

EM1401 / EM1401 UT Thickness Gauge



Operation Manual

Saint Petersburg
2023

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INTENDED USE

The EM1401 / EM1401 UT thickness gauge (further, the Device) is intended to measure thickness of steel pipe walls, flat steel, rods, and other products made of steel as well as aluminum and other metals using both non-contact electro-magnetic transducers and traditional contact piezoelectric transducers (for EM1401 UT version).

PRINCIPLE OF OPERATION

The Device measures time during which the acoustic wave transits through the test object. The measured time is converted into thickness using the specified value of speed of ultrasonic wave propagation.

The Device can be connected both to EMA transducers and to contact PE (piezoelectric) transducers.

A special data processing algorithm designed by Oktanta allows to measure the test object thickness correctly even in the presence of disruptors such as metal anisotropy, several reflectors and external noise. The Device enables to eliminate influence of the human factor making the thickness measurements completely automatic.

TECHNICAL SPECIFICATIONS

For EMA transducer (EM1401, EM1401 UT)

| | |
|---|---|
| Measured thickness range for steel | 2 to 80 mm |
| Measured thickness range without gap for steel | 2 to 120 mm |
| Thickness measurement error | 0.08 mm |
| Permissible gap between the sensor and the test object for EMT14012 transducer | up to 4 mm |
| Permissible gap between the sensor and the test object for EMT14013 transducer | up to 6 mm |
| Permissible skew of the sensor relative to the test object surface normal | $\pm 25^\circ$ |
| Minimum permissible radius of curvature of the test object surface | ≥ 10 mm |
| Operating frequency | 4 MHz |
| Working ambient temperature range | -20 to +50°C |
| Operating temperature range of the test object surface | -20 to +80°C (-20 to +750°C using the EMT14014T transducer*) |
| Maximum number of measurements per second | 16 |

For PE transducer (EM1401 UT)

| | |
|--|--|
| Measured thickness range for steel for EDC5P10FS15 transducer | 2 to 300 mm |
| Measured thickness range for steel for EDC5P7.2FS10 transducer | 1 to 150 mm |
| Measured thickness range for steel for EDC10P5F3 transducer | 0.5 to 20 mm |
| Operating frequency | 10 MHz for EDC10P5F3 5 MHz for EDC5P10FS15, EDC5P7.2FS10 |
| Thickness measurement error | 0.08 mm |
| Maximum number of measurements per second | 2 |
| Operating temperature range of the test object surface | -5 to +50°C |

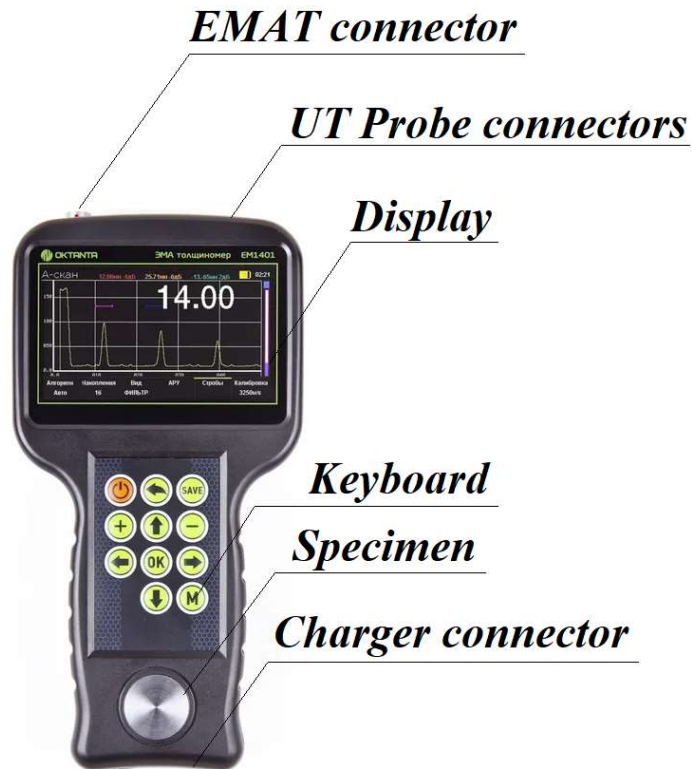
For both sensor types (EM1401, EM1401 UT)

| | |
|---|--|
| Acoustic speed adjustment range | 1000 to 9999 m/s with 1 m/s increments |
| Time of continuous operation without battery recharging | 7 hours |
| Overall dimensions | 122 x 231 x 42 mm |

**The EMT14014T transducer is not intended for long-term use at 750 °C. The maximum temperature of long-term use of this transducer is 300 °C. The objects with temperature of 300 °C to 750 °C shall be measured during short periods of time with 15 s intervals between measurements*

OPERATION DESCRIPTION

Device Appearance



Thickness gauge appearance

At the top of the Device, there are a connector for EMA transducers and two connectors for PE transducers. The Device has a color liquid crystal display screen to display measurement results. The Device is controlled by a keyboard with 11 push-buttons. At the bottom of the Device, there is a connector for a recharger.

Below are the functions of the control buttons.



The On/Off button switches on/off the Device;



The Back button allows the user to return to the previous menu items and to close the menu;



The Up button allows the user to navigate in the Device menu, change the A-scan scale and adjust the strobes and thresholds;



The Down button allows the user to navigate in the Device menu, change the A-scan scale and adjust the strobes and thresholds;



The Left button allows the user to navigate in the Device menu and adjust the strobes;



The Right button allows the user to navigate in the Device menu and adjust the strobes;



The "OK" button sets the parameter selected in the Device menu;



The Menu button opens/closes the Device menu;



The "Save" button saves data in the C-scan.




