound velocity in it.

A place where the transducer will be installed shall be clean, have no local defects complicating the installation of the transducer onto the surface. You cannot get the measurement results from a cavity if the transducer cannot be placed onto its bottom.

EMAT shall be installed perpendicular to the plane of the object being inspected. Don't force EMAT against the surface.

When EMAT touches the surface of the object being inspected a reliable acoustic contact of the transducer with the object is reached in a fraction of a second as a rule. At that the

instrument's screen will display readings which can slightly vary when inspecting the small-diameter pipes and the transducer is shaking a little. These redings remain stable when inspecting the flat objects.

Wait for 1-2 seconds after the readings are indicated to evaluate their stability. Afterwards leave the transducer on the surface of the object being inspected and read the measurement results on the instrument's screen or record them into the memory.

2.4.1 Functional check-out of the instrument during inspection

You may need to perform a functional check-out of the instrument during inspection if, e.g., you have a series of low-quality readings during the measurement.

The calibration sample built-in into the instrument is used to perform the functionality check. Its thickness is 5 mm, ultrasound propagation velocity in it is 3120 m/s.

Set the velocity value in the instrument to 3120 m/s and place EMAT on the sample. IF the instrument operates properly, the measured thickness value will be 5 mm taking into account the measurement uncertainty.

2.5 DATA TRANSFER TO PC

To transfer data recorded in the instrument to PC, connect the instrument to PC by means of the USB A – Micro B cable from the delivery kit.

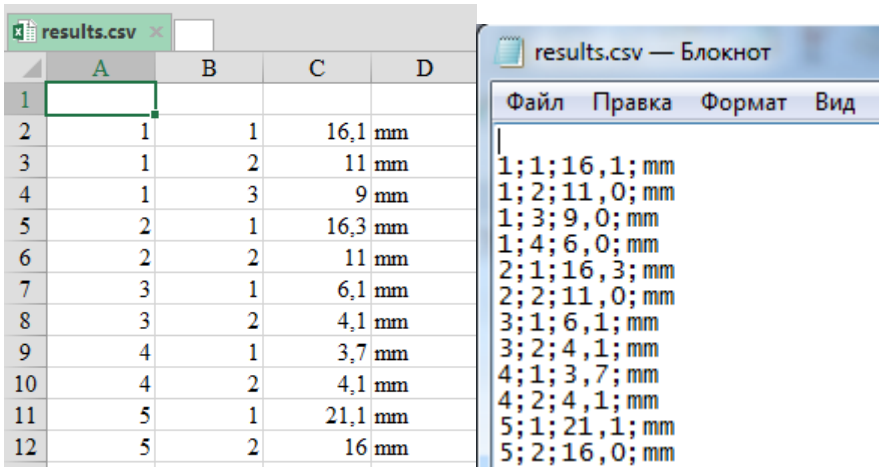
The operation system will detect the connected instrument as an external removable disk under the **ACSYS DISC** name. You can open its contents using the MS Windows Explorer or any file manager.

You can view the data opening the files directly from the instrument or copy the data to PC for further viewing.

You can name the copied data file as you like.

The ***digital data*** shall be stored in the instrument in the **CSV** format which is convenient for export to various applications **CSV** (in English the *CommaSeparatedValues* stand for the comma-separated values), thus allowing further analysis and processing of data by means of the external programs (Figure 59). Data shall be stored into a single file under the **results.csv** name. The results in the file are arranged sequentially according to the group number.

A-Scans shall be stored into the files under the name of the **aXXX-YYY.bmp** type, where **XXX** is a sequence number of the group, and **YYY** is a sequence number of the measurement in the group.



results.csv

	A	B	C	D
1				
2	1	1	16,1	mm
3	1	2	11	mm
4	1	3	9	mm
5	2	1	16,3	mm
6	2	2	11	mm
7	3	1	6,1	mm
8	3	2	4,1	mm
9	4	1	3,7	mm
10	4	2	4,1	mm
11	5	1	21,1	mm
12	5	2	16	mm

In the "MS Excel" program In the "Notepad" program

Figure 59 – Digital data displayed by the external programs

3 TECHNICAL MAINTENANCE

Technical maintenance of the thickness gauge represents cleaning the electronic unit from dust and dirty and charging the accumulator.

3.1 ACCUMULATOR

Instrument's accumulator is designed to be operated in a broad temperature range. At negative temperatures accumulator capacity decreases since at the lower value of the temperature range the capacity is by 15% less as compared with the normal temperature conditions.

If the accumulator goes dead the instrument will be switched off automatically.

The accumulator has a built-in protection against overcharge, over discharge, over current and over temperature.

The accumulator service life is designed for the whole guaranteed service life of the instrument.

The accumulator must be replaced by the service centers only.

ATTENTION: THE WARRANTY WILL BE VOIDED IF THE USER REPLACES THE ACCUMULATOR INDEPENDENTLY!

3.2 CHARGING THE ACCUMULATOR

The accumulator shall be charged via an external charger.

Accumulator charging time depends on the discharge level. Full charge time is 2 hours. Multiple recharging is allowed.

N o t e – You cannot conduct the measurements during charging.

ATTENTION: TO AVOID DAMAGE OF THE ACCUMULATOR DON'T STORE THE INSTRUMENT WITH THE DISCHARGED ACCUMULATOR!

3.3 TROUBLESHOOTING

Contact the representatives of the manufacturer if you have questions about operation of the thickness gauge to get assistance and consult the experts.

4 STORAGE

The thickness gauge shall be stored in the case included into the instrument's delivery kit. Storage conditions shall correspond to GOST 15150-69 (placement category 1).

The instruments should be shelf stored.

The arrangement of the instruments in warehouses shall enable their free movement by the personnel and unrestricted access to them.

Distance between the instruments and the walls, floor of the warehouse and other warehoused instruments shall be at least 100 mm.

Distance between the heating units in the warehouses and the instruments shall be at least 0.5 m.

The storage room shall be free from the current-conducting dust, admixtures of aggressive gases and corrosive vapors able to attack the instruments.

5 TRANSPORTATION

The thickness gauge should be transported in the case include into the instrument's delivery kit.

Transportation conditions with regard to the impact of the external environment climatic factors should correspond to storage conditions (placement category 5) according to GOST 15150-69.

The packaged instruments can be transported by any vehicle types for any distances without speed restrictions.

The packaged instruments shall be properly fastened in the transport vehicle. The packaged instruments shall be protected from precipitation and water splashes if the instruments will be transported by the open transport vehicle.

Packaged instruments should be properly and steadily fixed to prevent their hitting against one another and against vehicle walls during transportation.

Transportation conditions shall meet the technical requirements, rules and regulations applicable to each mode of transport.

If shipped by air transport, properly packed instruments should be placed in hermetically sealed and heated compartments.

If transportation conditions differ from the operation conditions, then the instruments shall be kept under normal climatic conditions for at least 2 hours prior to operation.

Electro-Magnetic Acoustic Thickness Gauge A1270

OPERATION MANUAL

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