

ULTRASONIC THICKNESS GAUGE

A1210

OPERATION MANUAL



Acoustic Control Systems – ACS Group
Saarbrücken, Germany 2019



CONTENTS

1 DESCRIPTION AND OPERATION.....	6
1.1 INTENDED USE.....	6
1.1.1 INTENDED USE AND RANGE OF APPLICATION.....	6
1.1.2 OPERATING CONDITIONS.....	6
1.2 TECHNICAL SPECIFICATIONS.....	7
1.3 SETUP AND OPERATION.....	8
1.3.1 SETUP.....	8
1.3.2 OPERATION PRINCIPLE.....	9
1.3.3 OPERATING MODES.....	9
1.3.4 DISPLAY OF THE INSTRUMENT.....	10
1.3.5 KEYBOARD.....	14
2 INTENDED USE OF THE INSTRUMENT.....	15
2.1 OPERATING RESTRICTIONS.....	15
2.2 PREPARING THE INSTRUMENT FOR USE.....	15
2.2.1 PREPARATION OF THE SURFACE.....	15
2.2.2 CONNECTION OF THE TRANSDUCER.....	15
2.2.3 SWITCH THE INSTRUMENT ON/OFF.....	16
2.2.4 SETTING OF THE INSTRUMENT TO THE PARAMETERS OF THE CURRENTLY USED PT.....	16



2.3 OPERATION	20
2.3.1 USING THE INSTRUMENT	20
2.3.2 THE SETUP MODE	20
2.3.3 THE STANDARD MODE	38
2.3.4 THE MEMORY MODE	40
2.3.5 THE A-SCAN MODE	42
2.4 MEASUREMENTS.....	45
2.4.1 MEASUREMENTS WITH DOUBLE CRYSTAL (PC) TRANSDUCER.....	46
2.4.2 MEASUREMENTS WITH SINGLE-CRYSTAL TRANSDUCER	46
2.4.3 CHECKING THE FUNCTIONALITY OF THE INSTRUMENT DURING TESTING.....	47
2.5 TRANSFER DATA TO A PC	48
3 MAINTENANCE.....	49
3.1 BATTERY	49
3.2 CHARGING THE BATTERY	49
3.3 POSSIBLE MALFUNCTIONS	49
4 STORAGE	50
5 TRANSPORTATION	51
APPENDIX A.....	52

The present operation manual (hereinafter referred to as the “Manual”) contains technical specifications, description and operating principle of the device as well as information necessary for correct operation of the ultrasonic thickness gauge A1210 (hereinafter referred to as “the thickness gauge” or “the instrument”).

Prior to start working with the device, please carefully read the manual.

Only properly trained personnel familiar with the operation manual and general principles of the theory of ultrasonic vibration distribution is allowed to operate the device.

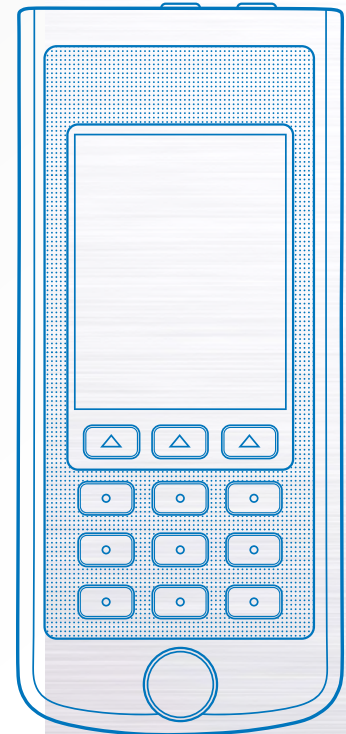
For proper ultrasonic testing, please perform the following preparatory works: define the testing objectives, testing techniques and select the transducer, evaluate the testing conditions of the given materials etc.

During production of the instrument some modifications can be introduced to it due to constant improvement of its reliability and serviceability. These changes do not affect the technical specifications of the device.

The instrument is manufactured by:

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1

DESCRIPTION AND OPERATION

1.1 THE INTENDED USE

1.1.1 Intended use and range of application

The instrument is a portable general-purpose ultrasonic device.

The instrument is used for measuring the thickness of pipe walls (including bends), boilers, cylinders, vessels under pressure, covers and other products from ferrous and nonferrous metals, with smooth or rough and corrosive surfaces, and also products from plastic and other materials with high fading of the ultrasonic sound at a unilateral access to the surface of such objects.

The instrument can be used in laboratories, work shops or in the field in various industries. Prior to use the device, it is necessary to perform a preliminary preparation of the surface and use a contact liquid, e.g. oil, water, glycerin, special contact liquids or gels for ultrasonic testing.

The instrument is equipped with a system of automatic adjustment to the shape and surface roughness of the inspected object. The system is patented in the Russian Federation (RF Patent No. 2082160). It ensures equally valid readings of the instrument for all practical purposes.

The A-SCAN mode allows to eliminate false results considerably increasing the inspection reliability, to perform express searches of foreign inclusions and separations and to receive accurate results of measuring through polymeric, varnish, paint and other types of insulated coatings.

Using the instrument, you can change the image orientation by 90 degrees to the right or to the left in the A-SCAN mode.

The instrument stores the measurement results in its non-volatile memory and transfers them to a personal computer (PC) for subsequent analysis, processing and documentation.

The instrument communicates with a PC via the USB-port.

1.1.2 Operating conditions

The instrument is intended for operation under the following operation conditions:

- Operating temperature range: from -20 to +50 °C;
- Relative air humidity up to 95 % at +35 °C.

1.2 TECHNICAL SPECIFICATIONS

The main technical specifications of the instrument are listed in the Table 1.

Table 1

Parameter	Value
Thickness measurement range (for steel), mm: with the D1771 4.0A0D12CL transducer with the S3567 2.5A0D10CL transducer	from 0.7 to 300.0 from 0.8 to 300.0
Limits of the absolute permissible inaccuracy of the thickness measurement, mm, max, where X is the measured thickness: at thickness from 0.7 to 3.0 mm at thickness from 3.01 to 99.99 mm at thickness from 100.0 to 300.0 mm	$\pm(0.01 \cdot X + 0.1)$ $\pm(0.01 \cdot X + 0.05)$ $\pm(0.01 \cdot X + 0.1)$
Thickness indication sensitivity, mm: at thickness up to 99.99 mm at thickness from 100.0 mm	0.01; 0.1 0.1
Ultrasonic velocity adjustment range, m/s	from 500 to 19,999
Power	A built-in lithium rechargeable battery
Rated supply voltage, V	3.7
Period of continuous operation of the instrument powered from the battery, min.	9 hours
Overall dimensions of the electronic unit, max.	161X70X24 mm
Maximum weight of the electronic unit	210 g
Mean time between failures	18,000 hours
Regular service life	5 years



1.3 INSTRUMENT DESIGN AND OPERATION

1.3.1 DESIGN


The thickness gauge consists of an electronic unit (Figure 1) with replaceable piezoelectric transducers (PT) connected via cables. The colour TFT display is located in the upper part of the front panel of the electronic block. It is used to display the measurement results and current information necessary to control the thickness gauge. The display enables to monitor the measurement process visually by means of color-coded indication.

Under the display a membrane keyboard is located. It is used to control the instrument.

In the lower part of the front panel a proof sample from stainless steel is located. The sample is 5 mm thick. The propagation velocity of the ultrasonic waves in it is 5750 m/s. The sample is used to enable the adjustment of the instrument to the connected PT and a quick assessment of the instrument functionality.

The ports for connection of the piezoelectric transducers are located on the upper front side of the electronic block. One of the ports is marked with a red dot (Figure 2).

On the lower front wall of the electronic block the USB Micro B socket is located. It is used to connect the USB cable with the PC and the 200 V USB power adapter to charge the built-in device battery (Figure 3).

Connect the "Micro B" connector of the USB cable with the  icon or the letter "B" facing upwards (Figure 4).

At the back side of the housing there is a magnetic holder. The magnetic holder provides safe fastening of the instrument on metallic surfaces. It facilitates inspection of heavily accessible places.

1

Figure 1



Figure 2



Figure 3

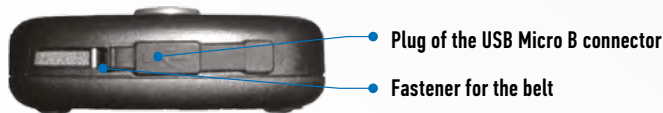


Figure 4



1.3.2 Operating principle

The instrument measures the time needed for the ultrasonic waves to pass the tested object from one surface to another. This time is subsequently converted into the thickness value.

The PT operates as a transmitting and receiving element of ultrasonic pulses and their reflections. Put the PT on the tested surface where the thickness should be measured. The ultrasonic transducer has a sharp emitting and receiving beam pattern, so the thickness is determined directly under the located transducer.

In case there are cavities on the surface of the TO opposite to the installed transducer, the US pulses are reflected from the cavities, the thickness is determined as the shortest distance from the external surface to these cavities.

1.3.3 Operating modes

The thickness gauge can be used in the following modes:

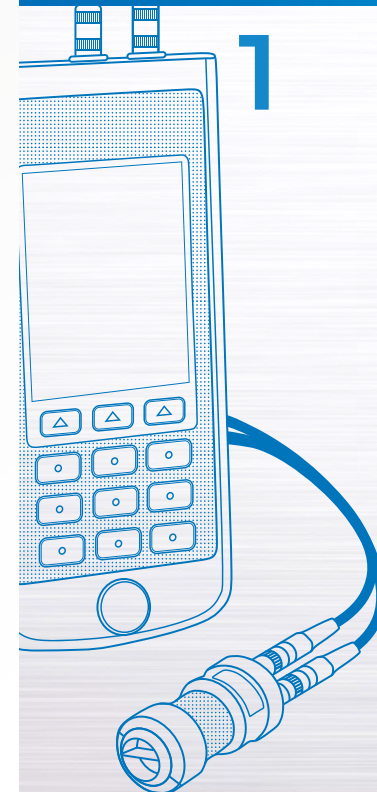
1. The measurement mode: here the measurement result is displayed in accordance with the appropriate set interval and the response parameter of the automatic flaw warning (AFW) STANDARD;
2. The measurement mode: indication of the saved results i.e. MEMORY;
3. The measurement mode: graphical signal indication in the A-SCAN;
4. The setup mode: configuration of the measurement parameters i.e. SETUP.

It is possible to save the results in the device memory in all measurement modes.

When in the STD mode, the thickness gauge measures the thickness of the TO and allows to quickly determine the appropriate set interval, and the response parameter of the AFW.

When in the MEMORY mode, the thickness gauge measures the thickness of the TO and allows to quickly determine the appropriate set interval and the response parameter of the AFW, view the measurement results saved in other modes on the display and correct the records performing repeated measurements and recording the information into the updatable memory cells.

The A-SCAN mode ensures the elimination of false results caused by irregularities in the material of the TO. In this mode the signals are displayed on the screen in the form of an A-Scan; The measurement conditions and criteria are adjusted directly during the measurement. You may use one of four measurement methods.









- Automatic measurement, when the signal exceeds the strobe level;
- Between two maximum signals in the strobe and the auto correlation function (ACF) in the strobe;
- View the selected parts of the signal, the current parameters and settings;
- Save the A-Scan image together with the measurement result.