The Plus button allows the user to navigate in the Device menu;



The Minus button allows the user to navigate in the Device menu;



Device Switching On and Off

To switch the Device on, press and hold the  button during 3 s. A window with information about the Device software version appears on the display.



Window with information about Device software version




Then a window with measured thickness appears.

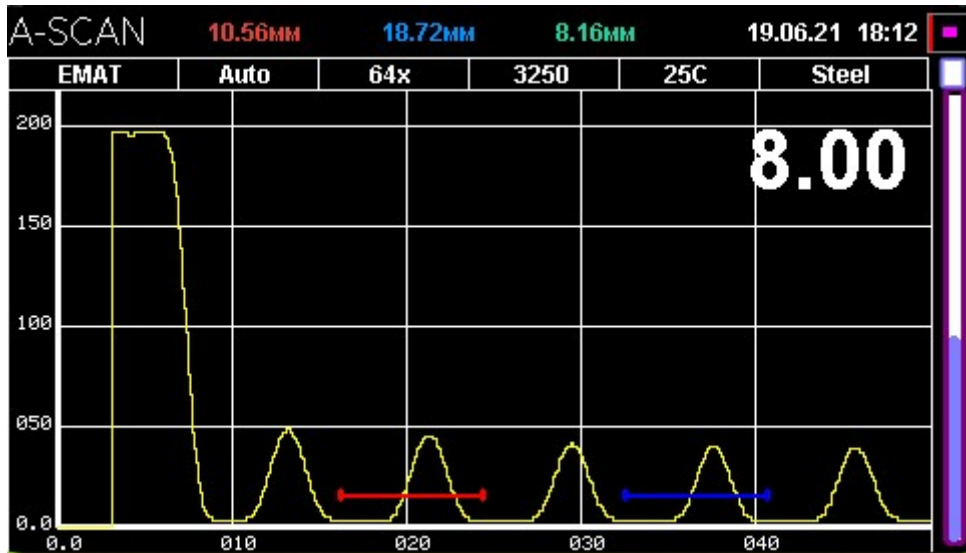


Window with measured thickness


To switch the Device off, press and hold the  button.

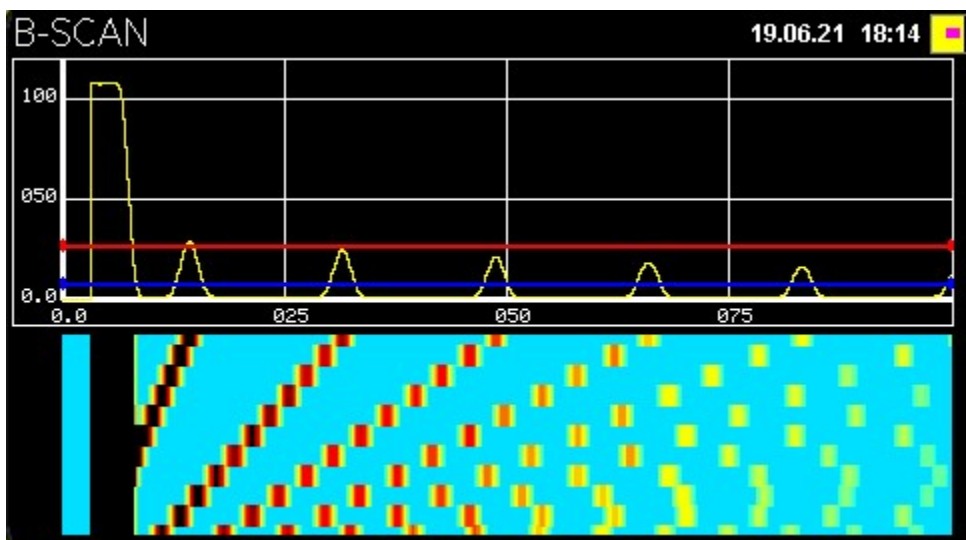
Information Display Mode Selection

The Device allows to visualize A-scan, B-scan, and C-scan. To switch between the information display modes, use the  and  buttons. Press the  button once to switch to the A-scan display mode.




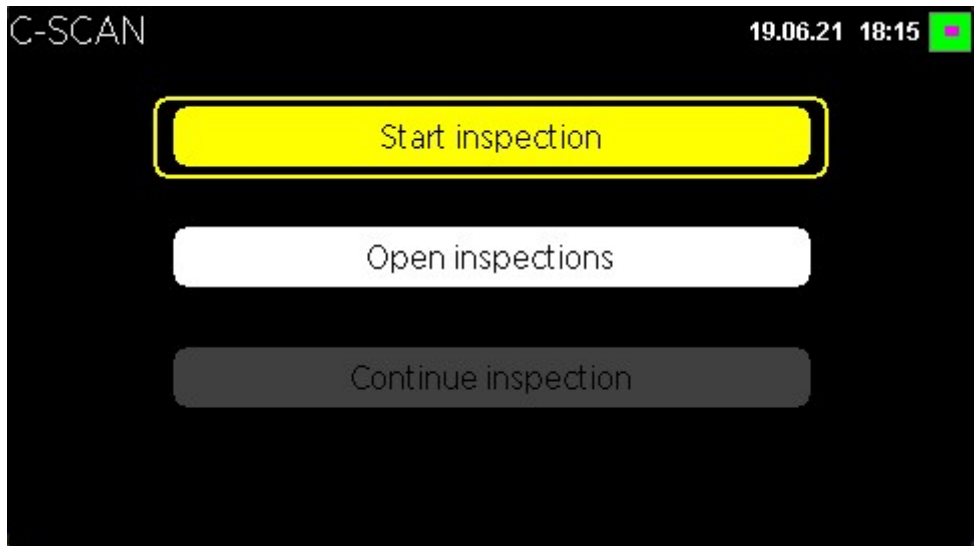
A-scan display mode

Press the  button again to switch to the B-scan display mode.



