

ELECTRO-MAGNETIC ACOUSTIC
THICKNESS GAUGE WITH THE
NOVEL ELECTRO-MAGNETIC
BIASING TECHNOLOGY



A1270 EMAT

OPERATION MANUAL



Acoustic Control Systems – Solutions GmbH
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CONTENTS

1 DESCRIPTION AND INSTRUMENT OPERATION	6
1.1 PURPOSE OF THE INSTRUMENT.....	6
1.1.1 Purpose and application range.....	6
1.1.2 Operating conditions.....	6
1.2 TECHNICAL SPECIFICATIONS.....	7
1.3 DESIGN AND OPERATION	8
1.3.1 Design	8
1.3.2 Operation principle.....	10
1.3.3 Operation modes.....	10
1.3.4 Display	11
1.3.5 Keypad.....	15
2 PROPER USE	16
2.1 OPERATING RESTRICTIONS.....	16
2.2 MAKING THE INSTRUMENT READY FOR OPERATION.....	16
2.2.1 Connecting the transducers	16
2.2.2 Switching On/Off the instrument.....	16
2.2.3 Configuring and adjusting the instrument to the parameters of the EMAT being used.....	17
2.3 WORKING WITH THE INSTRUMENT	20
2.3.1 Working with the instrument.....	20



2.3.2 SETUP mode.....	20
2.3.3 The MEMORY mode	44
2.3.4 The B-SCAN mode	47
2.3.5 The A SCAN mode	49
2.4 DOING MEASUREMENTS	52
2.4.1 Functional check-out of the instrument during inspection	52
2.5 DATA TRANSFER TO PC	53
3 TECHNICAL MAINTENANCE	54
3.1 ACCUMULATOR	54
3.2 CHARGING THE ACCUMULATOR	54
3.3 TROUBLESHOOTING	54
4 STORAGE	55
5 TRANSPORTATION	56

The current Operation Manual (hereinafter referred to as “the operation manual”) contains technical specifications, description, and operation principle of the AI270 Electro-Magnetic Ultrasonic 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 the operation manual before starting to work with the instrument.

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

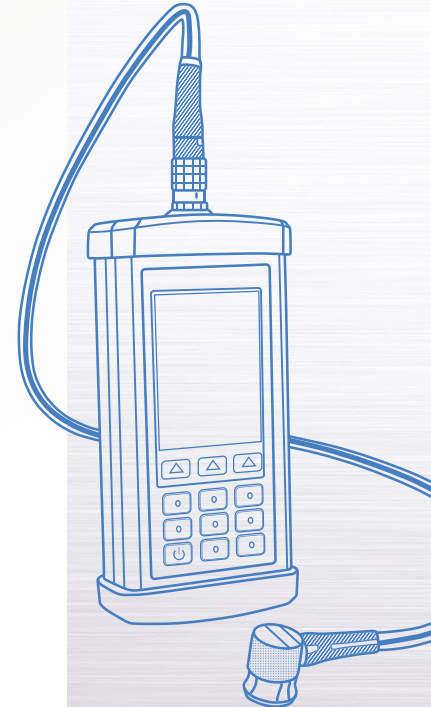
To perform the correct ultrasonic inspection the inspection tasks must be determined, the inspection schemes must be selected, the transducers must be chosen and inspection conditions for such materials must be evaluated.

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

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Operation Manual



1

DESCRIPTION AND INSTRUMENT OPERATION

1.1 THE INTENDED USE OF THE INSTRUMENT

1.1.1 Intended use and application range

The instrument is a portable ultrasonic thickness gauge of general purpose.

The instrument is designed for measurement of thickness of parts and walks of steel tubes and objects made of steel and metal alloys without the use of 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 the 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 for rotation of the image layout by 90° right and left in the operation modes.

The measurement results can be recorded in the memory of the instrument and then transferred to PC for processing, analysis and storage.

The instrument communicates with a PC via the USB port.

1.1.2 Operating conditions

The instrument is designed to work under the following conditions:

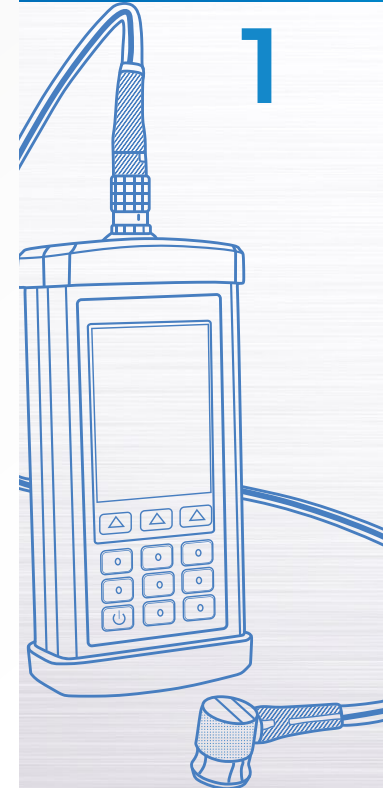
- ambient air temperature range from -30° to $+50^{\circ}$ C;
- relative air humidity up to 95% at $+35^{\circ}$ C.

1.2 TECHNICAL SPECIFICATIONS

The main technical specifications of the device are listed in the Table 1

Table 1

Parameter	Value
Range of the thickness for measurement, mm: for steel for aluminum	from 0.8 to 100.0 from 1.0 to 100.0
Limits of permissible absolute measurement error of thickness, where H is the thickness being measured	$\pm(0.01 \cdot H + 0.1)$
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 the ultrasonic sound velocity, m/s	from 1 000 to 9 999
Setting range of operation frequencies, MHz	from 2.5 to 5.0
Power source	rechargeable battery
Rated battery voltage, V	13.2
Period of continuous operation of the instrument powered by the battery under normal environmental conditions, min, h	9
Overall dimensions of the electronic unit, max., mm	190x87x40
Maximum weight of the electronic unit, g	900
Mean time between failures, h	18 000
Average service life, min., years	5



Operation Manual



1

1.3 DESIGN AND OPERATION

1.3.1 Design

The instrument is an electronic unit (Figure 1) to which replaceable electromagnetic ultrasonic transducers (EMAT) are connected via cables. Two rubber plugs are installed in the upper and lower end surfaces of the instrument.

A color TFT display is located in the upper part of the screen of the electronic unit. The measurement results and operation information required for the instrument control are shown on the display. The display is used for a visual monitoring of the measurement process via the color-coded indication.

A membrane keypad under the display allows to use the instrument functions.

The upper end surface of the electronic unit bears a connector for EMAT, and a 5 mm thick calibration sample D16T made of aluminum alloy D16T. The propagation velocity of ultrasonic waves in the calibration sample is 3120 m/s. The sample is used for adjustment of the instrument to the connected EMAT, as well as for quick evaluation of the instrument performance (Figure 2).

Calibration
sample

Red mark on
the connector

Red mark on
the cable



Figure 2



Figure 1

On the lower end surface of the electronic unit there is a lug for the belt, USB Micro B connector used for the USB connection of the communication cable to a PC, and a connector for connection/disconnection of the power adapter to charge the built-in battery (Figure 3).

Note: During the charging no measurements are possible.


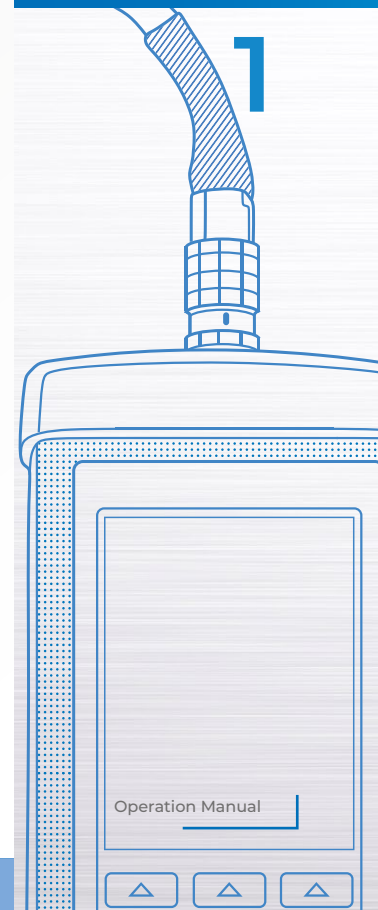
The "Micro B" connector of the USB cable shall be connected by the  symbol and/or the "B" letter facing upward (Figure 4)

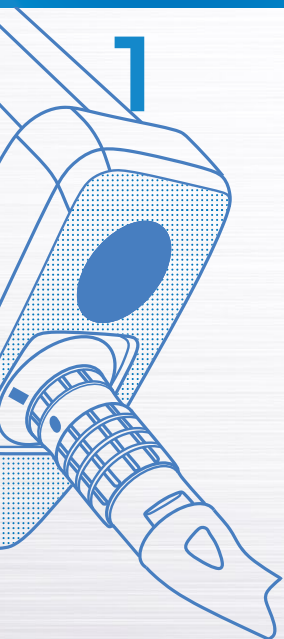


Figure 3



Figure 4





1.3.2 Operation principle

The operation principle of the instrument is based on the measurement of time required for the double traverse of ultrasonic waves through the inspected object from one surface to another, which is further recalculated into the thickness value.

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

1.3.3 Operation modes

The operation modes of the thickness gauge are as follows:

- MEMORY is the measurement mode with the indication of the recorded results;
- B SCAN is the measurement mode with the graphical indication of the profile testing object;
- A SCAN is the measurement mode with the graphical signal indication;
- SETUP is the mode for settings and selection of the measurement parameters.

The instrument allows for recording of the results in its memory when operated in any of the measurement modes.

In the MEMORY mode the thickness gauge allows for the prompt detection of thickness of the inspected object; it allows the operator to view the recorded measurement results on the display, edit the recordings by means of additional measurements and record the obtained data in the correctable memory cells.

The A-SCAN mode allows the elimination of false readings caused by the presence of discontinuities in the material of the inspected object. In this mode the signals are displayed in the form of an 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. It is also





possible to view the selected sections of the signal, current parameters and settings, record the A-SCAN image together with the measurement result in the present mode.

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

1.3.4 Display

In all operation modes the upper line on the display indicates the information on the current operation mode of the instrument and its battery charge level. Different icons of the operation mode are listed in the Table 2.

Table 2

Tab	Operation mode
	MEMORY
	B-SCAN
	A-SCAN
	SETUP

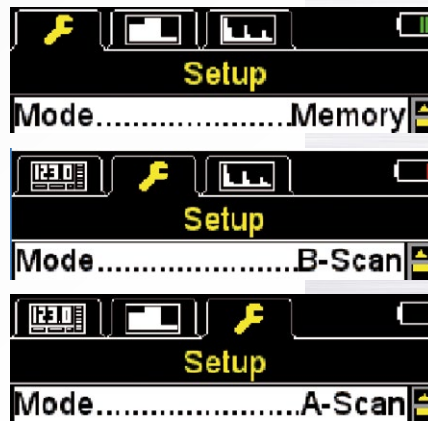
The icons of the measurement modes always go from left to right as follows: MEMORY–B-SCAN A SCAN. The icon of the active mode is highlighted (Figure 5).

When going to the SETUP mode, the setup icon is indicated on the display, the icon of the previous mode is no longer active, the parameters and settings of the mode can now be edited (Figure 6).

Figure 5

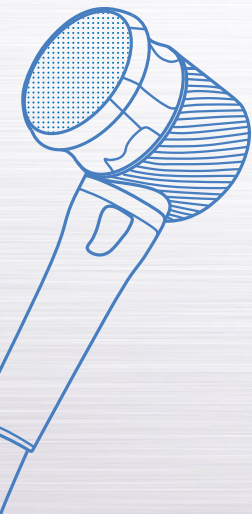


Figure 6












1



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

Table 3 description of indicators of the ultrasonic contact and measurement method.