The SETUP mode allows the user to change the selected measurement conditions and parameters. The set of the parameters accessible to editing employs measurements common for all modes and measurements individual for each mode.

1.3.4 Display of the instrument

In all operating modes in the upper line of the display the information on the current operating mode of the device and the battery charge level is indicated. The icons of different operating modes are listed in the Table 2.

Table 2

Tab	Operating mode
	STANDARD
	MEMORY
	A-SCAN
	SETUP

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

Figure 5



When you enter the SETUP mode its icon will be displayed instead of the icon of the mode, from where you entered the SETUP mode. All parameters and settings are now active and can be edited (Figure 6).

Figure 6



The characters informing on the presence of the signal and its level, as well as on the measurement method, information on the measurement units and digital value of the measurement result are always displayed in the STANDARD and MEMORY (see below).

The description of the ultrasonic contact indicators and the measurement method is given in the Table 3.

Table 3

Indicator	Description
	Maximum signal. The receiving path amplification setting is minimum.
	Medium signal. The receiving path amplification setting is medium.
	Minimum signal. The receiving path amplification setting is maximum.
	There is no signal or the signal intensity is too weak to perform measurements.
	No measurements
	Measurements using the ACF
	Measurements using the threshold method



The thickness gauge in the STANDARD mode is given on the Figure 7.
The thickness gauge in the MEMORY mode is given on the Figure 8.

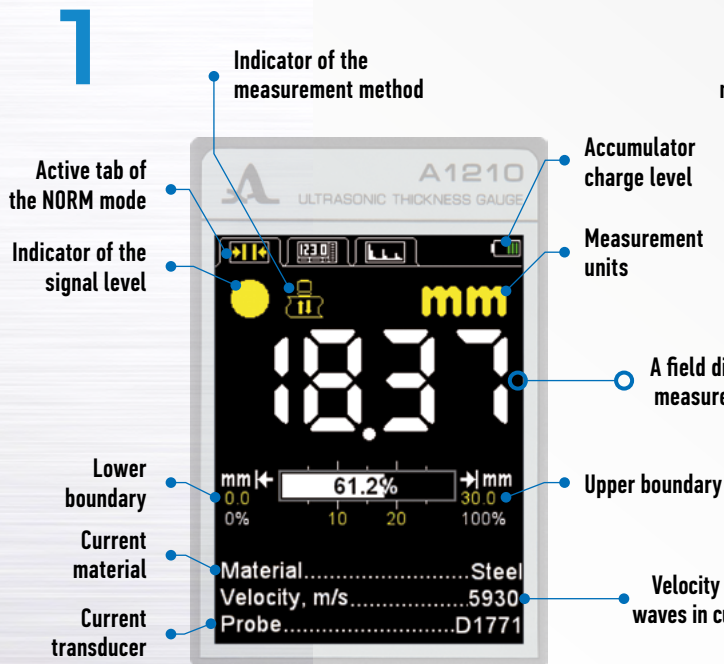


Figure 7

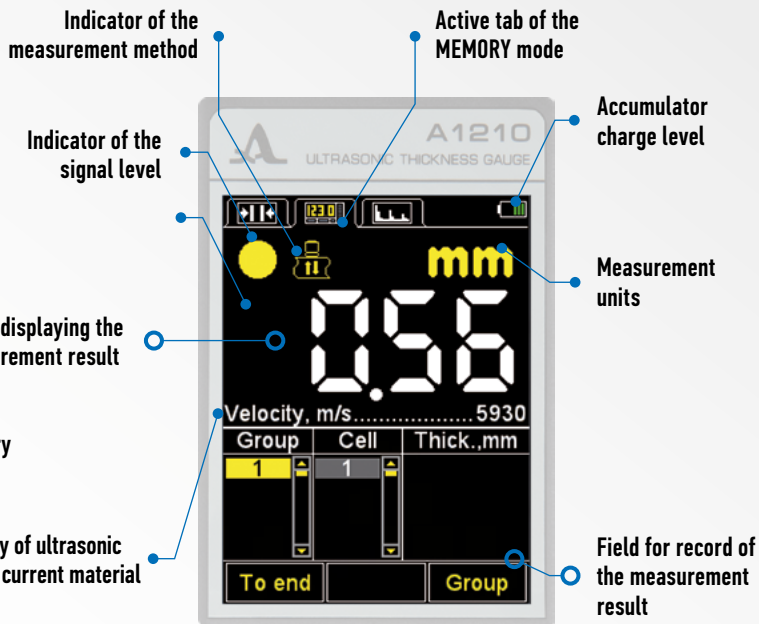


Figure 8

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

The instrument allows the user to rotate the image in the A-SCAN mode by 90 degrees to the right or to the left.

The the images on the screen are indicated depending on the selected orientation:

- vertical;
- left-horizontal;
- right-horizontal.

On the Figure 9 you see the instrument in the A-SCAN mode with the activated left horizontal orientation of the display.

On the Figure 10 you see the instrument in the A-SCAN mode with activated vertical orientation of the display.

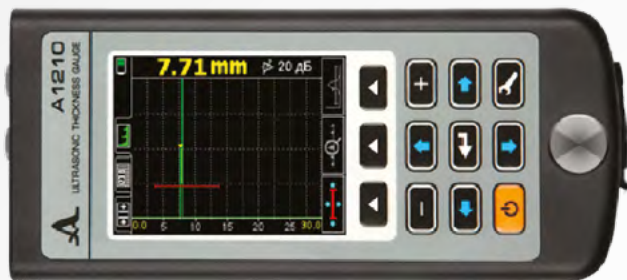


Figure 9

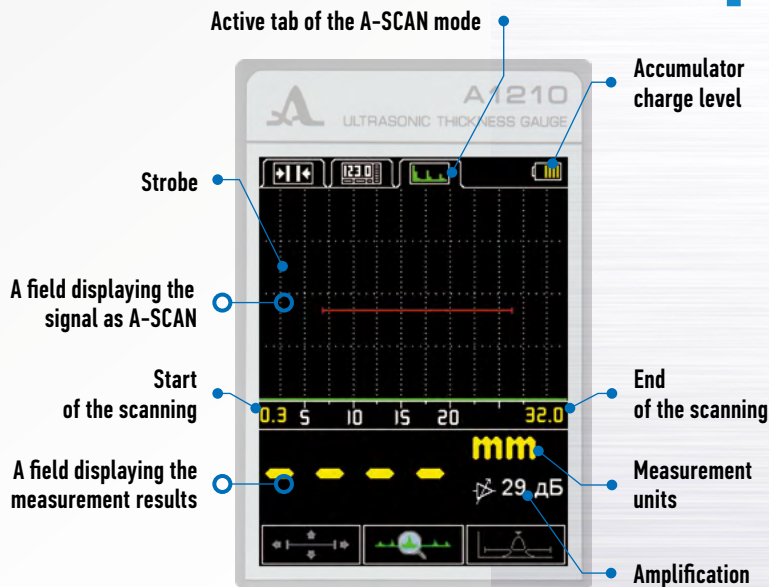


Figure 10



1.3.5 Keyboard


There are 11 functional keys and one ON/OFF key in the keyboard (Figure 11).


The main key functions:


The key  (On/Off) is used to switch the instrument on/off.







NOTE: THE INSTRUMENT WILL AUTOMATICALLY SWITCH OFF IF NO KEY IS PRESSED AND NO MEASUREMENT IS PERFORMED WITHIN 10 MINUTES (STAND BY MODE).

NOTE: IF NO KEY IS PRESSED OR NO MEASUREMENT IS FOR 2 MINUTES THE DISPLAY BRIGHTNESS WILL AUTOMATICALLY BE DECREASED TO 20%!

The functional keys  (F) carry out different functions depending on the selected operating mode. The name of the current function is indicated on the screen above each key. The functional keys are numbered in the present manual from left to right: F1, F2, F3 (Figure 12).

The key  is used to change between the measurement and the setup mode and vice versa.

The key  (ENTER) can perform different functions depending on the operating mode and the state of the thickness gauge.

The keys  / ,  /  and  /  are used to select and change active parameters. Their functions are similar for various operating modes of the device. They are ment for instinctive use. The icons of the keys reflect their functions.



F1

F2

F3

Figure 12



Figure 11

2.1 OPERATIONAL RESTRICTIONS

The instrument is designed to be operated under conditions in the Section 1.1.2.

2.2 PREPARING THE INSTRUMENT FOR USE

2.2.1 Preparation of the surface

Loose rust, corrosion or dirt on the surface of the tested object can influence the ultrasonic transmission to the material. Please clean the surface of the object, remove the rust and slag. Apply more contact fluid than the amount required for a smooth surface.

Thorough cleaning of the rough corroded surfaces will increase the measurement accuracy and prolong the life-time of the transducer.

2.2.2 Connection of the transducer

Double crystal transducers and single crystal transducers are used to determine the thickness of objects.

Connect the transducer to the instrument observing the marking.

Two cable types are be used depending on the type of the transducer; hence there are two ways to connect the PT.

Double crystal transducers are be connected by means of a double cable with LEMO 00 type plugs.

The cable with the red end shall be connected to the port marked with the red dot (Figure 13).

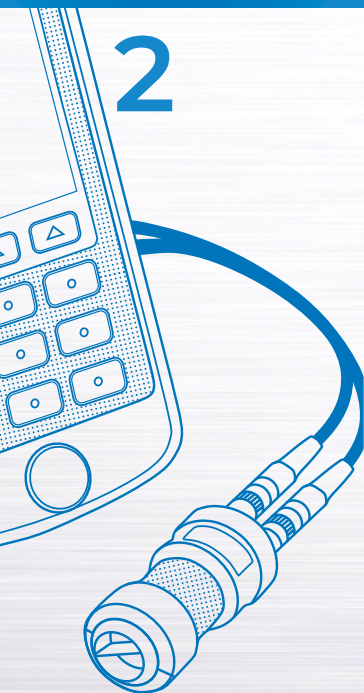
Single crystal transducers shall be connected by means of the single cable LEMO 00 to the unmarked port.




Figure 13




2




2.2.3 Switch the instrument on/off

Press the  key to switch off the instrument.

Press the  key to switch on the instrument. The information on the device, its name and the number of the firmware version is displayed on the screen (Figure 14).

The thickness gauge will automatically enter the mode which was active last time, when the device was switched off, all corresponding settings are saved.

In case the same transducer is connected to the instrument as the one that was used when the device was switched off last time, the device is immediately ready for operation. When you connect a different transducer, please first setup the device to be able to work with the transducer.

Press the  key to switch off the instrument manually. The instrument will switch off automatically if no keys are pressed or no measurement process is performed within 10 minutes.

All the settings are saved when the thickness gauge is switched off or its battery is completely discharged.

2.2.4 Setting of the instrument to the parameters of the currently used PT

NOTE: ALWAYS SETUP THE INSTRUMENT TO THE INDIVIDUAL PARAMETERS OF THE CURRENTLY USED PT PRIOR TO START WORKING WITH THE INSTRUMENT OR IN CASE YOU NEED TO CHANGE THE TRANSDUCER!

Otherwise the instrument can not be used. Any attempt to enter any measurement mode will bring the warning message: "Please check the PT".