B-scan display mode

Then, press the  button again to switch to the C-scan display mode.



C-scan display mode

Press the  button again to switch to the thickness display mode.

Thickness Window


The figure below shows the Thickness window.

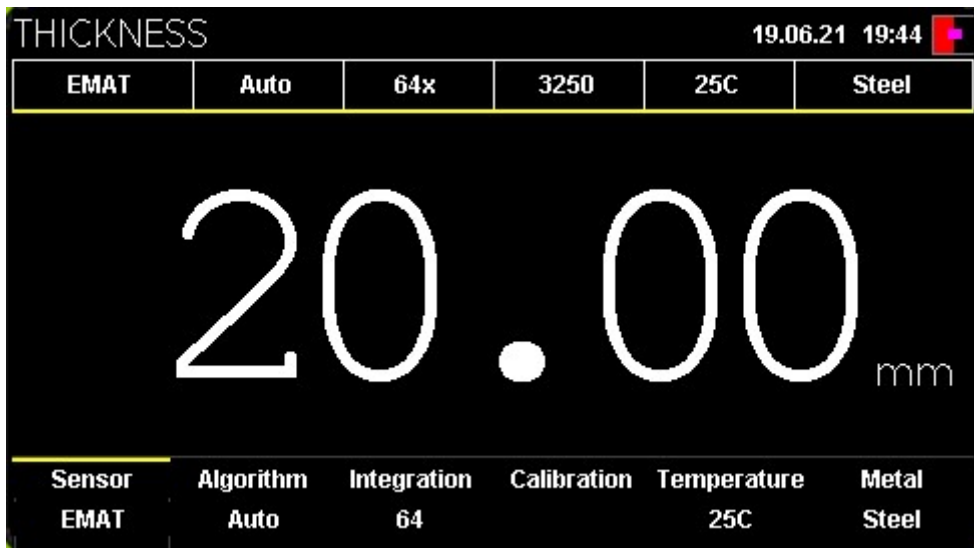


Thickness window




The top of the screen displays the following information:

- Name of the selected transducer;
- Thickness measurement mode. Possible settings are as follows: auto, one stroke and two strokes;
- Averaging number used in the Device;
- Selected acoustic speed;
- Selected temperature of the test object;
- Selected material of the test object;

When you press the  button, the window will be as shown in the figure below:

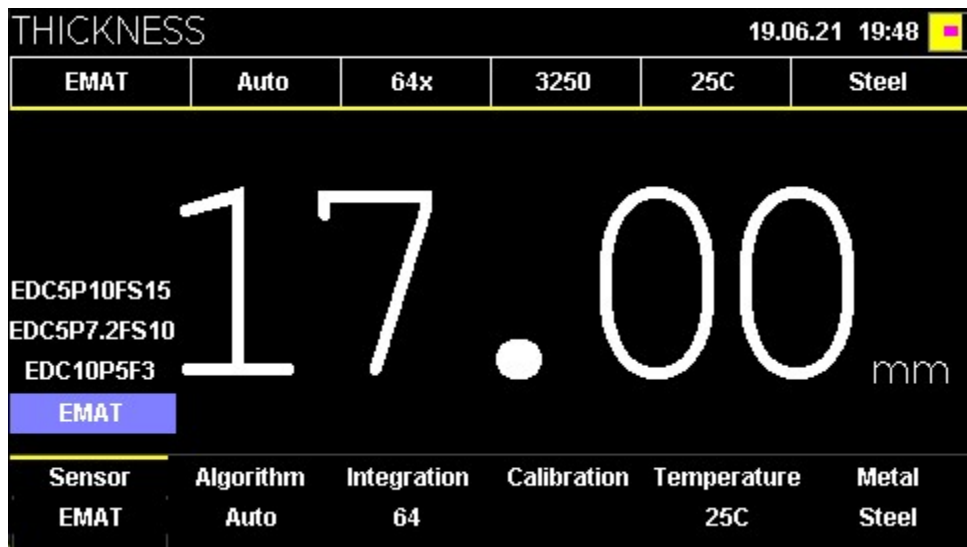


Change of parameters

Within this window, you can change the applicable transducer, measurement mode, averaging number, temperature as well as select the material of the test object and perform calibration. To select the appropriate menu item, press on the  and  buttons. To change the selected menu item, press on the  button.

Transducer Selection

The figure below shows the transducer selection window.