Table 3

Indicator	Description
	Maximum signal level, the amplification of the receiving channel is set to the minimum value
	Average signal level, the amplification of the receiving channel is set to the average value
	Minimum signal level, the amplification of the receiving channel is set to the maximum value
	The signal is missing or insufficient for measurements
	No measurements
	Measurement using the ACF method
	Measurement using the threshold method

The display of the thickness gauge in the MEMORY mode is shown in the Figure 7.
The display of the thickness gauge in the B-SCAN mode is shown in the Figure 8.

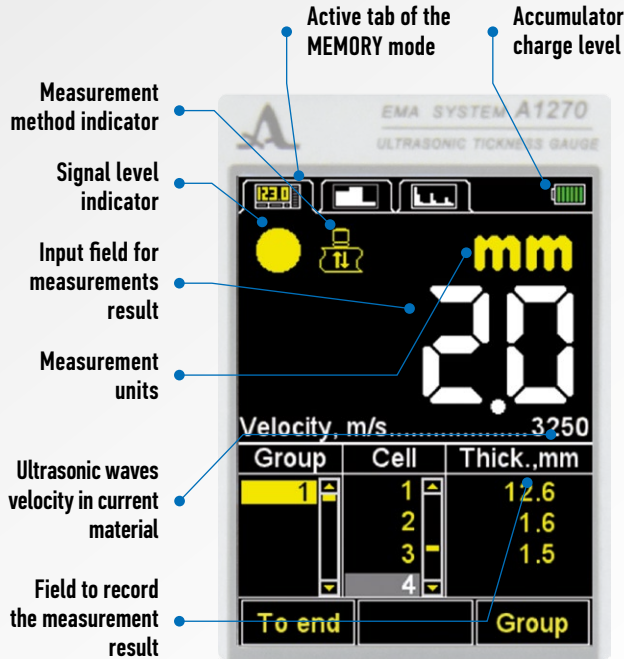


Figure 7

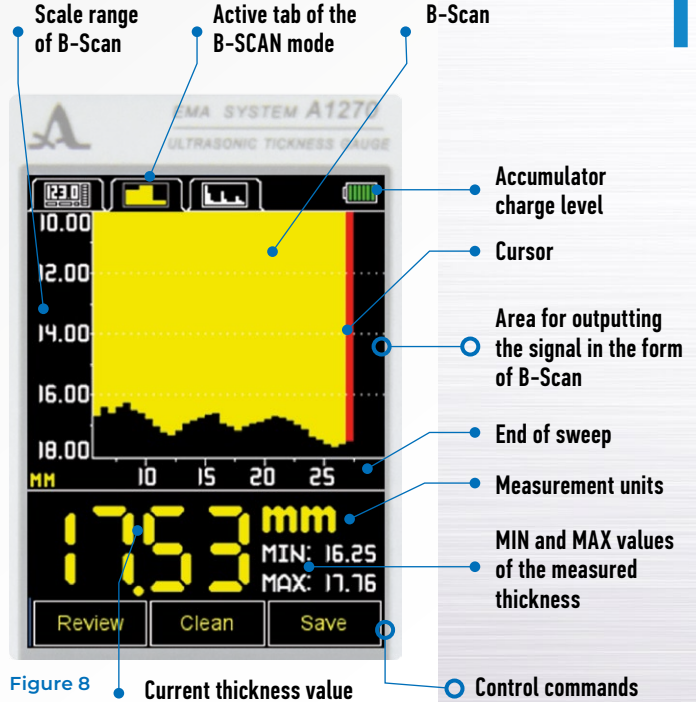


Figure 8

1



1

The display of the thickness gauge in the A-SCAN mode is shown in the Figure 9. In the A-SCAN mode the graphic image of the echo-signal, digital value of the measurement result, information on the measurement units and signal amplification are displayed. The check icons are located in the lower part of the screen.

The instrument allows to rotate the image by 90o to the right or to the left in the operation mode.

Depending on the selected image layout the display indication changes:

- vertical;
- horizontal left;
- horizontal right.

The view of the display in the A-SCAN mode with an enabled horizontal left display layout (orientation) is shown in the Figure 10.

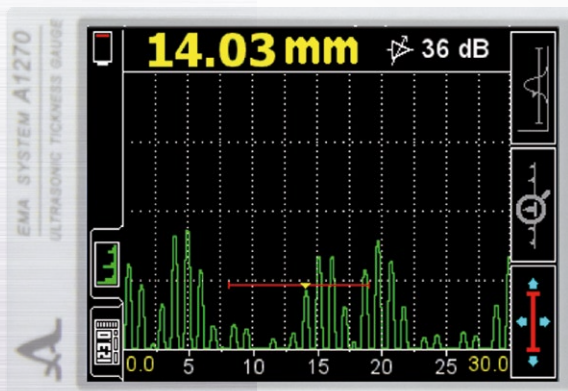


Figure 10

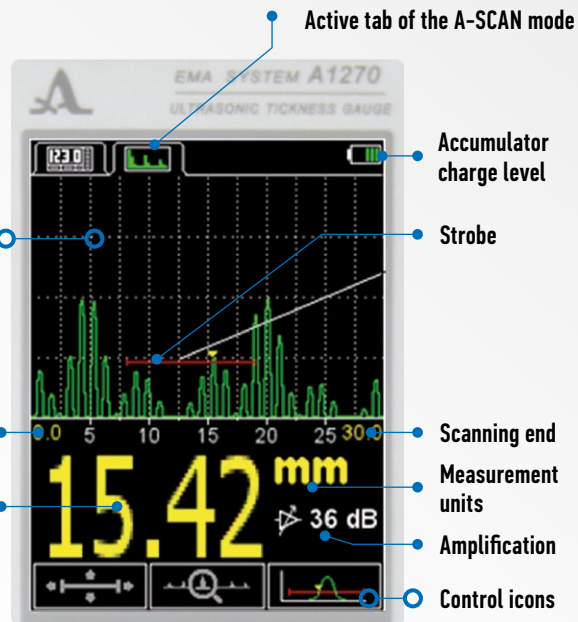



Figure 9

1.3.5 Keypad


The keypad (Figure 11) has 11 functional keys and the On/Off key.


Main functions of the keys:

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

ATTENTION: IF NO KEY IS PRESSED AND NO MEASUREMENT IS PERFORMED WITHIN 10 MINUTES THE INSTRUMENT WILL BE AUTOMATICALLY SWITCHED OFF.

ATTENTION: IN 2 MINUTES THE DISPLAY BRIGHTNESS WILL AUTOMATICALLY BE SET TO THE MINIMAL LEVEL – 5%, IF NO KEY IS PRESSED AND NO MEASUREMENT IS PERFORMED!

- The functional keys  (F) perform various functions depending on the selected operation mode of the instrument. The name of the current function is displayed under each key. The number of the functional keys is as follows, from left to right: F1, F2, F3 (Figure 12).

- The  key switches between the measurement modes and the SETUP mode and back.

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







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

Figure 12



Figure 11





2

PROPER USE

2.1 OPERATING RESTRICTIONS

The instrument is designed to be operated under conditions listed in paragraph 1.1.2.

2.2 PREPARING THE INSTRUMENT FOR OPERATION

2.2.1 Connecting the transducers


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

Two types of the transverse wave EMATs are used with the instrument - with a radial and linear polarization based on the pulsed electromagnet technology. EMAT S3850 5.0A0D8ES with the radial-type polarization and an electric solenoid are included in the basic delivery kit.

EMAT S7392 3.0A0D10ES and S7394 2.5A0R10x10ES with permanent solenoid can be connected to the electronic unit of the instrument using 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.

On the startup screen the name of the instrument and the hardware version will be displayed for several seconds (Figure 13).

The thickness gauge will automatically switch to the last active mode with corresponding settings before the instrument was switched off.

Note: In case the same transducer used prior to the last shutdown is connected to the instrument, the instrument is immediately ready for operation.

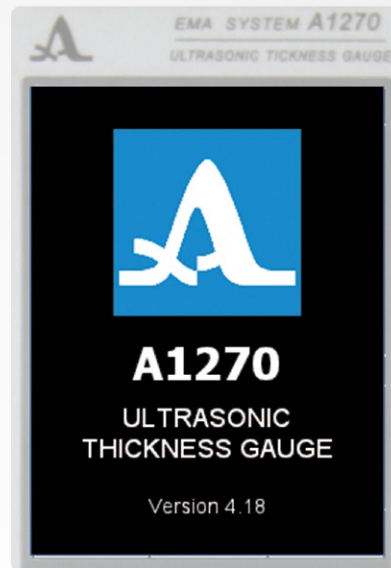



Figure 13

If another transducer is connected, please adjust the instrument for operation using the new transducer.

Press the  key manually to switch Off the instrument. The instrument will also be automatically switched off, if no key is pressed for 10 minutes or no other measurements are performed.

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 used EMAT parameters

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

Otherwise the instrument will not operate. Any attempt to switch to one of the measurement modes will display the "Run probe test" warning message (Figure 14) on the screen.

2.2.3.1 Selecting the transducer

Do the following to select the transducer:

- press the  key to enter the SETUP mode.
- using the keys   go to the Probe option and press the F3 key (Open) or  to enter the library of the transducers (probe) (Figure 15).
- Using the keys   go to the line with the name of the connected probe (transducer) and press the key  to select it (Figure 16).

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

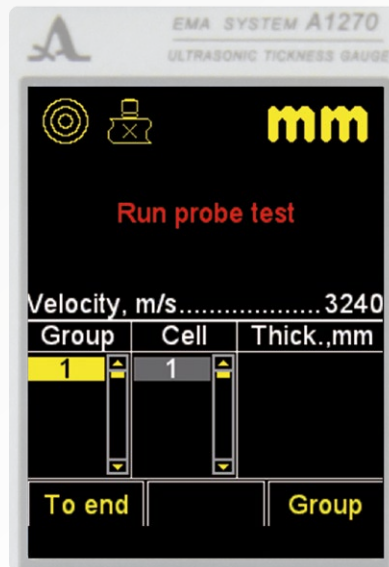


Figure 14

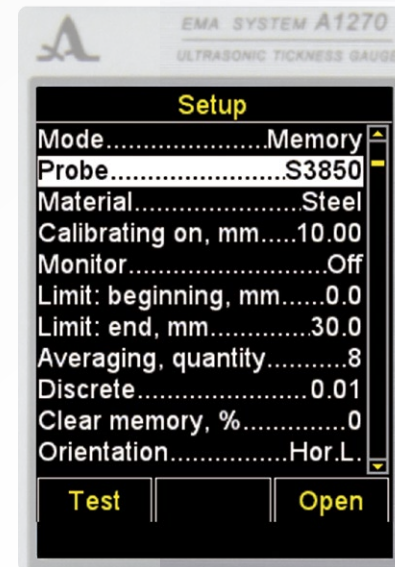


Figure 15

2

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

The adjustment is divided into 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 integrated in the instrument.

- to adjust the instrument to the individual used EMAT parameters:
- 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 and holding it in your hands press ENTER".

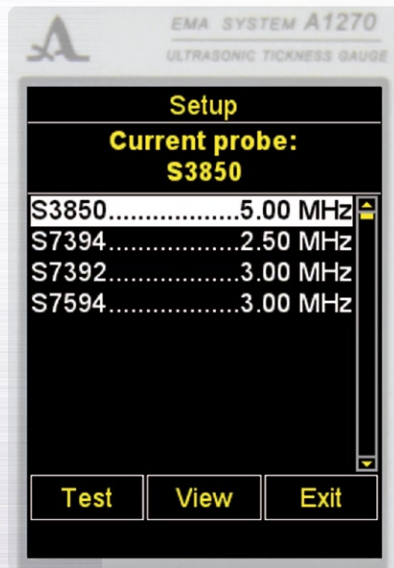




Figure 16

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

The message "Testing in process - Please wait..." is displayed on the screen.