Figure 14

2.2.4.1 Select the transducer

To choose the transducer, please:








1. Press the  key to enter the SETUP mode.
 2. Using the   keys go to the item PT and press the key F3 (Open) or  to enter the library of the transducers (Figure 15).
 3. Using the keys   go to the line with the name of the connected PT and press the key  to select it (Figure 16).
- After the transducer is selected the testing of PT will be started automatically followed by the setup of the instrument to its individual parameters.


Figure 16

2.2.4.2 Setup of the instrument to the parameters of the currently used transducer

The setup is performed in two steps. At the first step the instrument automatically analyzes the PT characteristics. At the second step it is adjusted to these features using the real echoed signal from the the calibrating sample built in the device.

To setup the instrument to the individual parameters of the currently used PT, please:

- Enter the SETUP mode.
- Go to the "PT" line and press the F1 key (Test). The message: **"PT TEST, raise the PT, remove any oil from it and press ENTER"** is indicated on the screen.

- Remove the contact liquid from the transducer. Don't touch the calibration sample and press .

The message: "Testing in process, please, wait..." is indicated on the screen.

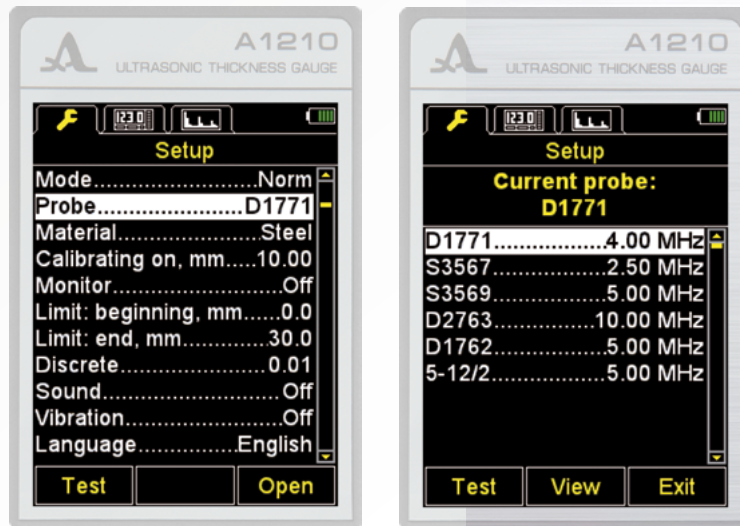



Figure 15

2

Wait for the message: "PT TEST. Put the PT onto the calibration sample and press ENTER" to appear on the screen.

- Apply some contact liquid on the calibration sample and place the transducer on it. Press the  key.

The message: "Testing is in process. Please, wait..." is indicated on the screen.

When the testing is completed the message on the testing results will appear on the screen. The result can be negative or positive. If the test result is positive, the thickness value of the calibration sample is indicated. If the test result is negative, the corresponding message is indicated (Figure 17).

Figure 17

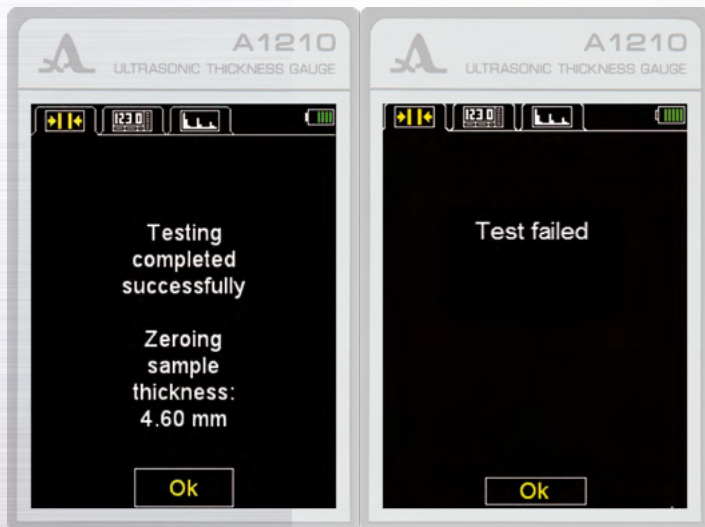


Figure 18

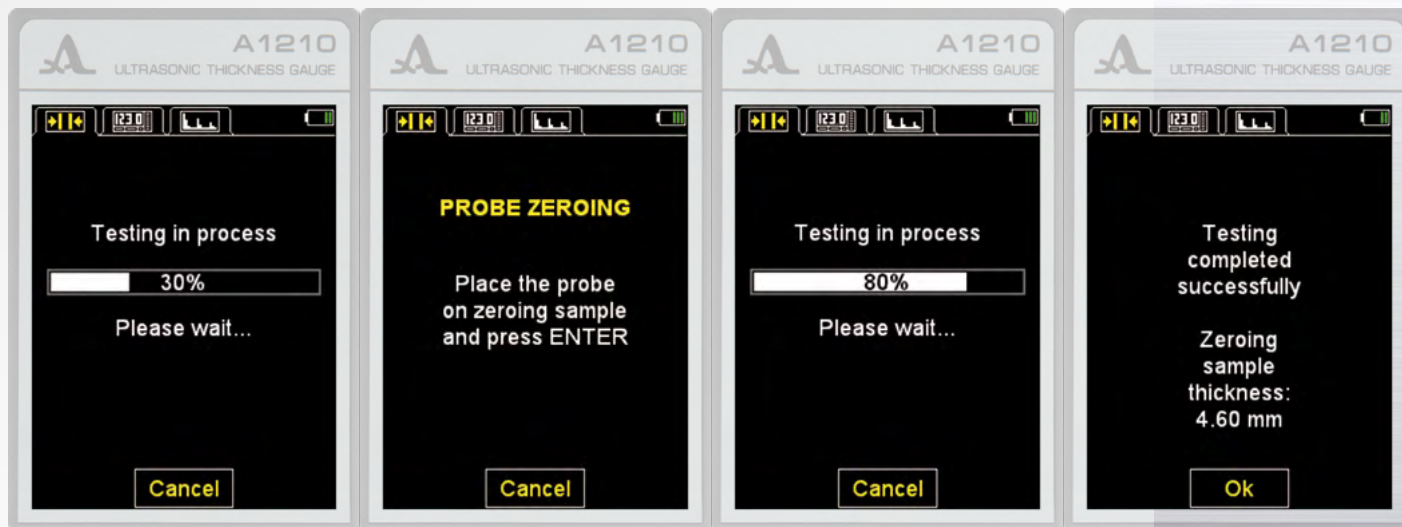


- Remove the transducer from the calibration sample.
- Press the F2 key (OK). If the test was successful, the instrument enters the measurement mode, if the test failed, the instrument will return to the main window of the SETUP mode.

To cancel the test any time, press the F2 key (Cancel). The instrument will return to the main window of the SETUP mode.

The successful setup process and the appropriate display images are shown on the Figure 18.

Figure 18



2

2.3 OPERATION

2.3.1 Using the instrument

It is not recommended to slide the operating surface of the PT along the surface of the tested object, if it is not necessary. If you have to inspect the TO in several points and the tested object has a large surface, please lift the transducer and put it on the required points. Do not continuously scan the whole surface. If it is necessary to perform the scanning, for example to determine the local material thinning, please perform it with outmost care without big pressure on the PT. Use only clean contact liquid and clean the surface from dirt prior to perform the scanning.

During the testing process please consider that the ultrasonic propagation velocity depends on the temperature of the tested material and differs in cold and warm objects.

To achieve the most accurate measurements, please set the device considering the ultrasonic velocity of the sample with the same temperature as the object to be tested.

Note: remove all contact liquid from the ultrasonic transducer after finishing the work. A drop of liquid can lead to the reflected signal. The device will not be able to switch off automatically.



2.3.2 The SETUP mode



In the SETUP mode you can perform the PT testing procedure, calibrate the velocity using the sample with a definite thickness, view the transducer library, work with the list if materials and view the list of parameters accessible to editing.

All device settings are saved when you switch off the device or when the battery is completely discharged.

The display of the instrument in the SETUP mode is shown on the Figure 19.

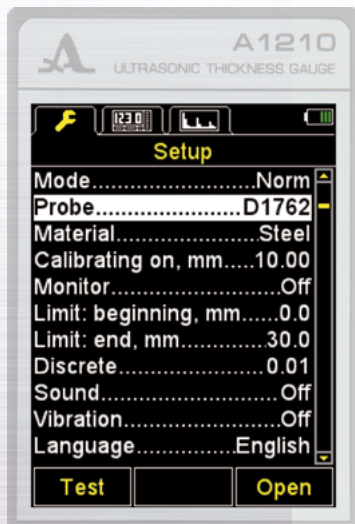
The following keys are active in any menu of the SETUP mode:

  Moving up and down the menu items, the navigation is performed cyclically in both directions. The parameter in the active line can be selected and edited;

 /  Reducing or increasing the numerical value of the selected parameter.

The items of the SETUP mode menu are identical for all measurement modes.

Figure 19



The corresponding parameters and functions are listed in the Table 4.

Table 4

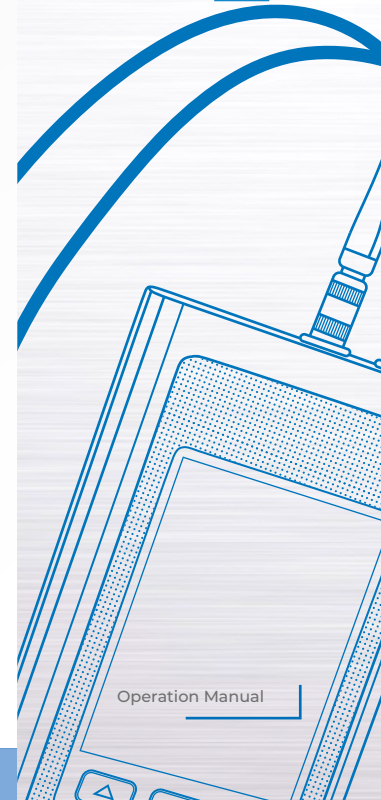
Menu item (parameter)	Parameter value	Description
Mode	Standard / Memory	Select the measurement mode
PT	Name of the PT	Enter the transducers library. Start the procedure of the PT testing
Material Calibration by, mm	Name of the material from 2 to 80	Enter the material library Set the thickness of the reference sample. Start the velocity calibration on the sample
Warning	On / Off	Regulate the sound indication
Vibro-	On / Off	Regulate the vibro-indication
Language	Russian / English	Select the interface language
Measurement unit	mm / inches	Select the system of measurements
Brightness, %	from 20 to 100	Adjust the display brightness

The additional menu items of the SETUP mode common to the modes STANDARD and MEMORY and corresponding parameters and functions are listed in the Table 5.

Table 5

Menu item (parameter)	Parameter value	Description
AFAS	Off / Beyond / Within	Off – turning off the AFAS beyond/within: tripping of the monitoring function when the result is beyond or within the previously set ranges
Limit: beginning, mm	from 0 to 150	Setting the initial limit of the AFAS

2





2



▼ Table 5

Menu item (parameter)	Parameter value	Description
Limit: end, mm	from 1 to 300	Setting the final limit of the AFAS
Discrete	0.01 / 0.1	Setting of the sampling rate of the result indication

The additional menu items of the SETUP mode and corresponding parameters (in the metric measurement system) and functions are listed in the Table 6.