Transducer Selection

The Device allows to select among four transducer types:

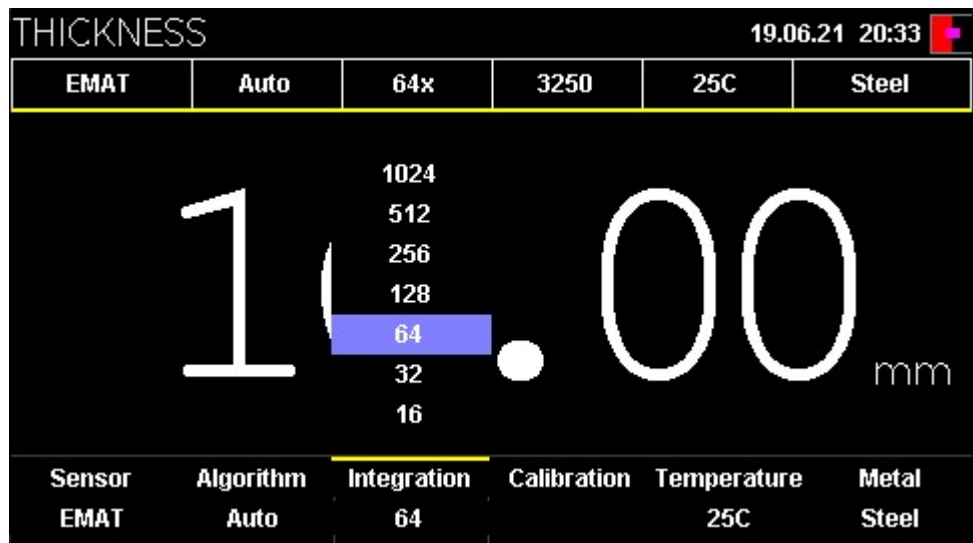
- EMAT: electromagnetic acoustic transducer. This setting shall be selected when any EMA transducer is used.
- EDC10P5F3: piezoelectric transducer to measure thickness ranging from 0.5 to 20 mm. This transducer operates at 10 MHz.
- EDC5P7.2FS10: piezoelectric transducer to measure thickness ranging from 1 to 150 mm. This transducer operates at 5 MHz.
- EDC5P10FS15: piezoelectric transducer to measure thickness ranging from 2 to 300 mm. This transducer operates at 5 MHz.

Thickness Measurement Mode Selection

The Device enables to use one of three thickness measurement modes: auto, manual with one strobe and manual with two strobes. For more details on manual measurement modes, see "A-scan window".

Accumulation Number Selection

The figure below shows the accumulation number selection window.

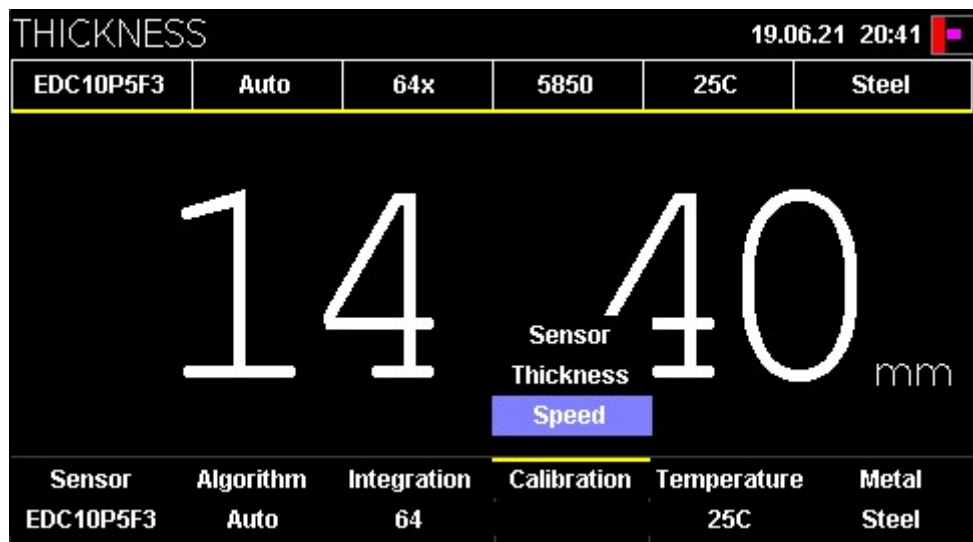


Accumulation Number Selection

By default, the Device uses 128 accumulations. Thus, the final thickness measurement is performed using 128 measured values by averaging them. When the test object has a poor surface quality or heavy corrosion, increase the number of accumulations up to 256-512.

Calibration

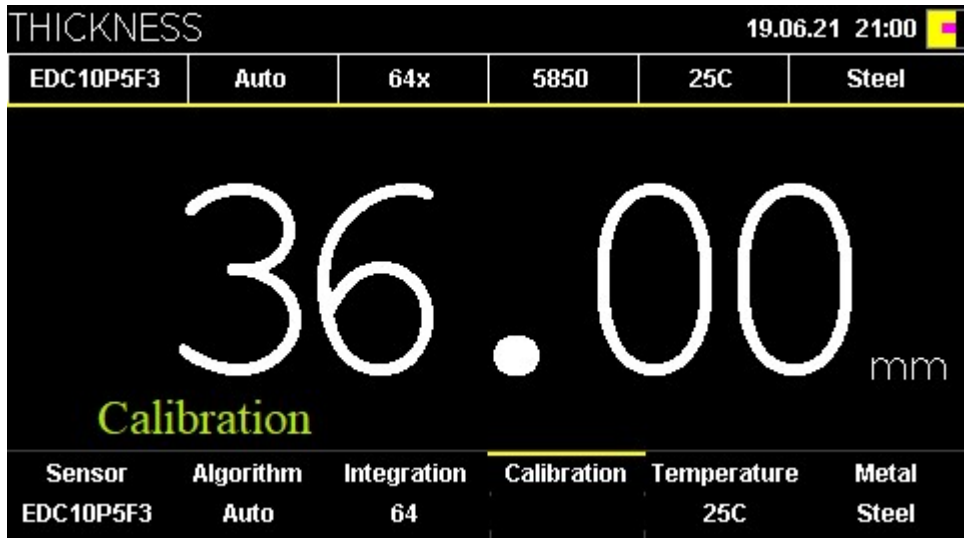
The calibration window appearance is shown in Figure below:



Calibration

The Calibration menu has three items:

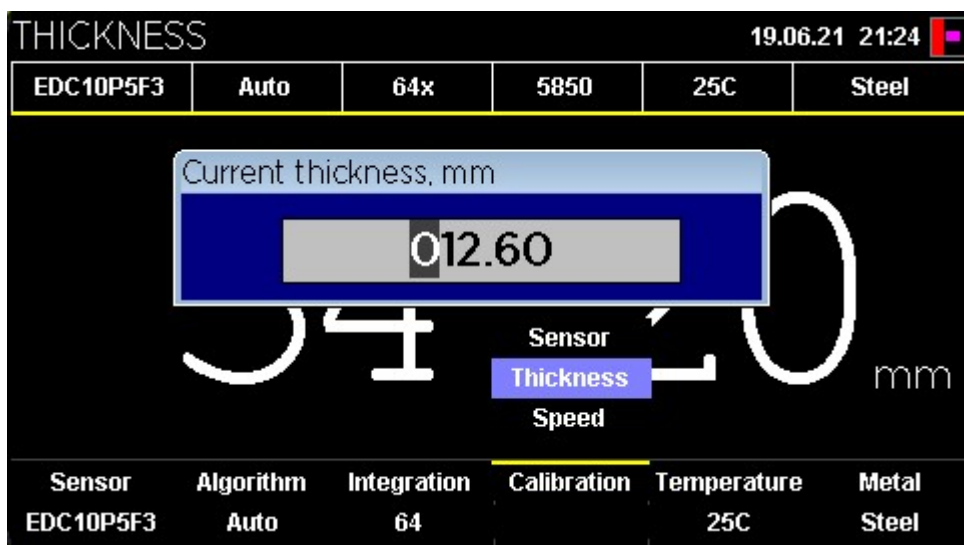
- **Sensor.** This item is available when one of three piezoelectric transducers is selected. The front cover of the Device includes the calibrations sample (see "Device Appearance") The piezoelectric transducers shall be calibrated prior to operation start by calculating delay in prism which sizes constantly decrease as the transducer wears out. When this item is selected, the Device window will be as follows:








Sensor calibration

When the Calibration text appears on the screen, put the sensor on the calibration sample coated with contact liquid. Then, the Device will calculate the delay in prism and will measure the thickness of this sample as 3 mm.

- **Thickness.** This calibration enables to calculate the acoustic speed in automatic mode according to the known thickness. To calibrate according to the known thickness, place the sensor on the object with known thickness and select this calibration item. Then, the following window will display:

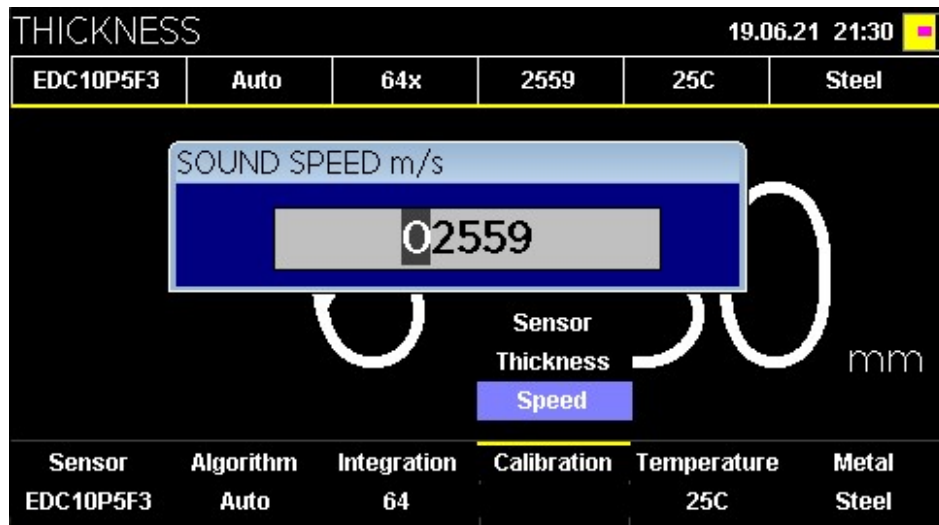


Calibration according to known thickness






In the opened window, press the , , , and  buttons to specify the known thickness value; then press the  button.

- Speed. This item enables to specify the acoustic speed.

The acoustic speed setting window is shown below:



Acoustic speed setting

In this window, press the , , , and  buttons to specify the known acoustic speed value; then press the  button.