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 message "Testing in process - Please wait..." is displayed on the screen.

- 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 message "Testing failed".

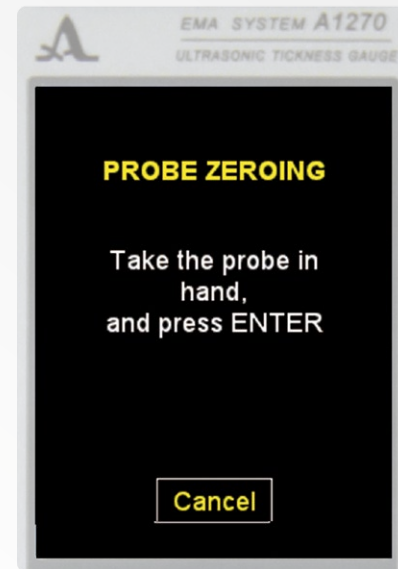


Figure 17

- 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 different window during adjustment with a positive result.

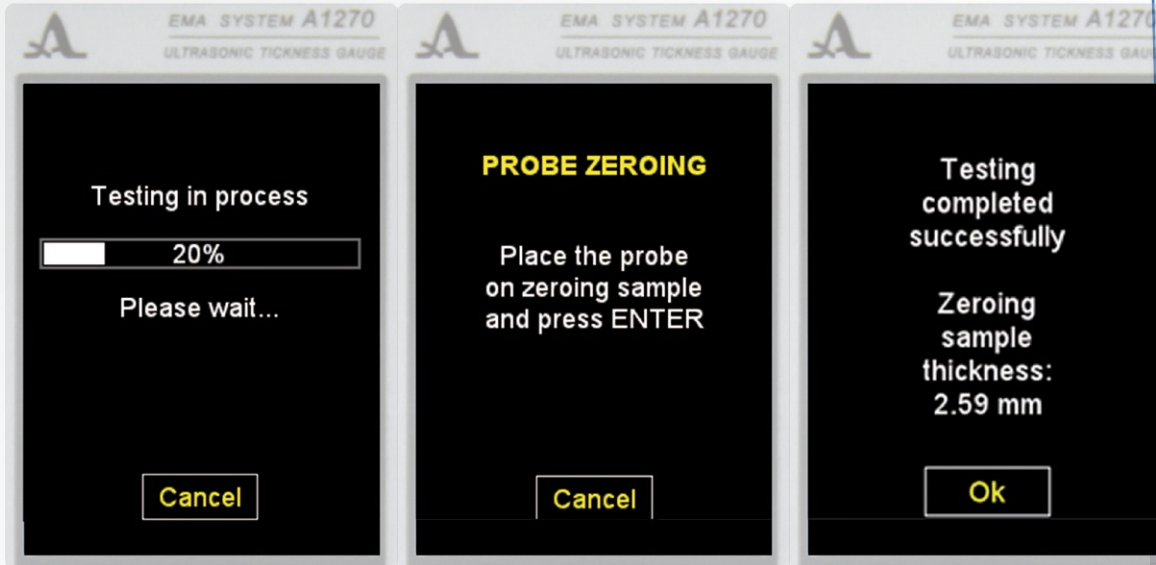
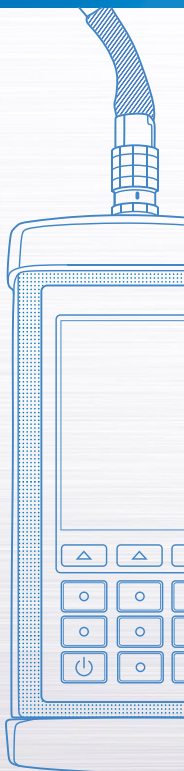


Figure 17

2



2.3 USING THE INSTRUMENT

2.3.1 Working with the instrument

During the inspection the temperature dependence between the ultrasonic propagation velocity in cooled or heated materials shall be considered. For the best measurement results the instrument must be adjusted to the ultrasonic velocity by the calibration sample with the same temperature as the temperature of the inspected object.



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 library of the transducer and operation with the library of materials.

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

The screen in the SETUP mode is shown in the Figure 18.

The active keys 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.

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

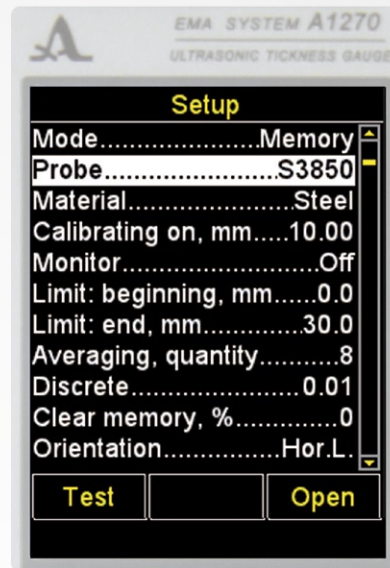
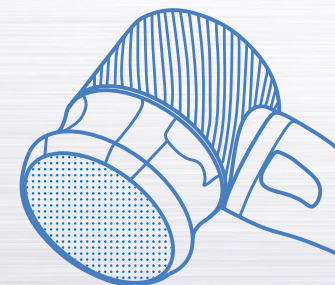


Figure 18

2

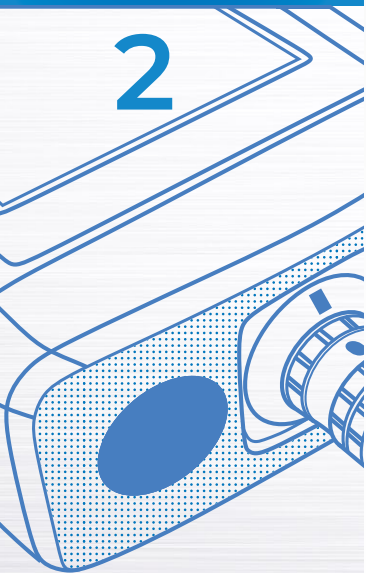
Table 4

Menu option (parameter)	Parameter value	Description
Mode	MEMORY / B-SCAN/ A SCAN	Selects the measurement mode
Probe	name of EMAT	Enters the library of the transducers. Starts the testing procedure of EMAT
Material	name of the material	Enters the library with materials
Calibrating on, mm	from 2 to 50	Sets the thickness of the sample. Starts the procedure of velocity calibration with the sample
Averaging, quantity	1 / 2 / 4 / 8 / 16	Increasing of average value improves the noise/signal ratio by repeated summing 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	Monitoring of the sound indication
Vibration	On / Off	Monitoring of the vibration indication
Language	Russian / English	Selecting the interface language
Meas. unit	mm / inches	Selecting the measurement unit system
Brightness, %	from 20 to 100	Setting the display brightness level
Date	DD.MM.YYYY	Date setting
Time	HH.MM	Time setting





2



The additional menu options of the SETUP MEMORY mode and their corresponding parameters (in the metric measurement system) and functions are listed in the Table 5.

Table 5

Menu option (parameter)	Parameter value	Description
Monitor	Off / Outside/ Inside	Off – switching Off of the display. 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 response limit of the display
Limit: end, mm	from 1.1 to 300	Sets the upper response limit of the display
Clear memory, %	from 0 to 100	Indication of the volume of the used memory. Starts the procedure of deletion of the measurement results from the memory

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

Table 6

Menu option (parameter)	Parameter value	Description
Scan start, mm	from 0 to 295	Sets the start of the scanning
Scan end, mm	from 5 to 300	Sets the end of the scanning
Gate: beginning, mm	from 0 to 300	Sets the lower boundary of the strobe
Gate: end, mm	from 0 to 300	Sets the upper boundary of the strobe
Amplification, dB	from 0 to 40	Sets the amplification
A-Scan image	Filling / Contour	Selects the visual image of the signal in the A-SCAN mode

The additional menu options of the SETUP B-SCAN mode, their corresponding parameters (in the metric measurement system) and functions are listed in the Table 7.

Table 7

Menu option (parameter)	Parameter value	Description
Range	min-max / 0-max	Selects the image option of vertical scale of the B-Scan range
Scan velocity, mm/s	from 1 to 10	Setts the scanning speed

2.3.2.1 The MODE option

Select the measurement mode:

- MEMORY: the measurement results stored in the memory are displayed on the screen;

- B-SCAN: the testing object profile is displayed;

- A-SCAN: the signal in form of an A-Scan is displayed on the screen.

Active keys:

F1 (Memory): selects the MEMORY mode;

F2 (B-Scan): selects the B-SCAN mode

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

 subsequent switching between the modes.

The MODE option is shown on the screen, Figure 19.

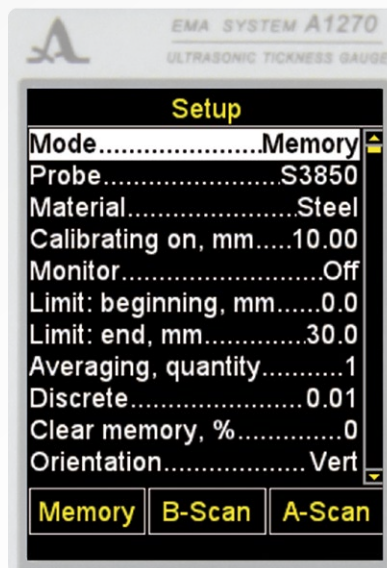


Figure 19



2




2.3.2.2 Probe option

- Enters the library with transducers.

Active keys:

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

F3 (Open) or : enters the library with transducers.

The Probe option is shown on the screen, Figure 20.

- Viewing the library with transducers.

The window header will show information on the currently used EMAT

“Current probe.”:


ATTENTION: USERS MAY NOT ADD THE TRANSDUCERS (PROBES) TO THE LIBRARY AND EDIT THE LIBRARY INDEPENDENTLY!

Active keys:

F1 (Test): starts the procedure of adjustment of the EMAT individual parameters.

F2 (View): provides viewing of the detailed information on a transducer. The name, type and frequency of the EMAT is displayed on the screen.

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

 selects the transducer from the list. The testing procedure of EMAT adjustment to the parameters of the instrument will be started automatically. The detailed description of the procedure is given in the paragraph 2.2.3.2.

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

Figure 21: the screen of the instrument when viewing the library with transducers.

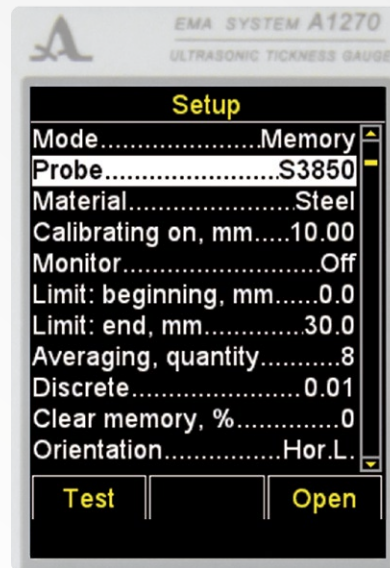



Figure 20

2.3.2.3 MATERIAL option

- Enters the library with materials.

Active keys:

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

The screen of the MATERIAL option is shown in the Figure 22.

- Working with the library of materials.