Table 6

Menu item (parameter)	Parameter value	Description
Clear memory, %	from 0 to 100	Indication of the memory usage. Starts deleting the measurement results from the memory

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

Table 7

Menu item (parameter)	Parameter value	Description
Scanning start, mm	from 0 to 150	Set the scanning start
Scanning end, mm	from 5 to 300	Set the scanning end
STROBE: from, mm	from 0 to 150	Set the lower strobe boundary
Strobe: to, mm	from 1 to 300	Set the upper strobe boundary
Amplification, dB	from 0 to 80	Setting the amplification value
View the A-Scan	Fill / Stroke	Select the signal image in the A-SCAN mode
Orientation	Auto / Horiz.Left / Vert / Horiz.Right	Select the orientation of the A-Scan image on the screen

2.3.2.1 The item MODE

Selecting the measurement mode:

STANDARD: measurements and indication of the measurement results belonging to the set interval or criteria;

MEMORY: measurements and indication of the measurement results saved in the memory.

A-SCAN: measurements and indication of the signals as an A-Scan.

Active keys:

F1 (STANDARD) select the Standard mode;

F2 (MEMORY) select the MEMORY mode;

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

 changing between the modes.

The item MODE is shown in the Figure 20.

2.3.2.2 The item Probe

Enter the transducer library.

Active keys:

F1 (Test) starting the Piezoelectric transducer / PT testing procedure and the device adjustment to the selected transducer;

F3 (Open) or  enter the transducer library.

The PT item is shown in the Figure 21.

View the transducer library.

In the upper part of the window the information on the currently used

PT – “Current transducer:” is indicated.

NOTE: THE USER DOES NOT HAVE THE POSSIBILITY TO MAKE CHANGES IN THE TRANSDUCER LIBRARY AND TO ADD TRANSDUCERS!

Figure 20

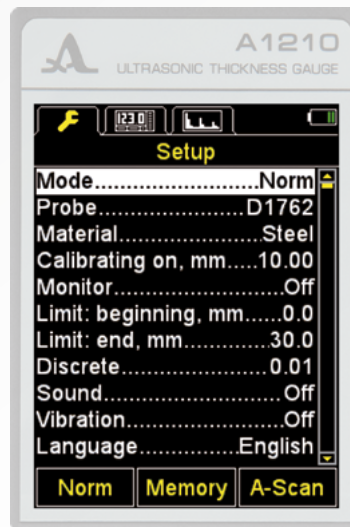
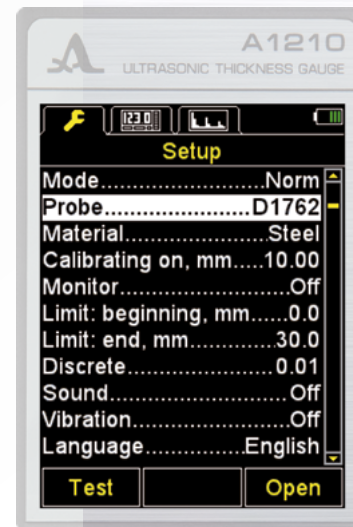


Figure 21




2

Active keys:

F1 (Test) start the procedure of setting and setup of the instrument to the individual PT parameters.

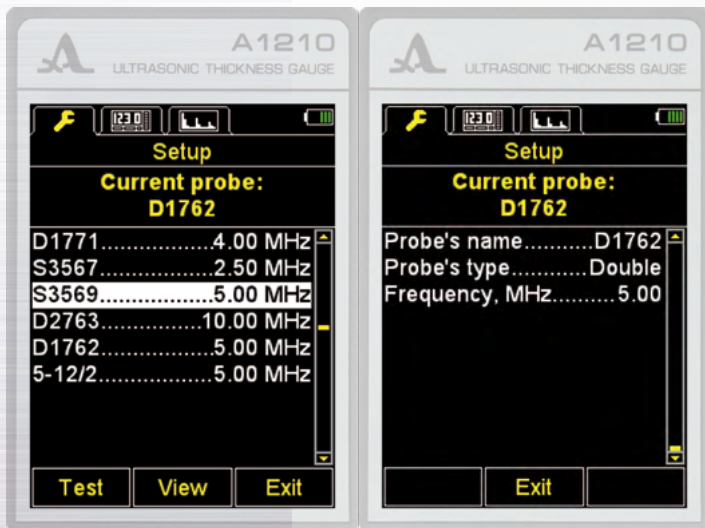
F2 (View) view the detailed information on the transducer. The information on the type, name and frequency of the PT will be displayed.

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

Using the  you select a transducer from the list. The PT testing procedure is then automatically started, the device is adjusted to the transducer parameters. The procedure is described in the Section 2.2.4.2.

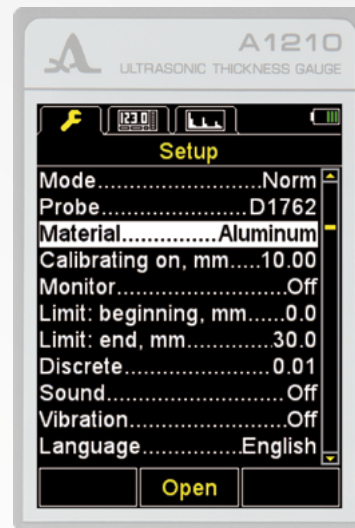
When you exit the library, the device saves the last active line and uses it when you enter the list again. When the device is switched off the information on the active line is reset.

Figure 22



The device screens when viewing the transducer library are shown in the Figure 22.


Figure 23



2.3.2.3 The item MATERIAL

Enter the library of the materials.

Active keys:

F2 (Open) or  enter the library of the materials to record a new and edit the existing materials, as well as to select the material for operation.

The item MATERIAL is shown in the Figure 23.

Working with the library of the materials.

In the device memory the information on 64 materials can be stored.

2

In the upper line of the window the information on current used material and the ultrasonic velocity in this material is indicated.

Add a new material.

The first menu item is NEW. It is followed by the name and the ultrasonic wave propagation velocity in a material saved in the device memory (Figure 24).

Active keys:

F1 (Create) open the material editor (Figure 25).

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

Active keys:

F1 (Save) exit the editor and save the changes.

F2 (XXX) switching between the Russian and English languages in the letter table and between the small and capital letters, e.g. “абв” or “АБВ” for Russian. “abc” or “ABC” for English.

F3 (Exit) exit the editor without saving the changes.

When you add a new or edit an existing material, the following information is displayed on the screen: the current name of the material with the inverted active symbol in the material field name, the propagation velocity of the ultrasonic waves in the material and tables with the available characters.

To change the name of the material, please:

- Using the keys **←** **→** select the character in the material name line, that you want to change or delete, for example “S” for **Steel**;
- Press F2 key to select the language and the case;
- Using the keys **←** **→** **↑** and **↓** select a new character in the table of the characters, for example “B” – **A B C D**, the function of the selected character, e.g. **Del** delete or the character preceding the selected one – **←**, press the **↶** key;

Figure 24

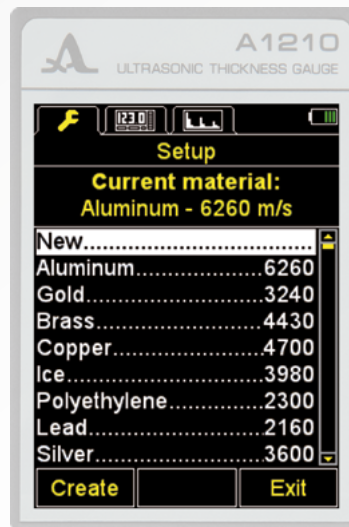


Figure 25





4. Press F1 to confirm changes, press F3 to cancel.

To change the ultrasonic propagation velocity in the material, please:

5. Using the keys or place the cursor in the velocity field. A soon as the velocity value becomes active, it changes its color from white **5930** to red **5930**. The value will be decreased/increased depending on the selected key.

6. Using the keys or set the required value of the ultrasonic velocity **Steel** | **5902**.

7. Press the key , the velocity value will change its color to white and the first character of the material name will become active **S**teel | 5902.

8. Press F1 to confirm changes, press F3 to cancel.

Table 8

Key	Function
	Moving in the table of characters
	Select the character for editing in the material field name. Change the velocity value
	Replace the active character with a character from the table. The next character will be active after replacement
F1 (Exit and save the changes
F2 (XXX)	Switching between the characters in the table of letters, where XXX: аЪв – Russian small letters АБВ – Russian capital letters abc – English small letters ABC – English capital letters
F1 (Exit the editor without saving the changes

Editing the information on a material.

Active keys:

F1 (Edit) open the editor of the information on the selected material. The process is similar to the process described above.

F2 (Delete) delete the material from the memory.

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

 select a material for further work and return to the main window of the SETUP mode.

When you exit the library, the device saves the last active line and sets it when you return to the library. When the device is switched off, the information on the active line is reset.

The library of materials is shown in the Figure 26.

After pressing the F2 key (Delete), the message "Delete the selected material?" is indicated on the screen (Figure 27). Confirm deletion by pressing F1 (Yes), or cancel it by pressing - F3 (No).

2.3.2.4 CALIBRATION FOR option

The item CALIBRATION FOR is used to determine the velocity of ultrasonic waves in the material of known thickness.

The thickness of the reference sample can be set within the range from 2 to 80 mm.

The item CALIBRATION FOR is shown in the Figure 28.

Active keys:

F1 (-) or  decrease the thickness value of the reference sample.

F2 (Start) starts the velocity calibration on the sample.

F2 (+) or  increase the thickness value of the reference sample.

Figure 26

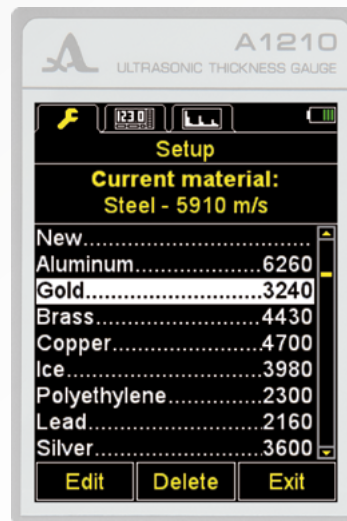


Figure 27



2

Set the thickness of the reference sample and calibrate the velocity on the sample.

Please perform the velocity calibration as follows:


1. Set the thickness of the sample.
2. Start the procedure of the velocity calibration on the sample.
3. The message "Put the transducer on the calibration sample and press ENTER" appears on the screen.
4. Apply contact liquid to the sample.
5. Place the PT on the sample with the preset thickness and press .
6. The message "Data retrieval on the sample with the thickness XXX is in process", appears on the screen, where XXX is the determined sample thickness.