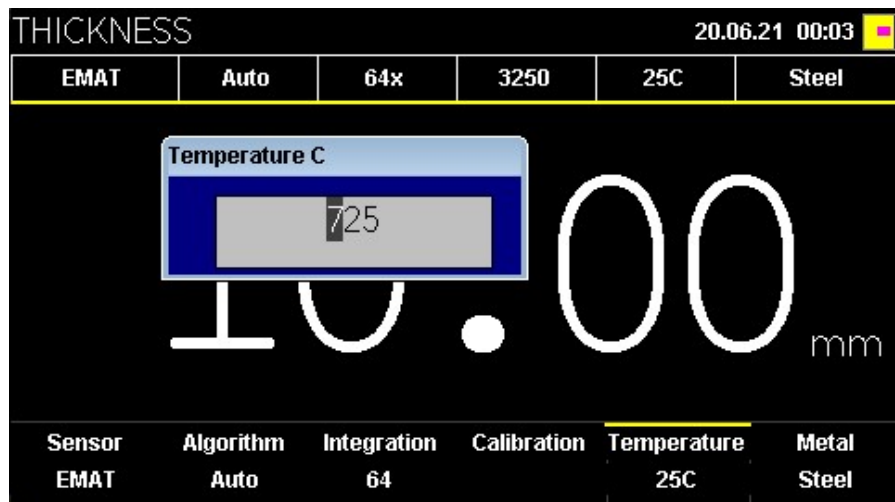
WARNING!

All EMA transducers intended for this Device use transverse ultrasonic wave. The typical speed of the transverse wave for the steel is 3250 m/s.






All PE transducers intended for this Device use longitudinal ultrasonic wave. The typical speed of the longitudinal wave for the steel is 5950 m/s.

Temperature

The acoustic speed depends on the material temperature. Therefore, different acoustic speed shall be used for different temperatures. The Device can automatically correct the acoustic speed depending on the test object temperature. To use this feature, set the test object temperature in this menu. The window used to enter the test object temperature is shown in Figure below.



Test object temperature entry

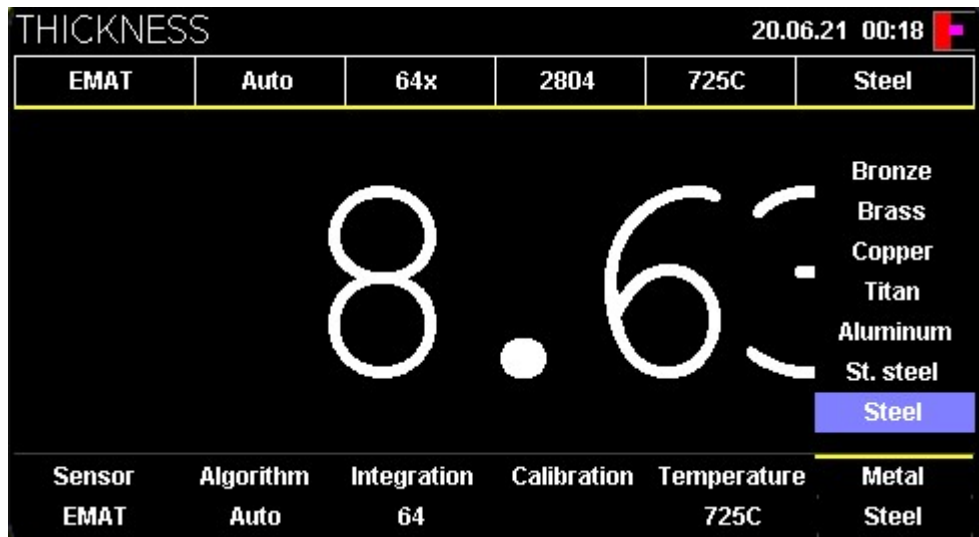
In this window, press the , , , and  buttons to specify the test object temperature; then press the  button.

WARNING!




To measure the thickness of the heated objects, use the special EMT14014T EMA transducer. Use of the other transducers for the objects which temperature exceed 80°C can cause their failure.

Metal

This item is used to select the material of the test object. The selected material influences both the acoustic speed and the function of the acoustic speed dependence on the temperature. Therefore, correct selection of the material is very important. The material selection window is shown below:

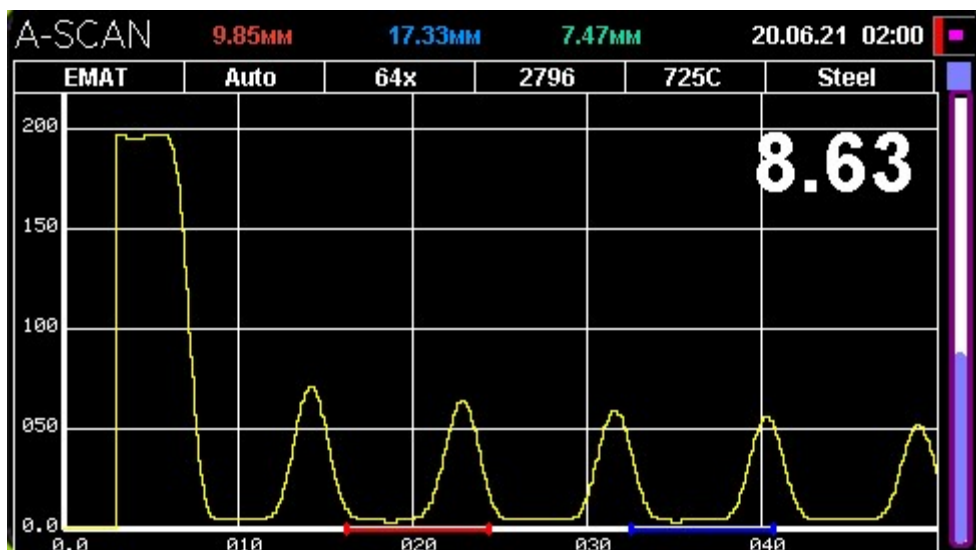


Test object material selection

To select the required material, use the ,  and  buttons/



A-scan window

The A-scan window appearance is shown in Figure below:

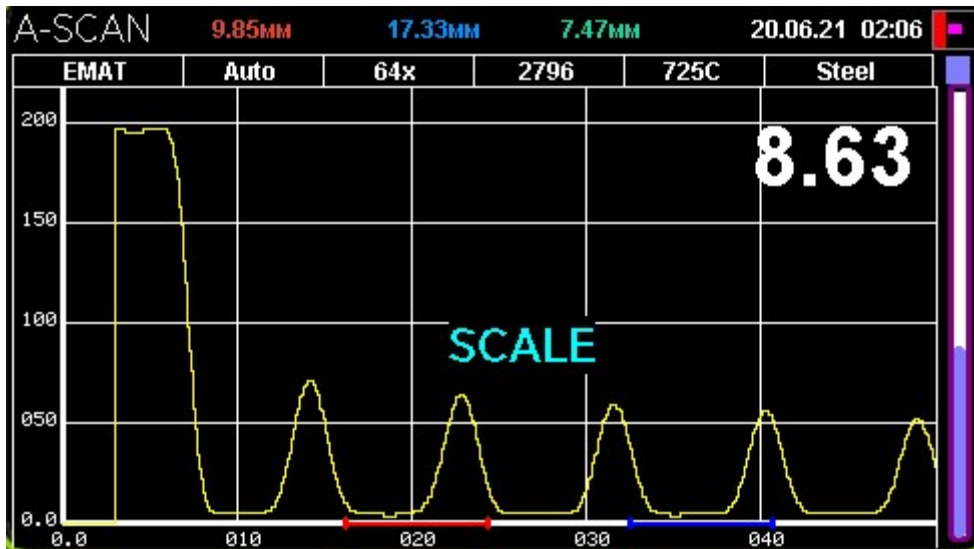


A-scan appearance





A-scan Scale Change



The user can change the scale of the A-scan display. To change the scale, press the  button or the  button while being in the A-scan window.

In this case, SCALE appears on the screen






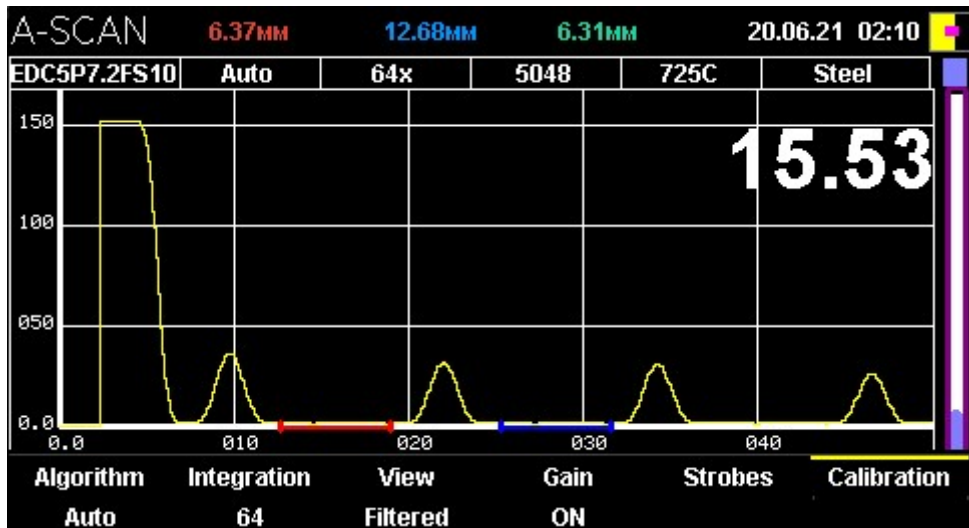
A-scan scale change mode

In this mode, you can change the A-scan scale using the  and  buttons you can also change the display area using the  and  buttons.



Upon selection of the position and size of the scaled area, press the  button or the  button.

Context Menu

To operate with the A-scan and strobes and to calibrate the Device, a special context menu is used. To open the context menu, press the  button. Then, a menu consisting of six items will appear at the screen bottom. You can navigate through the menu items using the  and  buttons



Context ("OK") menu

To close the context menu, change one of the menu settings by pressing the  button, or press the  button.





Thickness Measurement Algorithm Selection

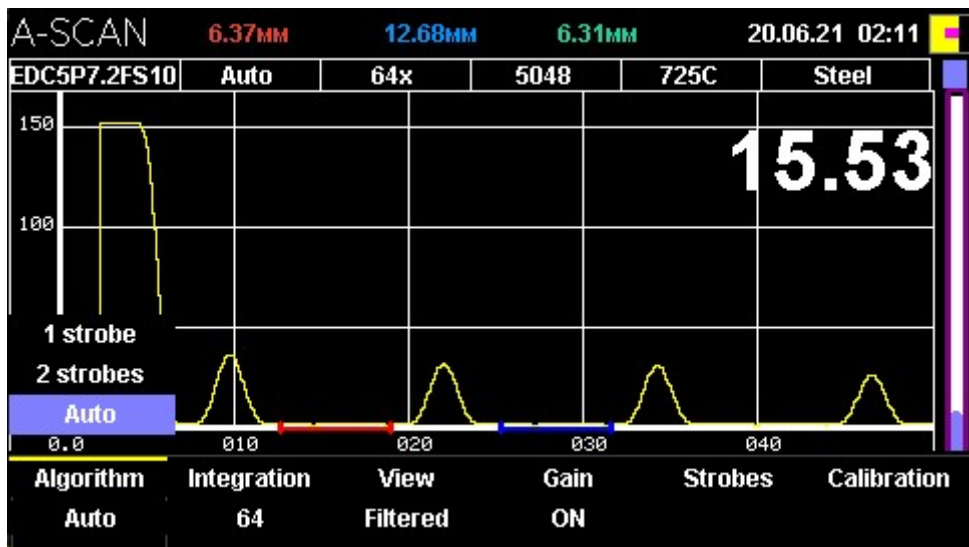
The Device has three thickness measurement algorithms: an automatic algorithm, a thickness measurement algorithm using one strobe and a thickness measurement algorithm using two strobes.