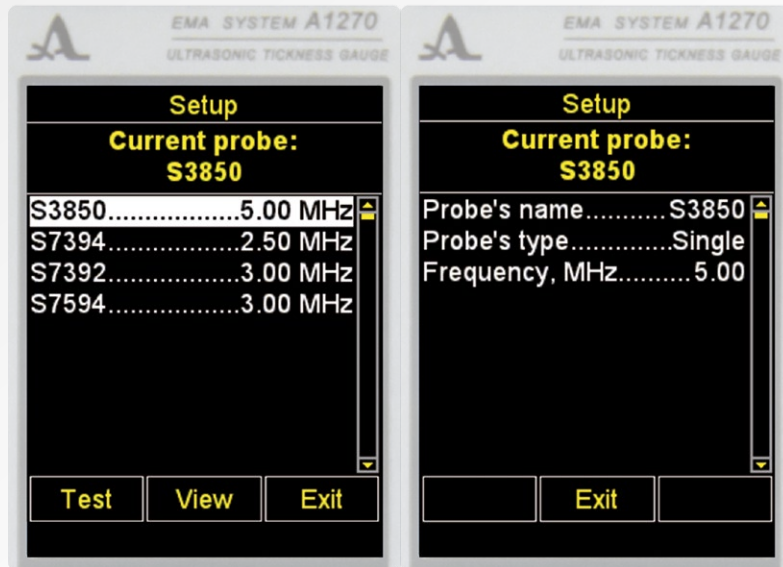


Figure 21

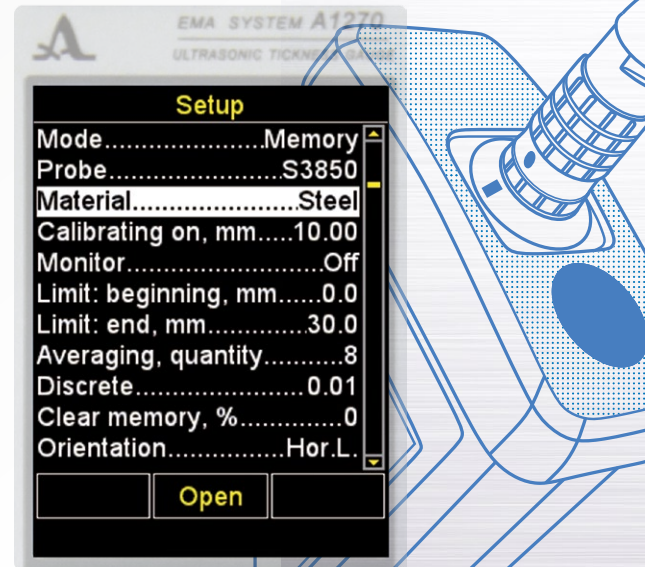


Figure 22

2

The memory contains information on 64 types of materials.

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

Creating new material.

The menu option NEW is listed in the menu first, followed by the following: names and propagation velocity of ultrasonic waves in the material types recorded in the memory (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 23

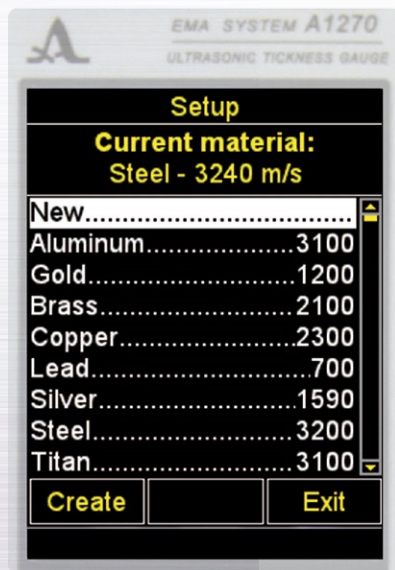


Figure 24

Active keys:



F1 (): exits the editor saving the changes.

F2 (XXX): switching between the characters in the letter table: аБв – Russian small letters, АБВ – Russian capital letters, abc – English small letters, ABC – English capital letters.








F3 (): exits the editor saving the changes.

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



To change the name of the material:



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


- use the F2 key to select the language and character case;

- Using the keys , ,  and  select a new character in the table of characters, for example "B" - **A B C D E F**, delete the highlighted character -  or a character prior to the highlighted one - , and press the key .

To change the ultrasonic propagation velocity in the material:









- Using the keys  or  move the cursor into the velocity value field. When the velocity value becomes editable it will change its color from white **3100** to red **3100** and the value will start decreasing or increasing depending on the key which was used.

- Using the keys  or  set the required velocity value of the ultrasonic sound **Aluminum** **3105**.

- Press the key , the velocity value will change its color to white, and the first character of the material name will become active **Aluminum** **3105**.

The functions of some keys during the work in the material name editor are described in the Table 8.

Table 2

Tab	Purpose
   	Scrolling through the table with characters
 	Selects a character to be edited in the material field name. Changes the velocity value
	Substitutes the active character with the character from the table. The next character will be active after substitutio
F1 	Exits the editor saving the changes

2

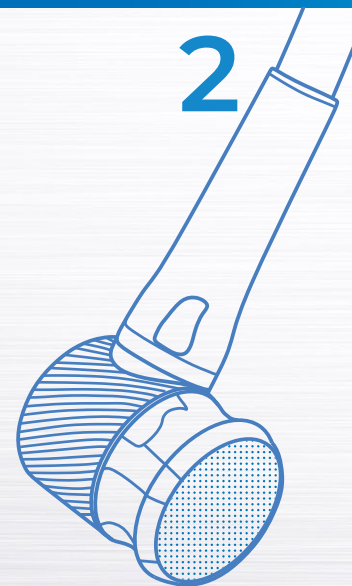





Table 2

Tab	Purpose
F2 (XXX)	Switching between the characters in the letter table, where XXX: aбѡ – Russian small letters АБВ – Russian capital letters abc – English small letters ABC – English capital letters
F1 	Exits the editor saving the changes

Editing the information on the material.

Active keys:

F1 (Edit): switches to the information edit mode of the selected material. The editing process is similar to the process of entering the information on material, described above.

F2 (Delete): deletes the material from the 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 last active line 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 set to zero.

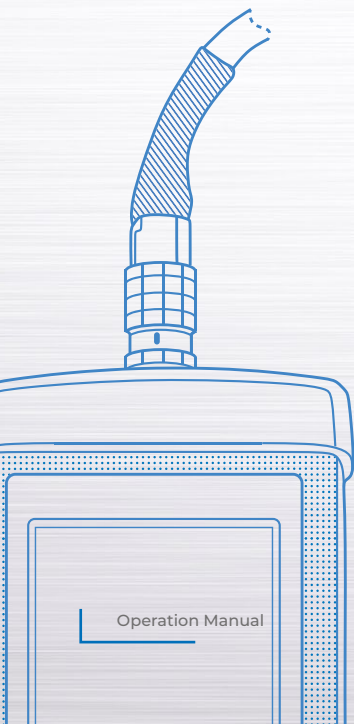
The library with materials is shown on the screen, Figure 25.

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).

2.3.2.4 The CALIBRATING ON Option

The CALIBRATING ON option is used for the determination of the ultrasonic wave velocity in the material of known thickness. The thickness of the calibration sample can be set within the interval from 2 to 50 mm

2



The CALIBRATING ON option is shown on the screen, 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  : increases the thickness value of the calibration sample.

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

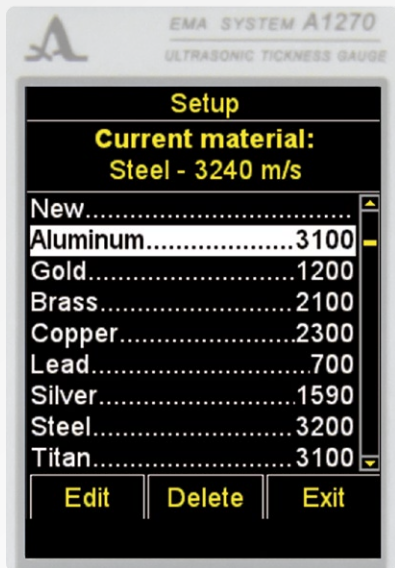


Figure 25



Figure 26

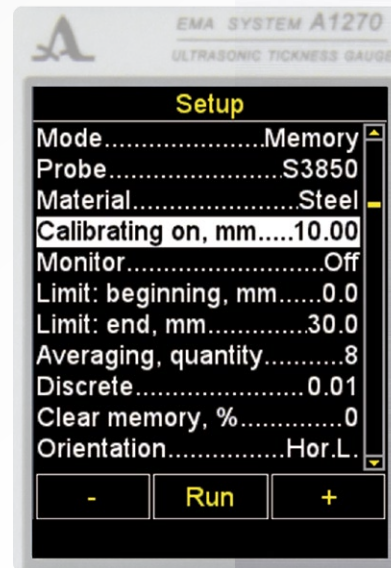
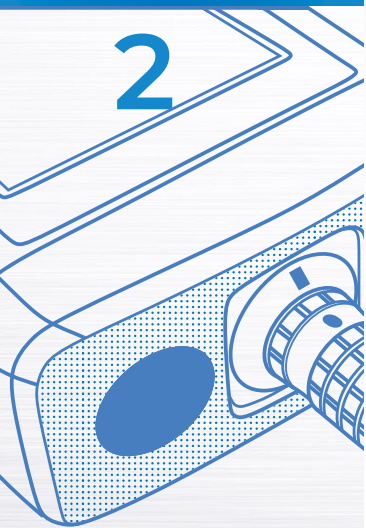



Figure 27



2



- To calibrate the velocity:
- Set the thickness of the sample.
 - Start the procedure of velocity calibration with the sample.
 - The message "Put the probe on calibrating sample and press ENTER" is displayed on the screen.
 - Apply some coupling liquid on the sample.
 - Place EMAT on the sample and press .
 - The message "Data acquisition on the sample thickness of XX.XX mm", where XX.XX is the set thickness of the sample, is displayed on the screen.

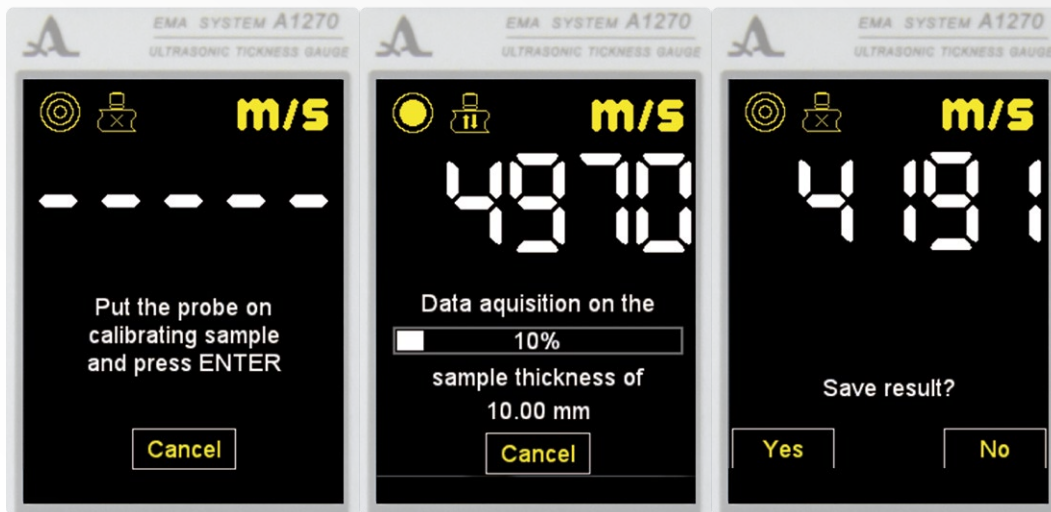


Figure 28

- The current velocity measurement result will be displayed on the screen. After performing all measurements, the velocity value and the message "Save result?" are displayed on the screen.

The screen layouts (orientation) of the instrument during the calibration procedure are shown subsequently in the 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 without saving the result.