Figure 28

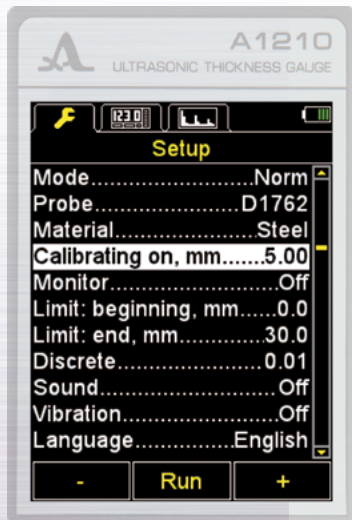
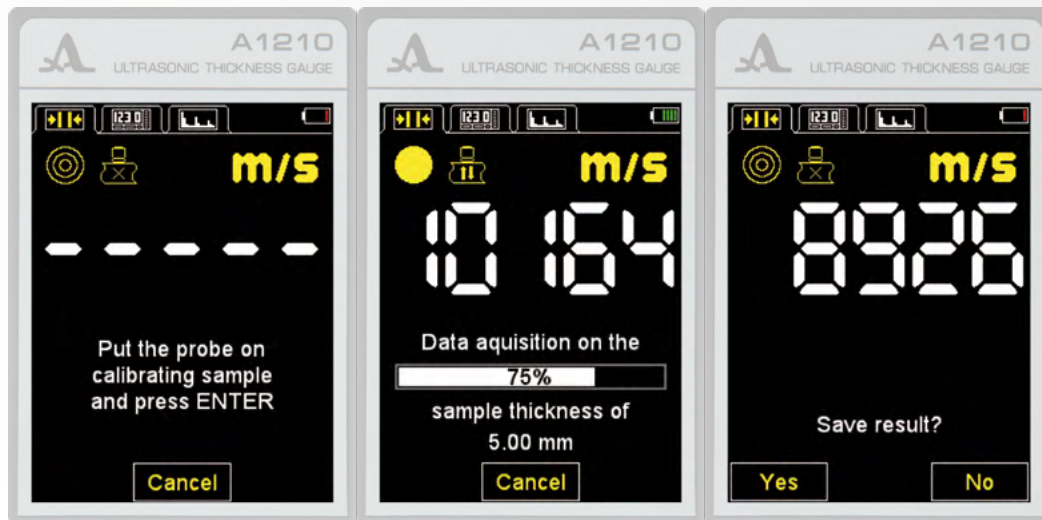


Figure 29



7. The current result of the velocity measurement is indicated on the screen. After the measurements are completed the velocity value will appear at the screen. The message “Save the result?” is indicated.

The calibration procedure using the sample with a definite thickness is shown in the Figure 29.

Saving the velocity values determined during calibration.

Active keys:

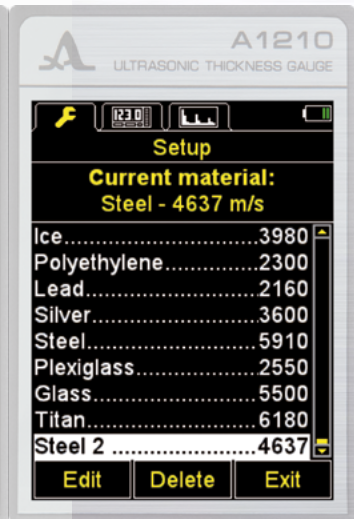
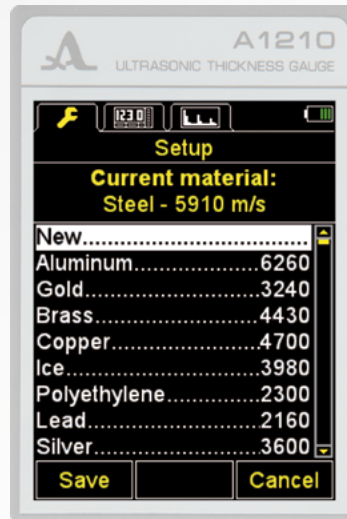
F1 (Yes) save the determined velocity value for the material from the library selected from the list, (Figure 30) or create a new one by selecting the item “New” (Figure 31), and pressing the F1 key (Save).

F3 (No) exit without saving the result.

Figure 30



Figure 29



2

2.3.2.5 The item AFAS (for the STANDARD and MEMORY modes only)

Setting the conditions for colour, acoustic and vibration alarm during the measurements.

Selecting the alarm conditions:

WITHIN means the measurement result is within the set interval;

BEYOND means the measurement result is beyond the set interval;

OFF the AFAS is switched off.

The item AFAS is shown on the Figure 32.

Active keys:

F1 (WITHIN) selecting the alarm conditions WITHIN;

F2 (OFF) the AFAS is switched off;

F3 (BEYOND) selecting the alarm conditions BEYOND;

 Switching between the conditions WITHIN / OFF / BEYOND.

Figure 32

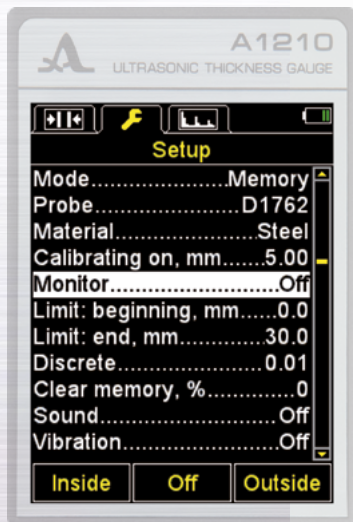
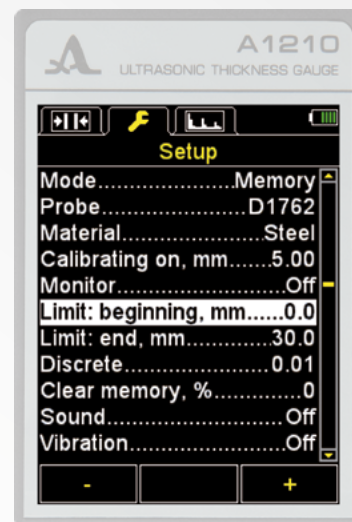


Figure 33




2.3.2.6 The item LIMIT: BEGINNING option (for the STANDARD and MEMORY modes only)


Setting the lower limit of the AFAS actuation.

The permissible values are from 0 to 150 mm.

The item LIMIT FROM is shown in the Figure 33.

Active keys:

F1 (-) or  decrease the value of the lower limit of the AFAS actuation.



F2 (+) or  increase the value of the lower limit of the AFAS actuation.

2

2.3.2.7 The item LIMIT: END (for the STANDARD and MEMORY modes only)

Set the upper boundary of the AFAS actuation.
The permissible values are from 1 to 300 mm.
The item LIMIT TO is shown in the Figure 34.

Active keys:

F1 (-) or  decrease the value of the upper limit of the AFAS actuation.
F2 (+) or  increase the value of the upper limit of the AFAS actuation.

2.3.2.8 The item DISCRETE (for the STANDARD and MEMORY modes only)

Setting the result of the image sensitivity on the screen.
The item Discrete is shown in the Figure 35.

Active keys:


F1 (0.1) set the measurement results indication with one hundredth;
F3 (0.01) set the measurement results indication with one hundredth;
 switching between the sensisvity values 0.1 and 0.01.

Figure 34

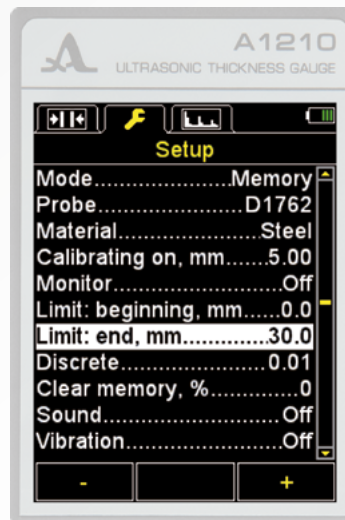
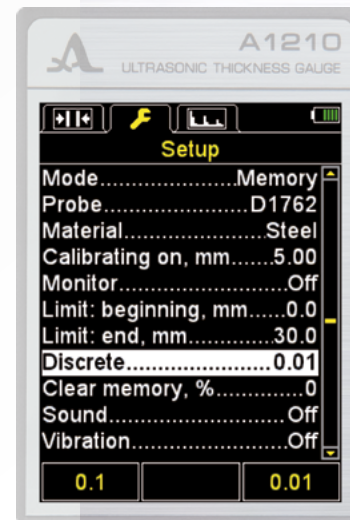


Figure 35



2


2.3.2.9 The item CLEAR MEMORY (for the MEMORY mode only)

Delete the measurement results from the memory.

As the item parameter the percentage of the memory filling with the measurement results is given.

The item CLEAR MEMORY is shown in the Figure 36.

Active keys:

F2 (Start) or  start the procedure of memory cleaning.

After the memory cleaning is started, the following message appears on the screen: "Saved data will be deleted. Continue?" (Figure 37).

Figure 36

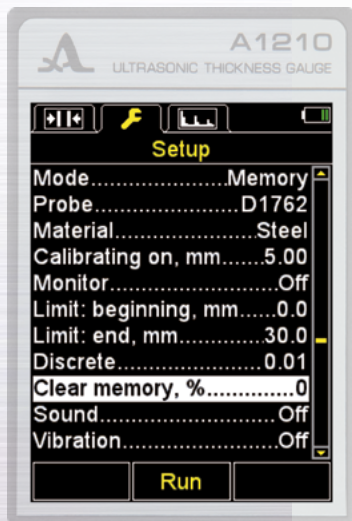


Figure 37



Active keys:

F1 (Yes) confirm the data deletion.

F3 (No) cancel the data deletion.


2.3.2.10 The item SCAN BEGINNING (for the A-SCAN mode only)


The item SCAN BEGINNING allows to set the beginning of the A-Scan display area on the screen.

The scanning start value can be set within the 0 - 150 mm range.

The item SCAN BEGINNING is shown in the Figure 38.

Active keys:

F1 (-) or  decrease the value of the scanning start.

F2 (+) or  increase the value of the scanning start.


2.3.2.11 The item SCAN END (for the A-SCAN mode only)

The item SCAN END allows to set the end of the A-Scan display area on the screen.

The scanning end value of can be set within the 5 - 300 mm range.

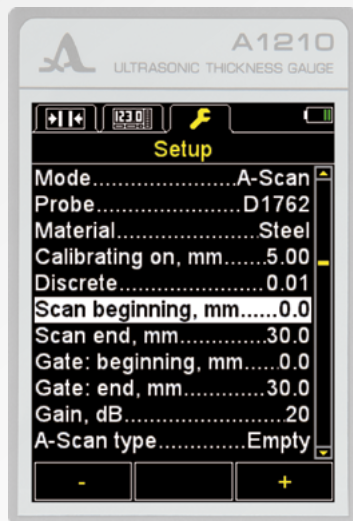
The item SCAN END is shown in the Figure 39.

Active keys:

F1 (-) or  decrease the value of the scanning end.

F2 (+) or  increase the value of the scanning end.

Figure 38




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

The item GATE: BEGINNING allows to set the lower limit of the strobe.

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

The item GATE: BEGINNING is shown in the Figure 40.

Active keys:

F1 (-) or  decrease the value of the lower limit of the strobe.

F2 (+) or  increase the value of the lower limit of the strobe.