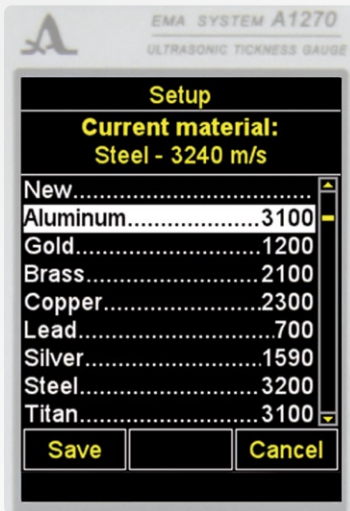


Figure 29

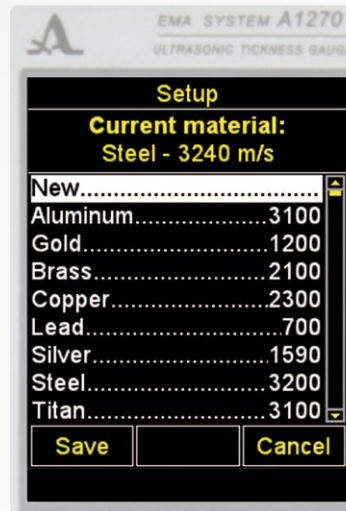


Figure 30



2

2.3.2.5 The Range option (only for the B-SCAN mode)

Choosing the vertical scale image during the formation of the B-Scan:

MIN – MAX: minimum to maximum measured values of the vertical scale of the B-Scan are displayed;

0 –MAX: the vertical scale of the B-Scan is constantly adjusted to show the range from the point zero to the maximum measured value. The Range option is shown in Figure 31.

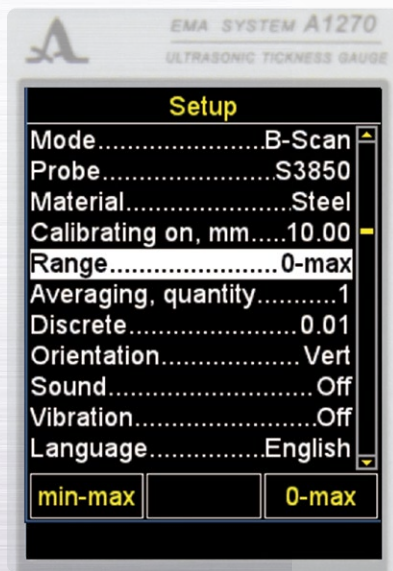


Figure 31

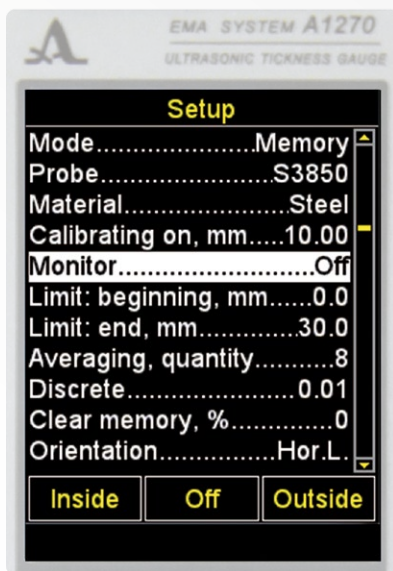


Figure 32

Active keys:

F1 (min max) range selection MIN – MAX;

F3 (0 max) selection of the range 0 – MAX.

2.3.2.6 Monitor option (only for the MEMORY mode)

Setting the actuation conditions for color, sound and vi-bro-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: the monitor is Off.

The Monitor option of the instrument is shown in the Figure 32.

Active keys:

F1 (Inside): selecting the actuation condition INSIDE;

F2 (Off): the Monitor is Off;

F3 (Outside): selecting the actuation condition OUTSIDE;

 switching between the INSIDE / OFF / OUTSIDE options.


2.3.2.7 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.

The LIMIT of the instrument: the beginning option is presented in the Figure 33.

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.


2.3.2.8 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.

The LIMIT of the instrument: the end option is shown in the Figure 34.

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.

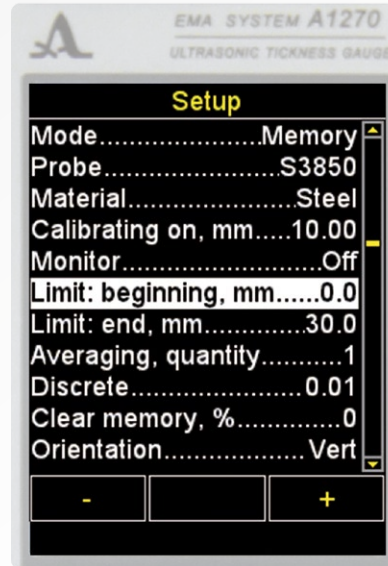


Figure 33

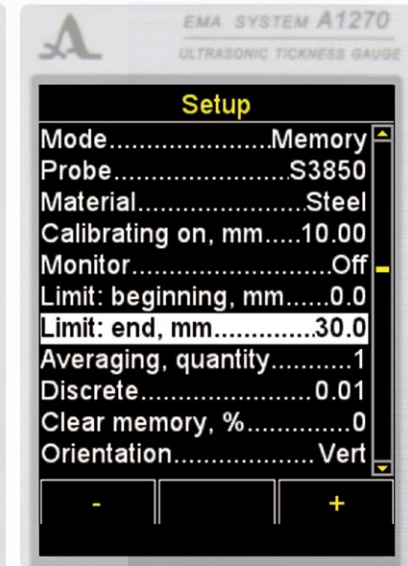


Figure 34

2


2.3.2.9 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 (+)  - increases the averaging value.

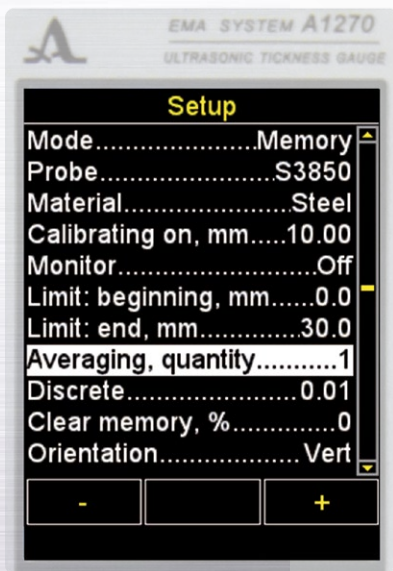


Figure 35

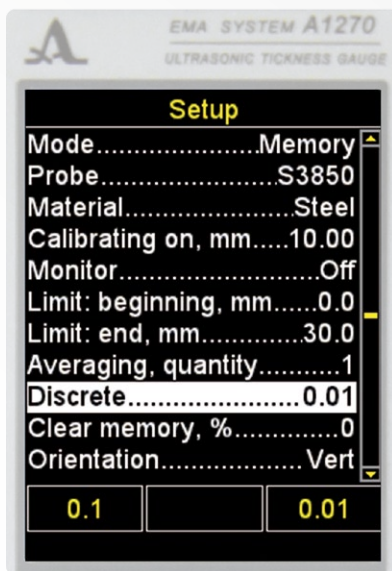


Figure 36

2.3.2.10 The DISCRETE option


Setting the discreteness of the image indication on the screen.

The screen DISCRETE option (for the metric measurement system) is shown in the Figure 36.

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 discrete values from 0.1 to 0.01.

2.3.2.11 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.

The screen CLEAR MEMORY option is shown in the Figure 37.

Active keys:

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

Upon starting the memory cleaning procedure the “Saved data will be deleted. Continue?” message is displayed on the screen (Figure 38).

Active keys:

F1 (Yes): confirms data deletion.

F3 (No): cancels data deletion.

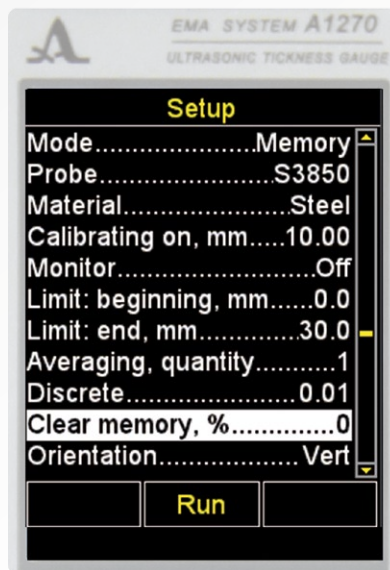


Figure 37

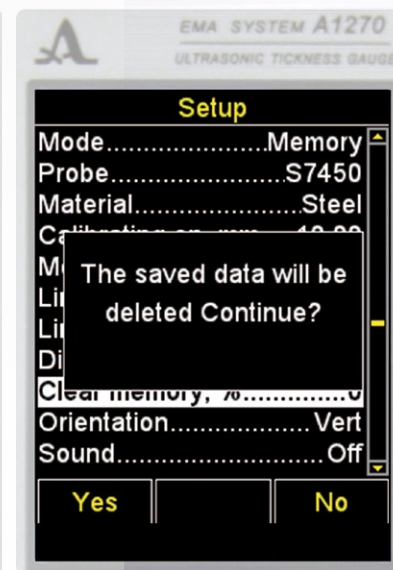


Figure 38

2

2


2.3.2.12 The SCAN BEGINNING (for the A SCAN mode only)


The option SCAN BEGINNING is used to set the start point of the image area of the A-Scan on the screen.

The value of the scan beginning can be set within the range from 0 to 295.0 mm.

The screen SCAN BEGINNING option is shown in the Figure 39.

Active keys:

F1 (-) or  : decreases the value of the scan beginning.

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

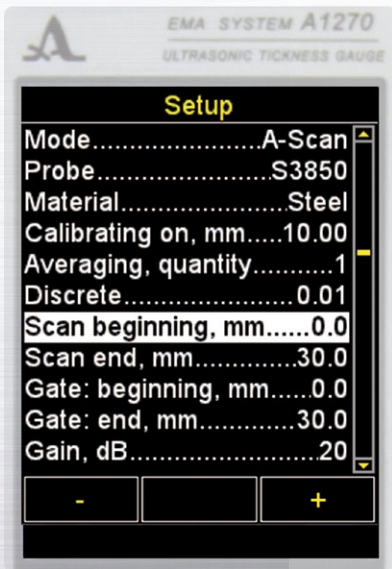


Figure 39

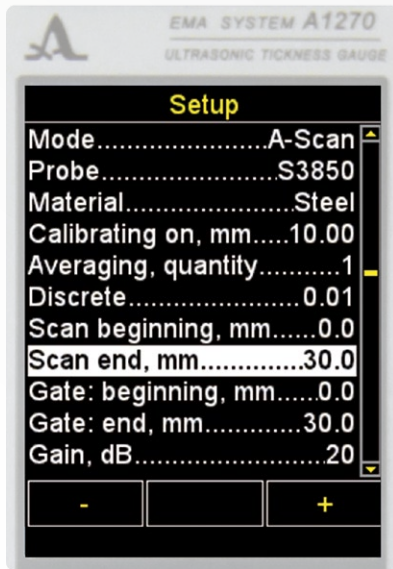


Figure 40


2.3.2.13 The SCAN END option (only for the A SCAN mode)

The option SCAN BEGINNING is used to set the end point of the image area of the A-Scan on the screen.

The value of the scanning (scan) end can be set within the range from 5.1 to 300 mm.

The screen SCAN END option is shown in the Figure 40.

Active keys:

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

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


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


The GATE:BEGINNING option is used for setting the lower limit of the strobe.

Values can be set within the range from 0 to 300 mm.

The screen GATE:BEGINNING option is shown in the Figure 41.

Active keys:

F1 (-) or : decreases the value of the lower limit of the strobe (gate).

F2 (+) or : increases the value of the lower limit of the strobe (gate).


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


The option Gate: end is used for setting the upper limit of the strobe.

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

The screen option Gate: end is shown in the Figure 42.

Active keys:

F1 (-) or : decreases the value of the upper limit of the strobe.

F2 (+) or : increases the value of the upper limit of the strobe.

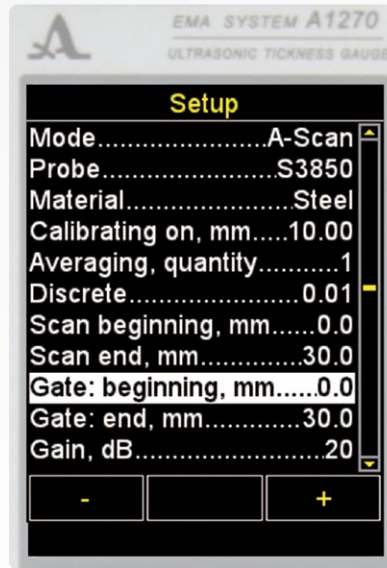


Figure 41

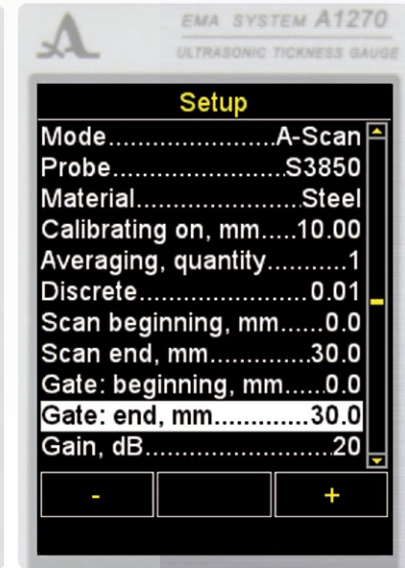


Figure 42

2

2.3.2.16 The Gain option (only for the A SCAN mode)

The Gain option is used for setting the amplification value of the receiving channel.

The Gain value can be set within the range from 0 to 40 dB.

The screen Gain option is shown in the Figure 43.

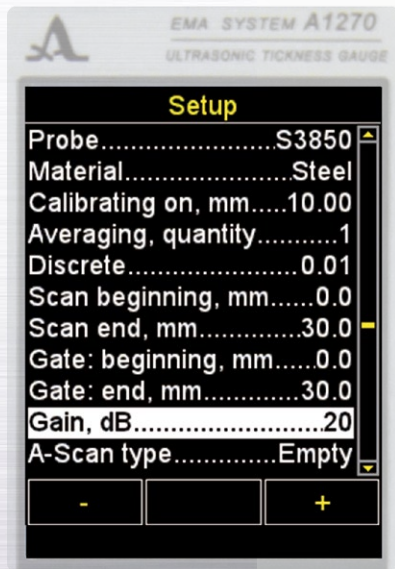


Figure 43

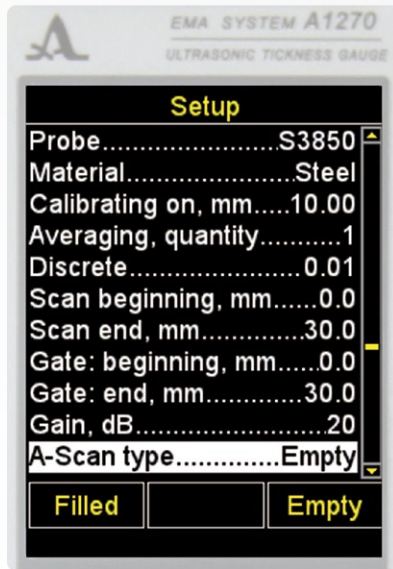


Figure 44

Active keys:

F1 (-) or  : decreases the gain value.

F2 (+) or  : increases the gain value.

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


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

The screen A SCAN TYPE option is shown in the Figure 44.

Active keys:

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

F3 (Contour): the detected signal is displayed as an outline.

 : switching between the signal display types.

2.3.2.18 The ORIENTATION option


Selecting the image orientation type – Hor.R. / Vert / Hor.L.
The screen ORIENTATION option is shown in the Figure 45.

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 position of the instrument.

2.3.2.19 The SOUND option

Switching On/Off the sound indication of the instrument.

For the convenient operation of the thickness gauge the main events of the thickness gauge during measurements, adjustment and key pressing are accompanied by sounds. The sound indication is also used for the acoustic monitoring of reception of ultrasonic signals. The acoustic signals inform the operator on the current processes without influencing the measurement results.

The screen SOUND option is shown in the Figure 46.

Active keys:

F1 (On): switching On the sound indication.

F3 (Off): switching Off the sound indication;

 : switching On/Off the sound indication.

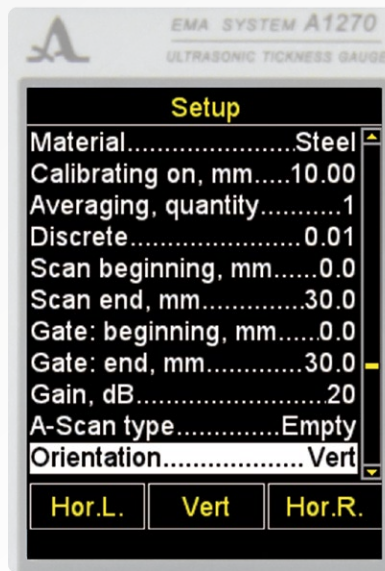


Figure 45

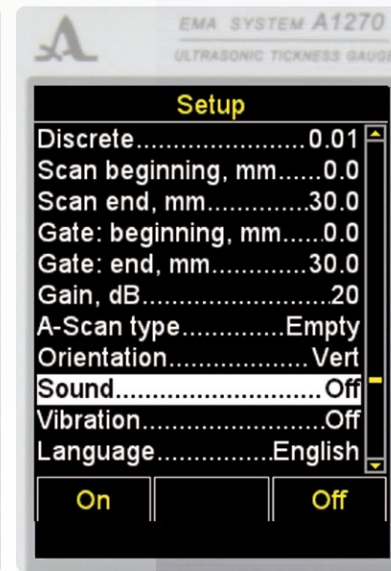


Figure 46

2

2.3.2.20 The VIBRATION option

Switching On/Off the vibration indication.

For the convenient operation of the thickness gauge the main events of the thickness gauge during measurements, adjustment and key pressing are accompanied by vibration. The vibration also informs the operator on the current processes without influencing the measurement results.

The screen VIBRATION option is shown in the Figure 47.

Active keys:

F1 (On): switching On the vibration.

F3 (Off): switching Off the vibration;

: Switching On/Off the vibration indication.

2.3.2.21 The LANGUAGE option

Switching between the interface languages of the instrument:

- Russian / English / German / French / Italian / Portuguese / Spanish / Chinese.


The screen LANGUAGE option is shown in the Figure 48.

Active keys:

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

F2 (Russian): current language;

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

: subsequent selection of the available interface languages.

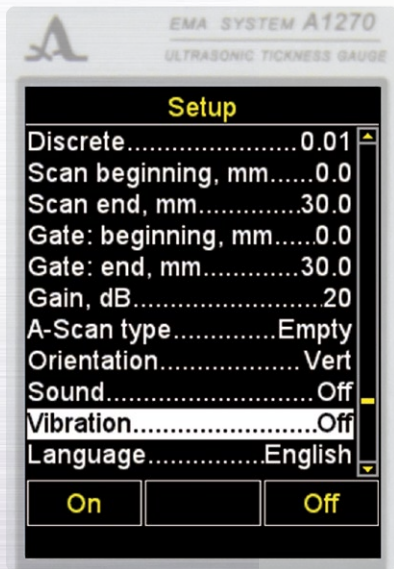


Figure 47

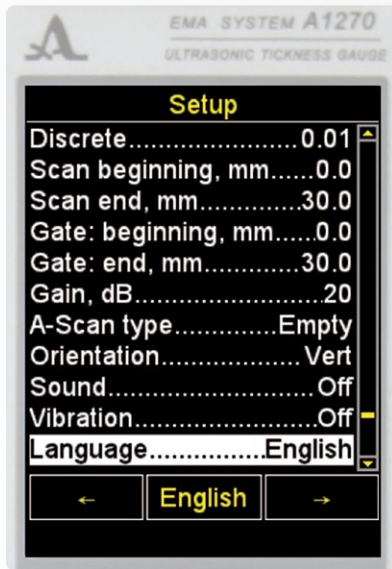


Figure 48

2.3.2.22 The MEASURING UNITS option


Selects the measurement unit system - MM / INCHES.

The screen MEASURING UNITS option is shown in the Figure 49.

Active keys:

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

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

 : switching between the measurement unit systems.

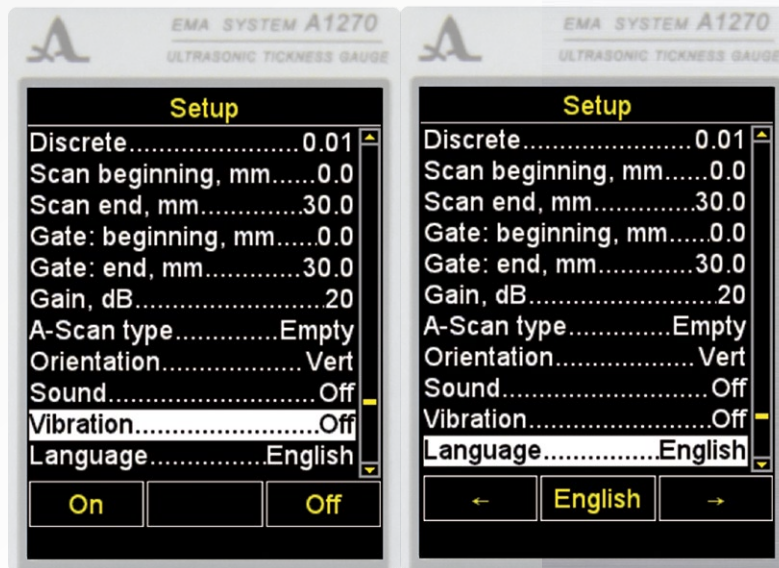


Figure 49

2



2

2.3.2.23 The BRIGHTNESS option

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

The screen BRIGHTNESS option is shown in the Figure 50.

Active keys:

F1 (-) or  : decreases the screen brightness.
F3 (+) or  : increases the screen brightness.

2.3.2.24 DATE option

Setting the date.

The menu item DATE is shown in the Figure 51.



Active keys:

F2 (Edit): start the date editing procedure.

The screen during the DATE editing procedure is shown in the Figure 52.

Active keys:

 /  ,  ,  : selection of parameter for editing

 /  : changing the selected parameter;

F1 (Save): save changes and exit the editing procedure;

F3 (Cancel): exit the editing procedure without saving changes.

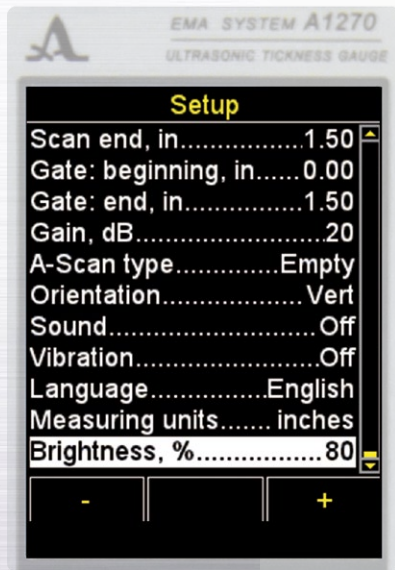


Figure 50

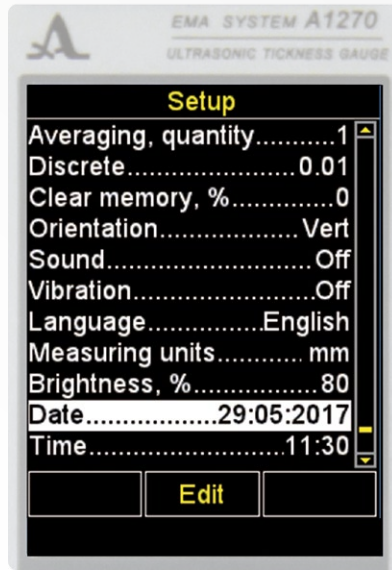


Figure 51

2.3.2.25 TIME option

Setting the time.

The menu item TIME is shown in the Figure 53.