Figure 39

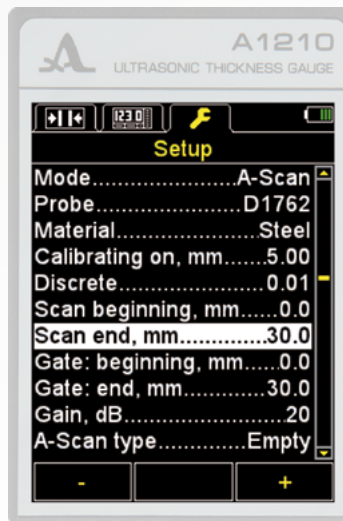
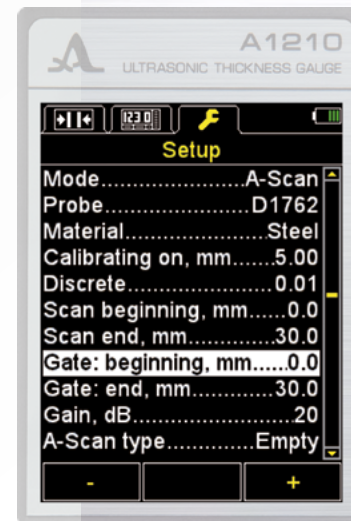


Figure 40



2

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

The item GATE: END allows to set the upper limit of the strobe.

The value can be set within the range from 1 to 300 mm.

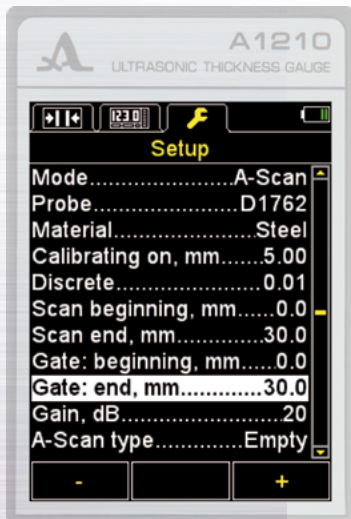
Display of the GATE: END option is presented on Figure 41.

Active keys:

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

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

Figure 41




2.3.2.14 The item GAIN (for the A-SCAN mode only)

The item GAIN allows to set the amplification value of the receiving path of the instrument.

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

The item GAIN is shown in the Figure 42.

Active keys:

F1 (-) or  decrease the amplification value.


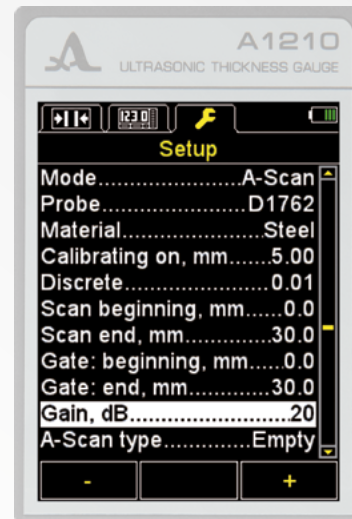
F2 (+) or  increase the amplification value.

Figure 42



2.3.2.15 The item A-SCAN IMAGE (for the A-SCAN mode only)

Select the signal indication in the A-SCAN mode and the possibility of viewing the saved A-Scans in the MEMORY mode. The signal can be indicated as FILL or STROKE. The item A-SCAN IMAGE is shown in the Figure 43.

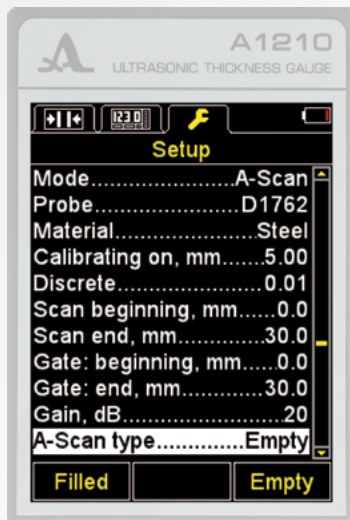
Active keys:

F1 (Fill) the detected signal is indicated in the filled form.

F3 (Stroke) the detected signal is indicated in the form of an outline.

 switching between the signal images.

Figure 43



2.3.2.16 The item ORIENTATION (for the A-SCAN mode only)


Select the form of the image orientation in the A-SCAN mode – AUTO / HORIZ. RIGHT / VERT / HORIZ.LEFT. The item ORIENTATION is shown in the Figure 44.

Active keys:

F1 (Horiz.Left) horizontal left.

F2 (Vert.) vertical.

F3 (Horiz.Right) horizontal right.

 change to the mode of the automatic image adjustment depending on the instrument position.

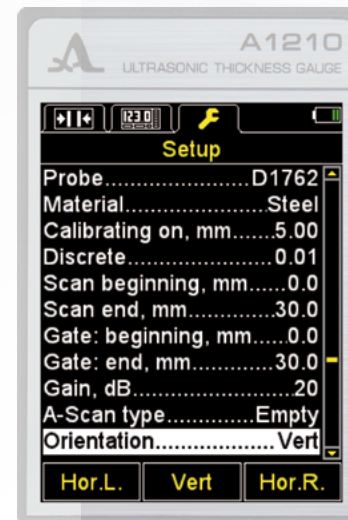
2.3.2.17 The item SOUND

SWITCH the acoustic indication of the instrument ON / OFF.

To increase the usability and the user friendliness of the thickness gauge the main events occurring inside it during measurements, settings and when pressing the keys are accompanied by acoustic signals. Acoustic signals allow to monitor the IS signal acoustically. Additionally, acoustic signals inform the operator on the current operations not influencing the measurement results.

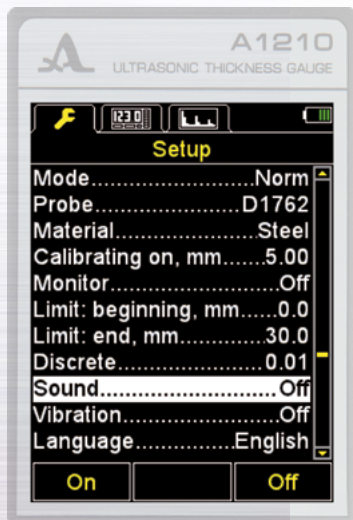
2

Figure 44



2

Figure 45



The item SOUND is shown in the Figure 45.

Active keys:

F1 (ON) switch on the acoustic indication.

F3 (OFF) switch off the acoustic indication;

 switch the acoustic indication on/off.

2.3.2.18 The item VIBRATION

SWITCH ON / SWITCH OFF the vibro-indication of the instrument.

SWITCH the vibro-indication of the instrument ON / OFF.

To increase the usability and the user friendliness of the thickness gauge the main events occurring inside it during measurements, settings and when pressing the keys are accompanied by vibration. Additionally, the vibration informs the operator on the current operations not influencing the measurement results.

The item VIBRATION is shown in the Figure 46.

Active keys:

F1 (ON) switch the vibro-indication on;

F3 (OFF) switch the vibro-indication off;

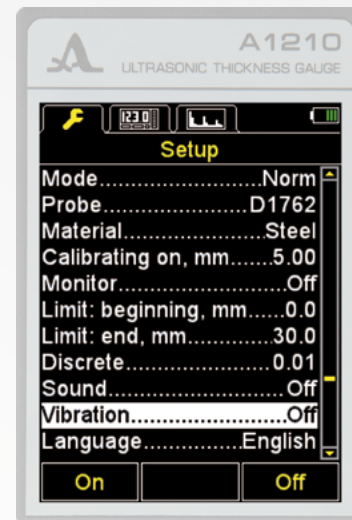
 switch the vibro-indication on/off.

2.3.2.19 The item LANGUAGE

The following instrument interface languages can be selected:

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

Figure 46




The item LANGUAGE is shown in the Figure 47.

Active keys:

F1 (Russian) scroll left to select the language;

F3 (→) scroll right to select the language;

 switching between the available interface languages.

2.3.2.20 The item MEASURING UNITS


Select the system of measurement units i.e. mm or inches.

The item MEASURING UNITS is shown in the Figure 48.

Active keys:

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

F3 (inches) Imperial measurement units. The thickness is displayed in inches, the velocity in inches/microsecond;

 switching between the measurement systems.

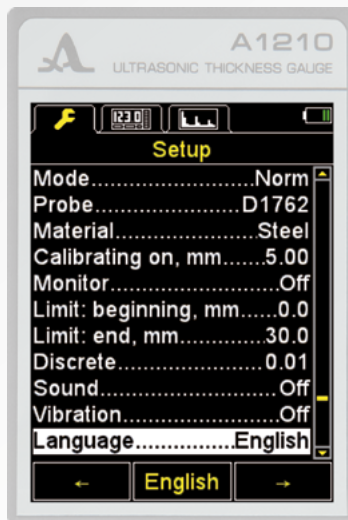


Figure 47

Figure 48





2

2.3.2.21 The item BRIGHTNESS

Set the display brightness from 20 to 100 %. The item BRIGHTNESS is shown in the Figure 49.

Active keys:

F1 (-) or  decrease the display brightness.

F3 (+) or  increase the display brightness.

2.3.3 The STANDARD mode



Please, use this mode to determine if the thickness of the tested object is within the set limits.

Aply some contact liquid on the surface of the tested object to perform the measurements. Place the transducer on the surface you want to inspect. In the upper left corner, there is the ultrasonic signal strength indicator and the measurement method indicator.

When the acoustic warning is on, the readings on the display are accompanied by short acoustic signals.

On the Figure 50 you see the device screen in the STANDARD mode when selecting the operating condition AFAS WITHIN or BEYOND. The measurement result is displayed in red if the AFAS actuation is activated, if it is not activated, the results are white.

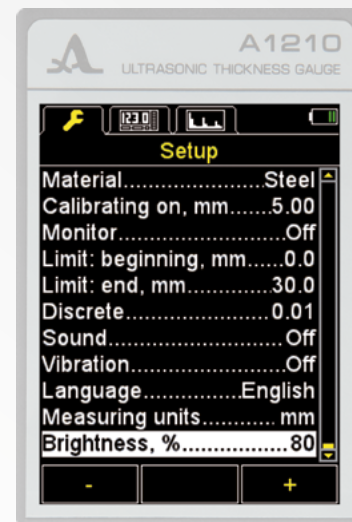
Active keys:


  change the velocity of ultrasonic waves in the material.

If the indication on the screen is instable and the acoustic warning is on, please wait for the ultrasonic transducer to stabilize and show constant values.

NOTE: WHEN YOU REMOVE THE ULTRASONIC TRANSDUCER FROM THE SURFACE OF THE INSPECTED OBJECT, THE MEASUREMENT RESULTS DISAPPEAR AND YOU SEE HORIZONTAL STROKES!

Figure 49



 save the current result.

Note: The result will be recorded into the first free cell of the last existing group, created in the MEMORY mode. Enter the MEMORY mode to select the groups and view the saved value.

The value recorded in the Standard mode of the memory can be adjusted in the MEMORY mode according to the instructions listed in the Section 2.3.4.3.

2

Figure 50



2

After the  key is pressed, the message “Save current result?” is indicated (Figure 51).

Active keys:

F1 (Save) save the result.

F3 (Cancel) cancel the saving.


2.3.4 The MEMORY mode

In the MEMORY mode the screen is divided in two parts. In the upper part the measurement information is indicated in the same way as in the STANDARD mode (thickness, level of the signal, measurement method, velocity of the ultrasonic waves in the current material). In the lower part the information on the already saved results in the STANDARD, MEMORY and A-SCAN modes (groups, cells of the groups and thickness measurement results) is indicated (Figure 52).