The TIME editing procedure is similar to the DATE editing (p. 2.3.2.24).

2

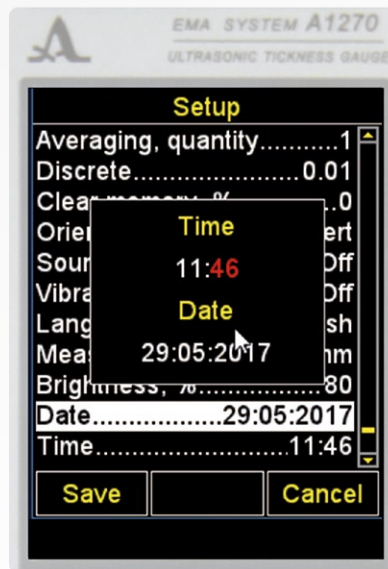


Figure 52

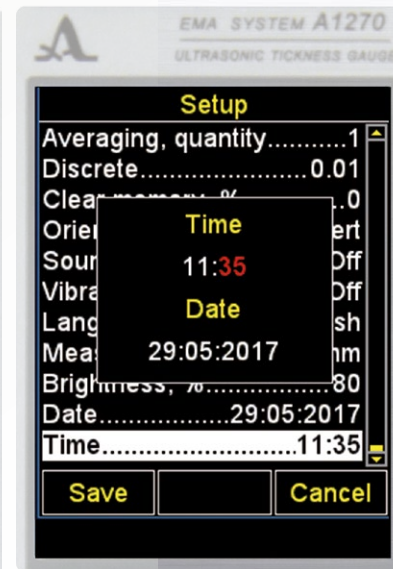


Figure 53

2

2.3.3 The MEMORY mode

In the MEMORY mode the screen is divided into two parts: in the upper part the measurement information is shown (thickness, signal level, measurement method, velocity of the ultrasonic wave in the current material), in the lower part the information on the previously recorded results (groups, cells of the groups and thickness measurement results) is shown (Figure 54).

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

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

The screens Monitor-INSIDE or Monitor OUTSIDE are shown in the Figure 55 (the measurement result is displayed in red if the actuation condition of the monitor is fulfilled, or in white if the actuation condition of the monitor is not fulfilled).

Active keys:



changes the velocity of ultrasonic waves in the material.

If acoustic signals are emitted and the readings are changing on the screen, keep the EMAT calm for 2-3 seconds and wait for stable readings.

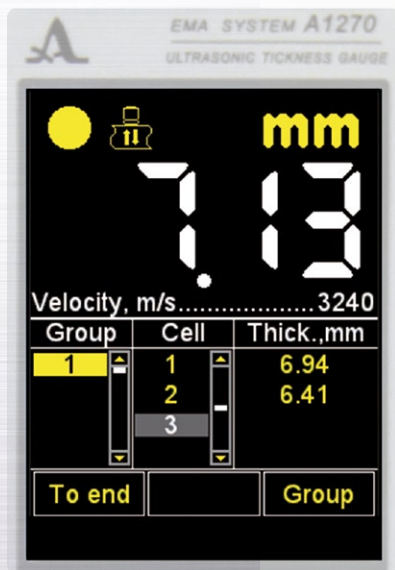


Figure 54

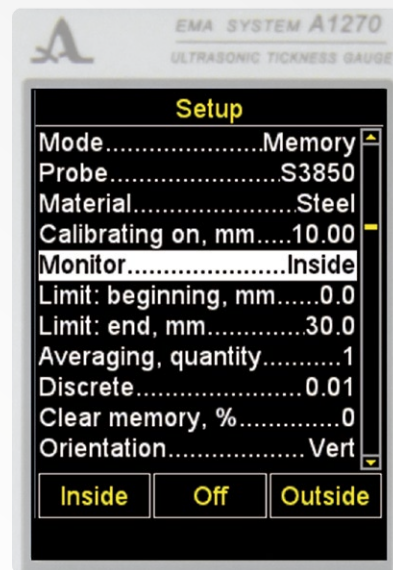


Figure 55

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

 : saves the current result.

Note: the result will be recorded into the first free cells of the last existing group.

You can correct the value recorded in the memory according to the instructions given in the paragraph 0.

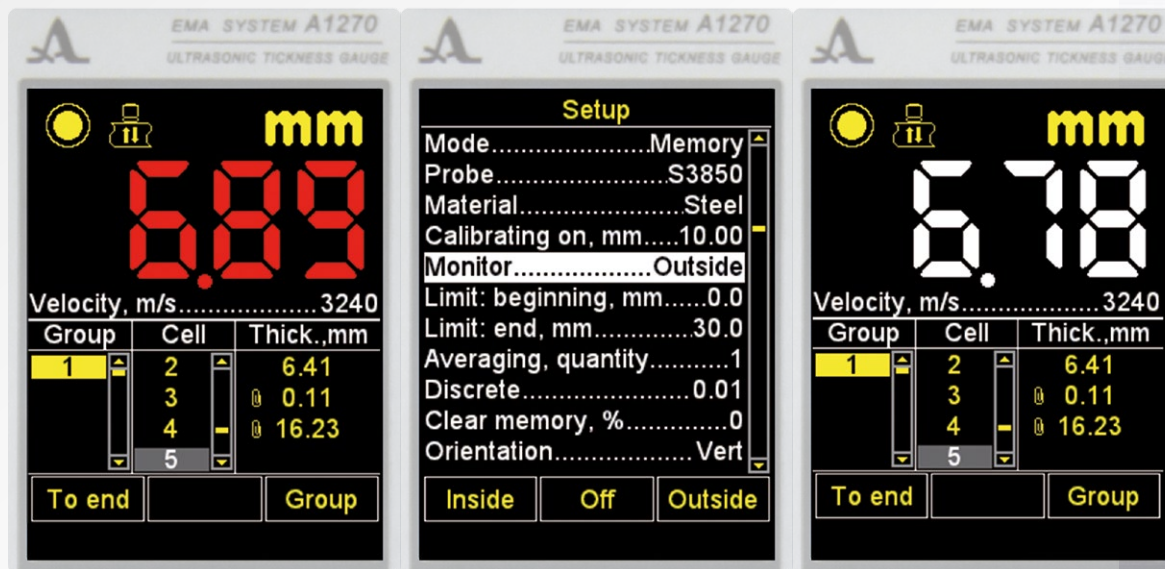


Figure 55

2

2.3.3.1 Adding a new/deleting the last group

Upon pressing the key F3 the message "Add new or remove the last group?" will be displayed on the screen (Figure 56).

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 56

2.3.3.2 Saving the result

The measurement results are stored in the memory of the instrument in its cells. The cells are organized into the groups. The groups and cells in the groups are identified by the item No.. The groups and cells in each group are numbered starting with "1".

The maximum quantity of the cells in the group is 500.




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

Viewing and adjusting the measurement results




All results recorded in the memory can be viewed and corrected if there are any doubts about their reliability. To correct the result, you have to conduct another measurement in the same point and re-record the low-quality value.


The key  is used to enter the mode to view and edit the results. Upon pressing the  key, the  character (Figure 57) will appear on the screen.


The key  is used to return to the MEMORY mode. Use the   keys to view the recorded

results. Scrolling through the measurement results is done using the group cells, according to the selected view direction. When the last/first cell in the group is reached, the scrolling will go 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 , the ❄ character will disappear.

Note: In practice the result remains in the memory up to the moment a new value is recorded in the selected cell. To go back to the view mode without 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 B-SCAN mode

The B-Scan mode is used to search for corrosion damage when scanning a test object.

The graphical B-SCAN is formed from the results of the measurements received during scanning, each subsequent measurement is added to the current B-Scan and is displayed on the screen.

The maximum number of measurements in one B-Scan is 500.

In B-SCAN mode with vertical orientation, the screen is divided into two parts: in the upper part a signal in form of a B-Scan is displayed, and in the bottom part numerical values of measurement results and control icons are displayed (Figure 58).

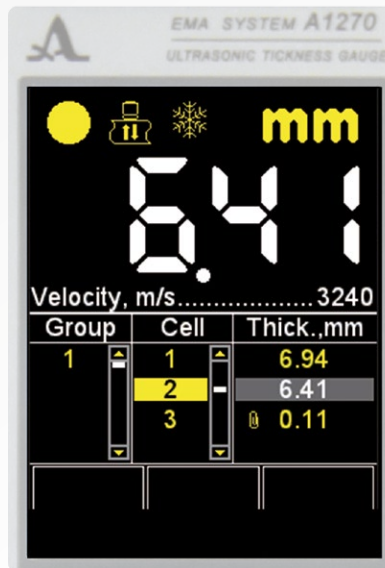


Figure 57

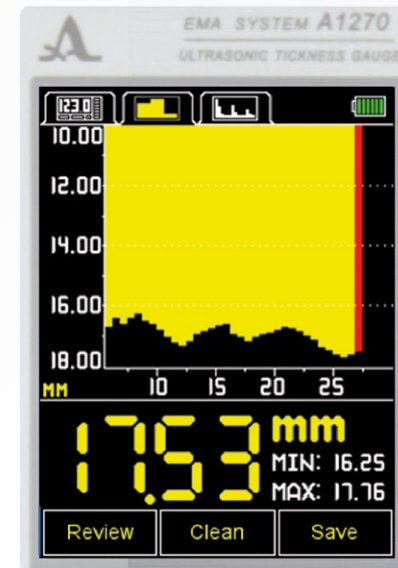
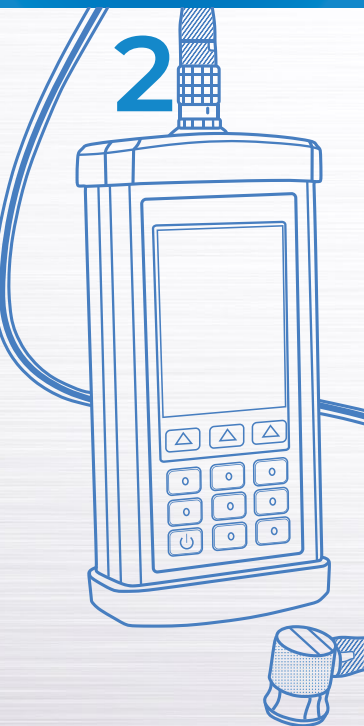


Figure 58



Active keys:

/ : changing the sweep length.

F1 (Review): viewing the saved B-Scans.

F2 (Clean) – cleaning current B-Scan.

F3 (Save): saving the current B Scan.

Saving B-Scan

By pressing the F3 (Save) key, a message will appear on the screen requiring confirmation, «Save current B-Scan?».

Active keys:

F1 (Saving): saving B Save.

F3 (Cancel): cancel saving.

In the memory of the device you can save up to 4 000 B Scans.

2.3.4.1 Viewing saved B Scans

When the F1 (Review) key is pressed, the view mode of the stored B-Scans is started.

Active keys:

: moving up and down in the column of the measurement results, where the B- Scan was collected.

: changing the sweep length.

F1 (A ←): go to the previous frame, where A is its number.

F2 (Exit): exit the view mode stored in B- Scans.

F3 (→B): go to the following frame, where B is its number.

: delete the current B Scan.

When you press a key, the message appears on the screen requiring confirmation

When you press the key the message appears on the screen requiring confirmation, «Delete current B Scan?».

Active keys:


F1 (Yes): confirm deletion of the B Scan.

F3 (No): cancel deletion of the B Scan.





2.3.5 The A SCAN mode


The thickness measurement in the A SCAN mode is the analysis of the image shape of the obtained echoed signal, a selection of the analysis interval and criteria for calculation of propagation time of the ultrasonic pulses 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 ultrasonic pulses in the material.

In the A SCAN mode when working with the vertical orientation the screen is split into two parts: in the upper part the signal is shown as an A Scan, in the lower part the digital values of parameters and checking icons are shown (Figure 59). Main active keys:

F1 : monitoring the size and position of the strobe.