Active keys:

F1 (to the last) go to the empty cell (the cell following the last recorded) of the last existing group.

F3 (group) add a new group or delete the last group.

 save the measurement result in the current group. Select any group before measurement or during it to save the result.

 view and adjust the measurement results recorded in the memory.

2.3.4.1 Add a new group or delete the last group

Press the F3 key. The message “Add new or delete the last group?” will appear on the screen (Figure 53).

Active keys:

F1 (-) delete the last group.

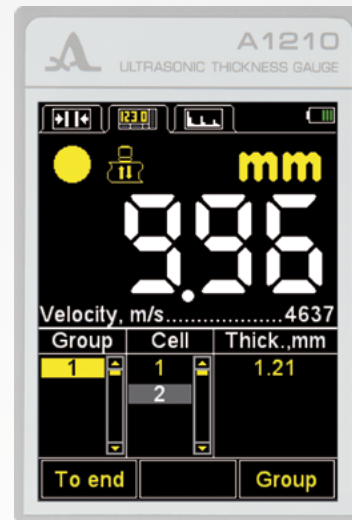
F2 (Cancel) exit the window.

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

Figure 51



Figure 52



2.3.4.2 Save results

Measurement results are stored in the device memory in cells, which form groups. Groups and cells in groups are identified by serial numbers. Groups and cells in each group are numbered, started with number ONE.

The maximum number of cells in a group is 500.




The maximum number of groups is 100.


As soon as the maximum number of groups or the maximum number of cells in a group is reached, the corresponding message will appear on the screen.



From experience it is more comfortable to record the results in small groups with several dozens of parameters. If necessary, you can return to any existing group and continue recording the results in this group (Section 2.3.4.1).

2.3.4.3 View and adjust the measurement results

Any result recorded the device memory can be viewed. If you have any doubts concerning its reliability, you can correct it by performing a new measurement in the same point and recording it.

The key  is used to enter the view mode and edit the results. BY pressing the key  the icon  appears on the screen (Figure 54).

Using the key  you return to the MEMORY mode.

To view the recorded results, use the keys  . Moving within one group of cells you see the measurement results according to the selected direction of viewing. As soon as you reach the last/first cell in a group, you will move to the next or the previous group of results accordingly.

To to correct the results, please:


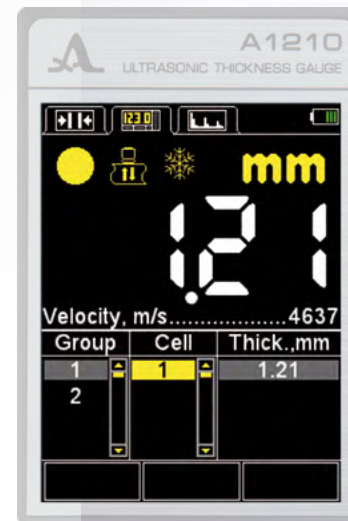
- Using the keys   go to the cell with the recorded result which will be corrected;





Figure 53



Figure 54











2. Press the key  the icon  will disappear.
Note: as a matter of fact, the result remains in the device memory until a new value is recorded in the selected cell. To return to the view mode, without changing the value recorded in the cell please press .
3. Perform the measurement. If the measurement result is satisfactory, press the key  to record in into the selected cell. The instrument will automatically return to the view mode after doing it.

2.3.5 The A-SCAN mode

The thickness measurement process in the A-SCAN mode includes the analysis of the image shape of the echoed signal, the selection the analysis interval and criteria of calculation of the time required for the ultrasonic pulses to pass through the material from one surface to another. This is converted to the thickness value of the TO using the propagation velocity of the ultrasound pulses in the material.

In the A-SCAN mode with the vertical orientation the display is divided into two parts: in the upper part the signal in the form of an A-Scan is indicated. In the lower part the digital values of the parameters and control icons are indicated (Figure 55).

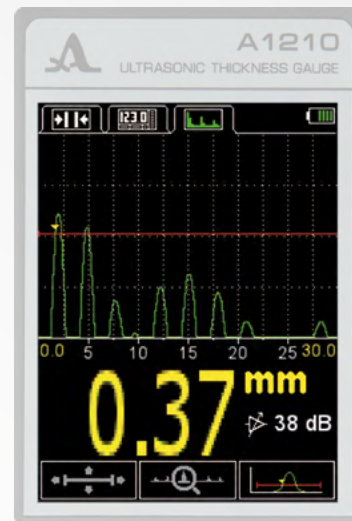
The main active keys:

- F1 () control the strobe size and position.
- F2 () control the signal indication.
- F3 ( /  /  / ) select a measurement method: ACF acc. to the strobe/ AUTO / acc. to the maximum point it the strobe / between two peaks in the strobe.

 save the measurement result.




Note: The result is recorded into the first free cell of the last existing group, created in the MEMORY mode. Enter the MEMORY mode to select the group and view the saved value.

Figure 55






The functional purpose of the keys with the first active icon is described in the Table 9.

Table 9

Key	Function
	Change the length of the strobe relative to its left boundary
	Vertical strobe displacement
	Horizontal strobe displacement

The functional purpose of the keys with the second active icon is described in the Table 10.

Table 10

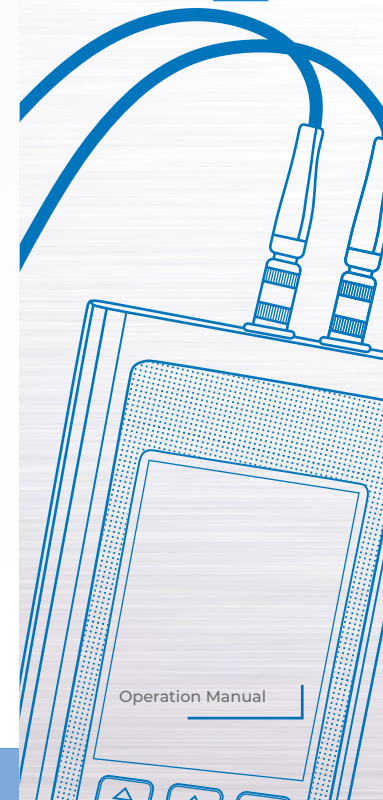
Key	Function
	Change the scanning length
	Change the amplification value
	Horizontal scrolling of the signal on the display

The functional purpose of the keys with the third active icon is described in the Table 11.

Table 11

Key	Function
	Change the amplification value

2





2

2.3.5.1 Save the A-Scan

After the key is pressed the message “Save the current A-SCAN?” appears on the screen. The message must be confirmed (Figure 56).

Note: The result is recorded into the first free cell of the last existing group created in the MEMORY mode. Enter the MEMORY mode to select the group and view the saved value.

Active keys:

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

F3 (Cancel) cancel the saving.

Figure 56



Figure 57

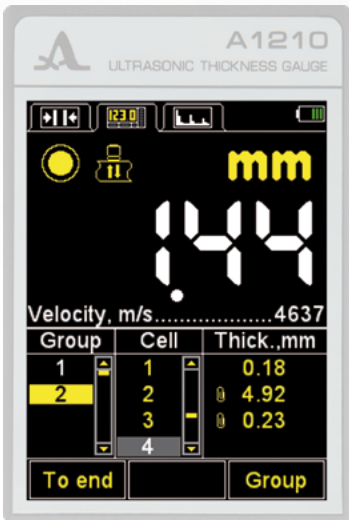


Figure 58

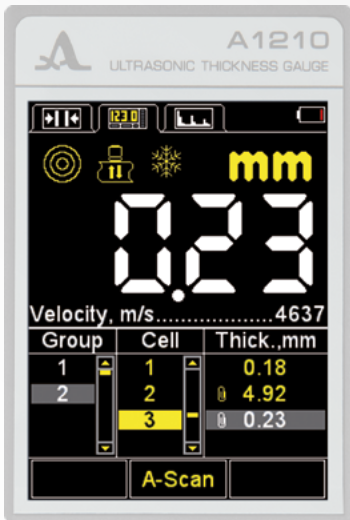
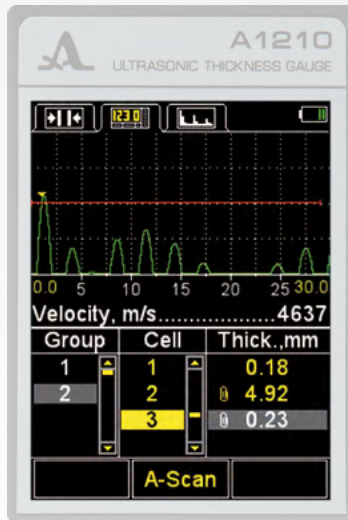




Figure 59



2.3.5.2 Viewing the saved A-Scans

Enter the MEMORY mode to view the saved A-Scans and corresponding measurement results. The data for which the A-Scans are saved in the column of the measurement result are marked with the  sign in front of the result value (Figure 57).

Press the key  to enter the view mode and press the F2 key (A-Scan) (Figure 58).

The A-Scan saved for the selected result (Figure 59) is displayed in the upper part of the screen.

Press the F2 key (A-Scan) to return to the viewing mode of the results.

The value recorded into the memory in the A-SCAN mode can be adjusted in the MEMORY mode as described in the Section 2.3.4.3.

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

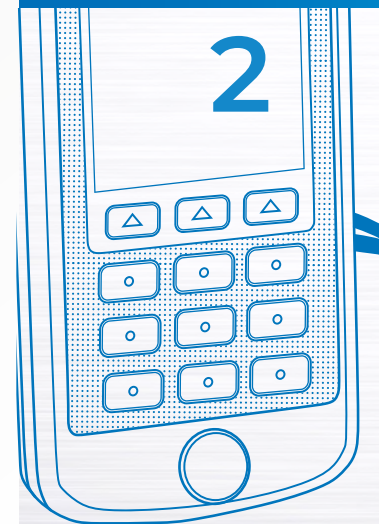
2.4 MEASUREMENTS

Prior to measure the thickness, please select a transducer from the reference list. Adjust the instrument and select a material to perform the measurement. If the set material velocity differs from the actual velocity, please correct the velocity manually or perform calibration.

The more accurate the velocity setting, the more accurate are the measurements. If estimation is allowed during the measurements, please use the table given in the Annex A and set the value specified in the Table.

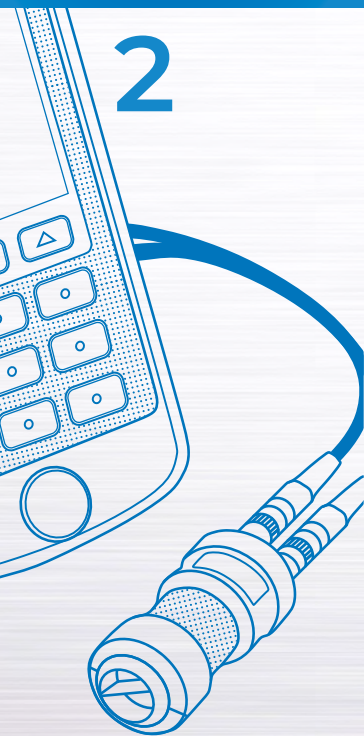
If you need accurate results, please take a sample from the same material as the inspected object and adjust the velocity according to it. Please set the velocity using the same PET, that will be used to perform the measurements. The best solution is to use a plane parallel sample with smooth surfaces. Please remember, the bigger the thickness of the sample (within the accessible range) and the better the quality of its surface, the more accurate will be the device adjustment to the ultrasonic velocity of the sample

During the measurements ensure the place where you put the transducer is clean, covered with liquid and has no rough edges or cavities preventing the transducer installation on the surface. If it is not possible to install a transducer on the bottom of the cavity, you will not receive measurement results.





2



2.4.1 Measurements with double crystal (PC) transducer

To perform measurements of flat objects you just have to carefully press the ultrasonic transducer to the testing surface and wait for 2-3 seconds to squeeze the excess of the lubricant. During this time the readings of the instrument should stop changing and show the final result. Without lifting the transducer from the surface of the tested object read the measurement result on the screen or save it in the device memory, depending on the selected measurement mode.

If the surface is covered with slag and rust, please remove the loose slag and corrosion and apply more liquid than with a smooth surface. When the ultrasonic contact indication is absent, the measurement results will not be indicated on the screen. Please perform the testing again after thorough cleaning the contact place from corrosion. Always remove rough edges and corrosion from the TO, as this increases the measurement accuracy and allows to increase the service life of the transducer.

To test circular objects, please follow some important steps. To measure the wall thickness of a pipe, especially of pipes with small diameter, please use more viscous liquids than transformer oil or water. Apply more liquid to the contact place. The screen dividing the vision blocks of the transducer shall be positioned across the pipe axis. The light strip at the end of the transducer is located along the working surface diameter. Press the transducer to the pipe wall and observe the device readings, then slowly tilt the transducer within the cross-section plane of the pipe in both sides. Please mind however, you have to roll the transducer along the pipe wall and do not slide along the wall. When the transducer deviates from the neutral position the device readings will increase. Commonly the readings are minimal in the position where the transducer touches the pipe walls in the middle of its operating surface, i.e. when the longitudinal transducer axis crosses the pipe axis. When the transducer highly deviates from this position the readings increase explosively. As the correct value of the measured thickness please take the smallest stable reading of the device when the PET contacts the pipe wall in the middle of the operating surface.

2.4.2 Measurements with single-crystal transducer

As soon as the PT touches the surface of the TO in a fraction of a second the reliable ultrasonic contact of the transducer and TO is established. The first readings appear on the screen. These readings may differ insignificantly on pipes with small diameters when the transducer is shaking. On flat objects the readings are stable.

When inspecting the flat metal objects with a thickness of less than 4-5 mm there is no need to make the contact liquid

layer as thin as possible, i.e. there is no need to strongly press the transducer against the surface, forcing it against the surface. Press the transducer a little so that to make the thickness gauge to display the measurement results. From this moment the readings will remain almost the same.

When the thickness of a flat object is more than 20 mm please ensure the transducer is well pressed to the surface.

The pipe wall thickness measurement is especially easy to perform, as you do not have to align the transducer with the generating line of the pipe. It is also not necessary to rock the transducer on the pipe to find the smallest measured value. It is enough to place the middle of the operating surface of the transducer on the generating line of the pipe approximately. Please always use a thick liquid, e.g. mineral fat or lithol.

While testing the objects with dual convex shape always provide the contact point of the object with the center of the working surface of the transducer.

Single-crystal transducers have advantages as compared to the PT transducer when performing measurements of objects with rough or coarse surfaces. The single-crystal transducer allow to perform scanning along the surface even with rough surfaces and rests of abrasive particles. This is useful when searching for places with thinnings. At this please use more viscous contact liquids, e.g. mineral motor oil.

In any case, wait 2 seconds after the readings appear on the display to evaluate their stability. After that, with the transducer on the surface, read the measurement result from the screen or save it to the memory.

2.4.3 Checking the functionality of the instrument during testing

You will have to check the functionality of the instrument during inspection if, for example, you have a series of questionable readings during measurement.

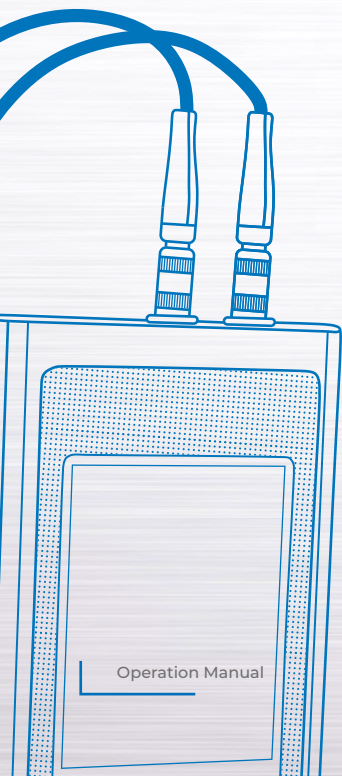
Use the reference testing sample built in the instrument to to check the functionality. The sample thickness is 5 mm, the propagation velocity of the ultrasonic waves in it is 5750 m/s.

Please set the velocity value in the instrument to 5750 m/s, apply some contact liquid onto the reference sample and place the ultrasonic transducer on the sample. If the instrument operates properly, the thickness measurement result will be 5 mm considering the measurement error.





2



2.5 TRANSFER DATA TO A PC

Digital data are saved in the memory in the **CSV** format convenient for export. Thus, the measurement results can be further analysed and processed by means of the external programs (Figure 60). The data will be saved into a single file named **"results.csv"**. The results are arranged in the file according to the number of the group.

A-Scans must be saved into the files named **"aXXX-YYY.bmp"**, where **XXX** is a serial number of the group, and **YYY** is a serial number of the measurement in the group.

To transfer the data from the instrument to a PC please:

1. Connect the instrument to a PC using the USB A – Micro B cable included in the delivery kit.

The OS will detect the instrument as an external removable disk named **"ACSYS DISC"**. It can be opened in the MS Windows "Explorer" or any File Explorer.

The data can be read directly from the instrument as well as copied to a PC.

You can name the data file as required for copying.

	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

Data in MS Excel

```

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

```

Data in Notepad

Figure 60

The maintenance of the device includes cleaning of the electronic unit from dirt and dust and loading the battery.

3.1 BATTERY

The device battery can be used in a wide temperature range.

In the lower temperature range the battery capacity is app. 15% lower than under normal temperatures. When the battery is completely discharged the device will be automatically switched off. There is an internal overcharge protection, overcurrent protection and temperature protection inside the battery. The battery lifetime is rated for the guaranteed service period of the device. The battery can only be changed by a service center.

PLEASE NOTE: THE USER MAY NOT EXCHANGE THE BATTERY ON HIS OWN AS THIS LEADS TO THE ANNULMENT OF THE WARRANTY FOR THE DEVICE!

3.2 CHARGING THE BATTERY

The battery can be charged from an external charger or a PC using the USB port.

The loading time of the battery depends on the level of its discharge. To completely load the battery, you will need 4 to 5 hours. Repeated recharging is allowed.

The device can be operated during the process of loading from an external charger, in this case the loading time will increase by 2 to 3 times.

PLEASE NOTE: TO AVOID THE BATTERY FAILURE NEVER STORE THE INSTRUMENT WITH BATTERY DISCHARGED.

3.3 POSSIBLE MALFUNCTIONS

When malfunctions occur during the device operation or if you you have any questions on how to use the device, please contact the manufacturer representatives.

3

MAINTENANCE



4

STORAGE

Please store the device in the rigid suitcase from the scope of delivery. The storage conditions must conform with the relevant international standards (see chapter 1.3).

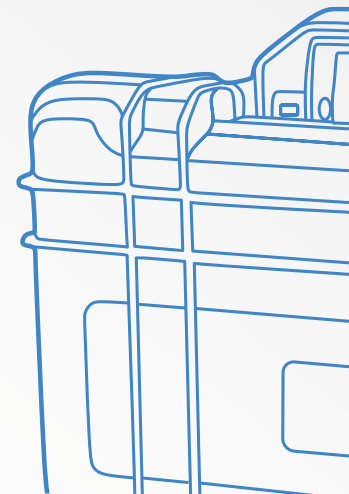
Please store the device on a shelf.

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

The distance between the device and the walls and floor of the warehouse shall be at least 100 mm.

The distance between heating units of the warehouse and the device should be min. 0.5 m.

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



Please transport the thickness gauge in the bag included in the delivery kit.

The packaged devices can be transported in any vehicles at any distances without speed limits.

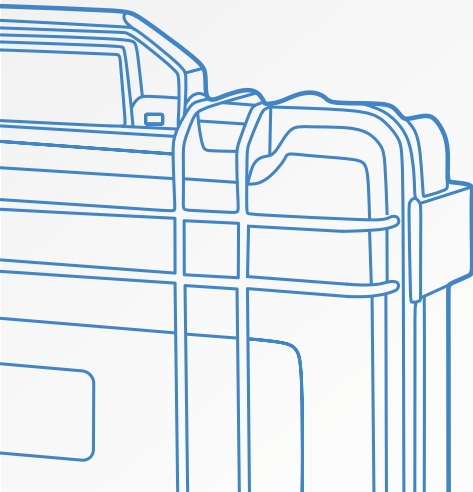
Packaged devices should be properly and steadily fixed to prevent their hitting against one another and against vehicle walls during transportation. When transported in open vehicles the instruments shall be protected from rain and water splashes.

The arrangement and fixation of the packed devices in transport facilities should provide their stable position and exclude strokes against each other as well as against the walls of the transportation facilities.

The conditions for device transportation should meet the requirements of the valid specifications, rules and norms for each type of transport.

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

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



TRANSPOR- TATION



The propagation velocity of longitudinal ultrasonic waves in some materials are specified in the Table A.1

Table A.1

Material	Velocity, m/s	Material	Velocity, m/s
aluminium	6260	concretes	2000 – 5400
aluminum alloy D16T	6320	touchstone	5930
bronze (phosphorous)	3530	gabbro 38	6320
vanadium	6000	gypsum	4790
bismuth	2180	gneiss	7870
wolframite	5460	basil	4450
ferrum	5850	diabase 85	5800
gold	3240	magnesian lime	4450
konstantan	5240	limestone	6130
brass	4430	limestone 86	4640
brass LS-59-1	4360	nylon 6	2640
magnesium	5790	silica molten	5930
manganin	4660	labradorite 44	5450
manganese	5561	solid water	3980
copper	4700	marble	6150
molybdenum	6290	plexiglass	2670
nickel	5630	polystyrene	2350
stannum	3320	rubber	1480

APPENDIX A

▼ Table A.1

Material	Velocity, m/s	Material	Velocity, m/s
osmium	5478	mica	7760
plumbum	2160	organic glass	2550
silver	3600	silicious glass	5500
glass-ceramics	6740	steel Ch15H15GS	5400
steel 20 GSNDM	6060	steel St3	5930
steel ChN77TYUR	6080	cloth laminate	2920
steel 40ChNMA	5600	teflon	1350
steel ChN70VMTYU	5960	porcelain	5340
steel ChN35VT	5680	solid rubber	2400
tantalus	4235	zirconium	4900
chrome	6845	cast iron	3500 – 5600
zinc	4170		

APPENDIX A



ULTRASONIC THICKNESS GAUGE

A1210



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