F2  – monitoring the signal display.







F3  /  /  / : selecting 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.

Note: The result will be recorded in 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 9 contains the description of the keys for the first active icon.

Table 9

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

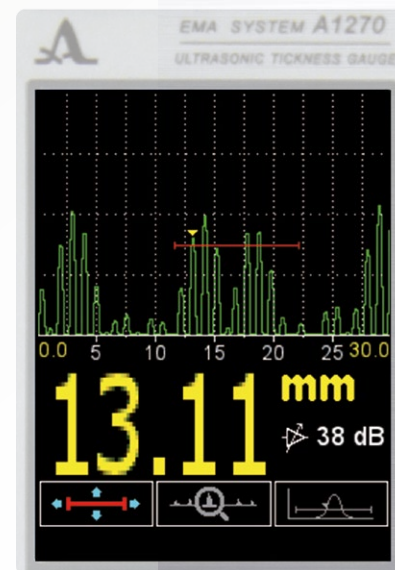


Figure 59

2

Figure 60

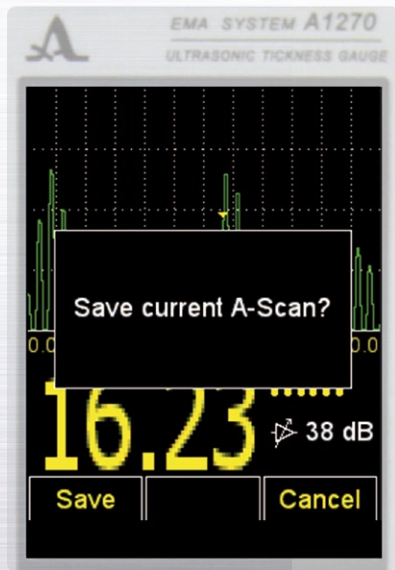


Table 10 contains the description of the keys for the second active icon.

Table 10










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

Table 11 contains the description of the keys for the third active icon.

Table 11

Key	Designation
 	Changing the amplification value

2.3.5.1 Saving the A-Scan

Upon pressing the  key the message is displayed on the screen: "Save current A Scan?" here you shall confirm (Figure 60).

Note: The result will be recorded in 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): save the digital value of the measurement result and its A Scan.

F3 (Cancel): cancel saving.

2.3.5.2 Viewing the saved A Scans

To view the saved A Scans and their corresponding measurement results, go to the MEMORY mode. The data with the A Scans saved in the measurement result column are specified by the  character. The character is in front of the result value (Figure 61).

Press the  key to enter the view mode and press the F2 key (A Scan) (Figure 62).

The A Scan saved for the selected result will be displayed in the upper part of the screen (Figure 63).

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

The value recorded in the memory in the A SCAN mode can be corrected in the MEMORY mode according to the instructions given in the paragraph 0.

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

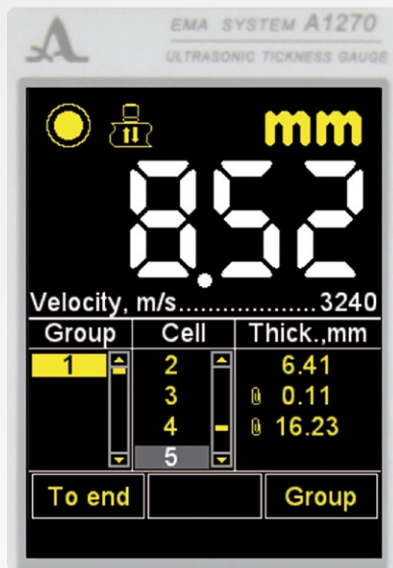


Figure 61

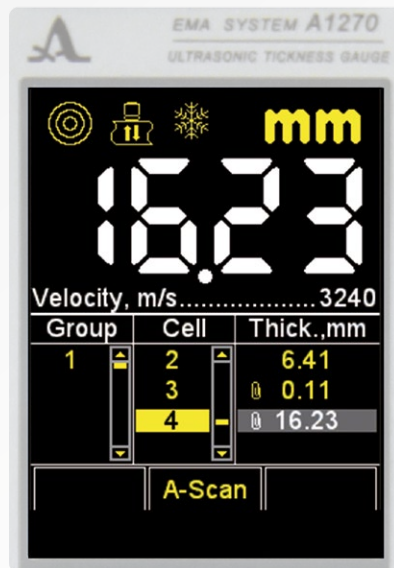


Figure 62

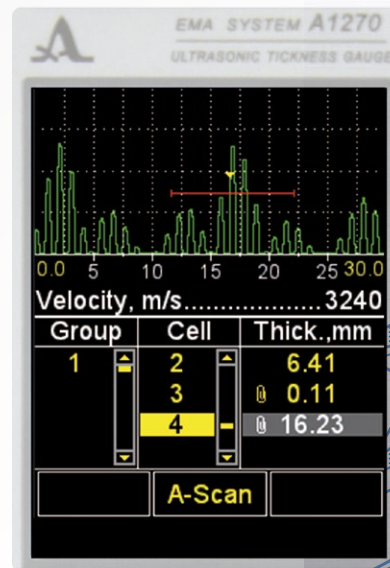


Figure 63

2



2



2.4 PERFORMING 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 differs from the actual value, adjust the velocity manually or perform the calibration.

The accuracy of the settings influences the measurement accuracy directly. You can use the 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 inspected object, 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 ultrasonic velocity in it.

The place where the transducer is installed shall be clean, without local defects hindering the installation of the transducer on the surface. It is not possible to receive measurement results from a cavity if the transducer cannot be placed on its bottom.

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

When the EMAT touches the surface of the inspected object a reliable ultrasonic contact of the transducer with the object is reached in a fraction of a second as a rule. Now, readings are displayed on the screen of the instrument. The readings can slightly deviate when inspecting small-diameter pipes and if the transducer is shaking a little. The readings remain stable when inspecting 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 screen or record them in the memory.

2.4.1 Functional check of the instrument during inspection

You may need to perform a functional check 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, the ultrasonic propagation velocity in it is 3120 m/s.

Set the velocity value in the instrument to 3120 m/s and place the 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 the data recorded in the instrument to a PC, connect the instrument to a 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 name ACSYS DISC. You can open its contents using the MS Windows Explorer or any file manager.

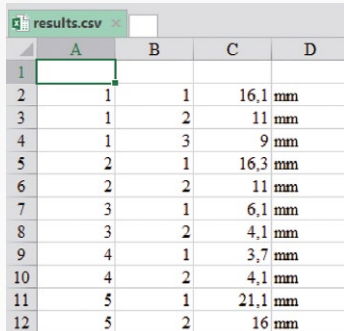
You can view the data opening the files directly from the instrument or copy the data to a PC for further viewing.

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 means comma-separated values. The files allow for further analysis and data processing by means of external programs (Figure 64). The data shall be stored into a single file under the name results.csv. The results in the file are arranged sequentially according to the group number.

A-Scans shall be stored in 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.

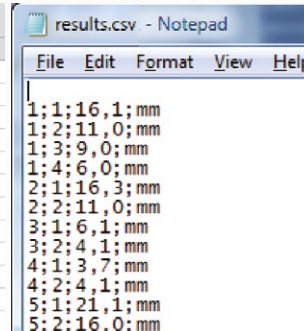
In the "MS Excel" program ▶



	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

– Digital data displayed by the external programs

Figure 63



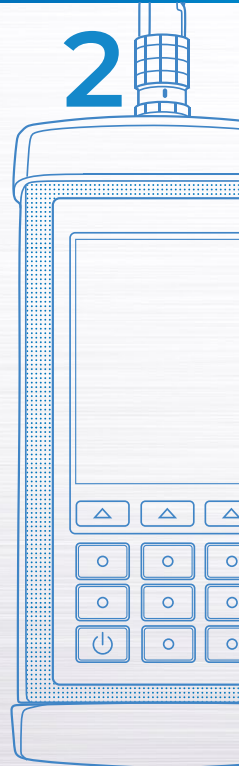
```

File Edit Format View Help
1; 1; 16, 1; mm
1; 2; 11, 0; mm
1; 3; 9, 0; mm
1; 4; 6, 0; mm
2; 1; 16, 3; mm
2; 2; 11, 0; mm
3; 1; 6, 1; mm
3; 2; 4, 1; mm
4; 1; 3, 7; mm
4; 2; 4, 1; mm
5; 1; 21, 1; mm
5; 2; 16, 0; mm

```

◀ In the "Notepad" program

2





3

MAINTENANCE

The maintenance of the thickness gauge includes cleaning the electronic unit from dust and dirt and charging the rechargeable battery.

3.1 ACCUMULATOR

The rechargeable battery is designed to be operated in a broad temperature range. At negative temperatures battery capacity decreases. At lower temperatures the battery capacity is 15% less as compared to the normal temperature conditions.

If the rechargeable battery goes dead the instrument will be switched off automatically.

The rechargeable battery has a built-in protection against overcharge, over discharge, over current and overheating.

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

The battery must be replaced by the service centers only.

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

3.2 CHARGING THE BATTERY

The battery shall be charged via an external charger.

The battery charging time depends on the discharge level. The complete charging takes 2 hours. Multiple recharging is allowed.

Note: You cannot conduct the measurements during charging.

ATTENTION: TO AVOID THE BATTERY DAMAGE 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 instruments should be shelf stored.
- The arrangement of the instruments in a warehouse shall enable their free movement by the personnel and unrestricted access to them.
- The distance between the instruments and the walls, floor of the warehouse and other warehoused instruments shall be at least 100 mm.
- The distance between the heating units in a warehouse 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

TRANSPOR- TATION

The thickness gauge should be transported in the case included in the delivery kit.

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

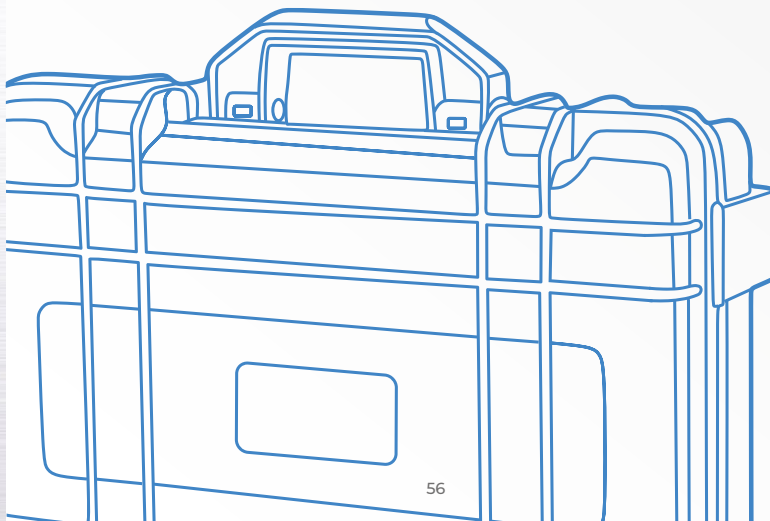
The packaged instruments shall be properly fastened in the transport vehicle. The packaged instruments shall be protected from precipitation and water splashes if the instruments will be transported in an open transport vehicle.

The packaged instruments should be properly and steadily fixed to prevent shocks of devices against each and against vehicle walls during the transportation.

The transportation conditions should confirm to the requirements of the technical conditions and regulations applicable to each type of transportation.

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

In case the transportation conditions differ from the operation conditions, the instruments shall be kept under normal environmental conditions for at least 2 hours prior to operation.





NOTES



NOTES

A large area of the page is filled with horizontal dashed lines, intended for handwritten notes.



ELECTRO-MAGNETIC ACOUSTIC THICKNESS GAUGE WITH THE NOVEL ELECTRO-MAGNETIC BIASING TECHNOLOGY

A1270 EMAT



OPERATION MANUAL

Revision: February 2018