The automatic algorithm is suitable for most applications and allows to obtain the thickness without user intervention.

The thickness measurement algorithm using one strobe calculates the position of the maximum in the red strobe and converts the obtained value into thickness. The position of the red strobe and its length are specified by the user. It is recommended to use the algorithm for the test objects made by casting, as well as for the test objects prone to severe corrosion.





The thickness measurement algorithm using two strobes calculates the positions of the maximums in the red and blue strobes. The Device calculates the thickness using the difference between the positions of the maximums in the red and blue strobes. The position of the strobes and their lengths are specified by the user.

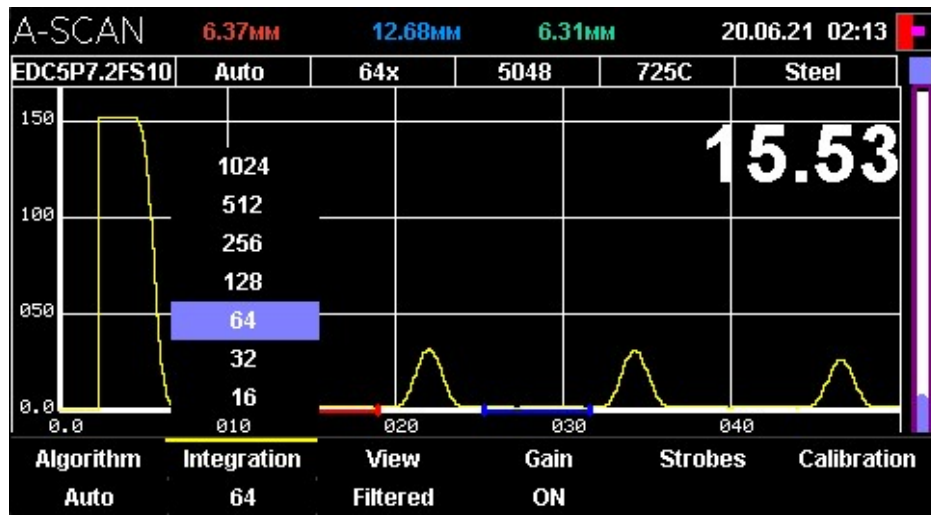
To enter the menu of thickness measurement algorithm selection, press the  button. The algorithm is selected by the  and  buttons. After selection of the required algorithm, press the  button.



Thickness measurement algorithm selection

Accumulation Number Selection

By default, the Device uses 128 accumulations of the useful signal and calculates thickness using the average values. When the Device measures thickness of a test object with poor surface quality and across a wide gap, it is recommended to increase the number of accumulations and, thereby, to increase the reliability and accuracy of the measurements. To enter the menu of accumulation number selection, press the  button. The accumulation number is selected by the  and  buttons. After selection of the required accumulation number, press the  button.







Accumulation number selection

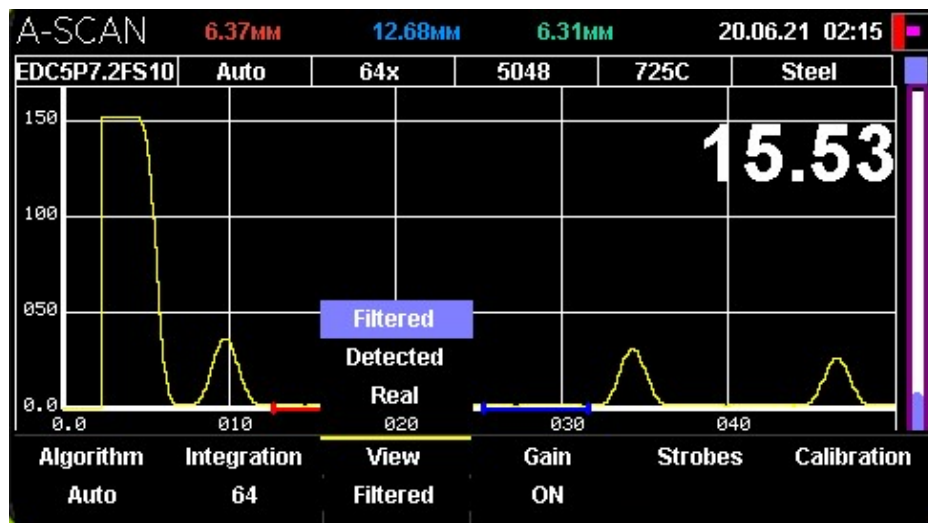
The accumulation number can be as follows: 8, 16, 32, 64, 128, 256, 512, or 1024;

Note that increase of the accumulation number will increase the measurement time.

A-scan View Change

The Device can display the A-scan in three ways: the original bipolar signal, the detected signal and the filtered signal (envelope filter).


To enter the menu of A-scan view selection, press the  button. The A-scan-view is selected by the  and  buttons. After selection of the required view, press the  button.



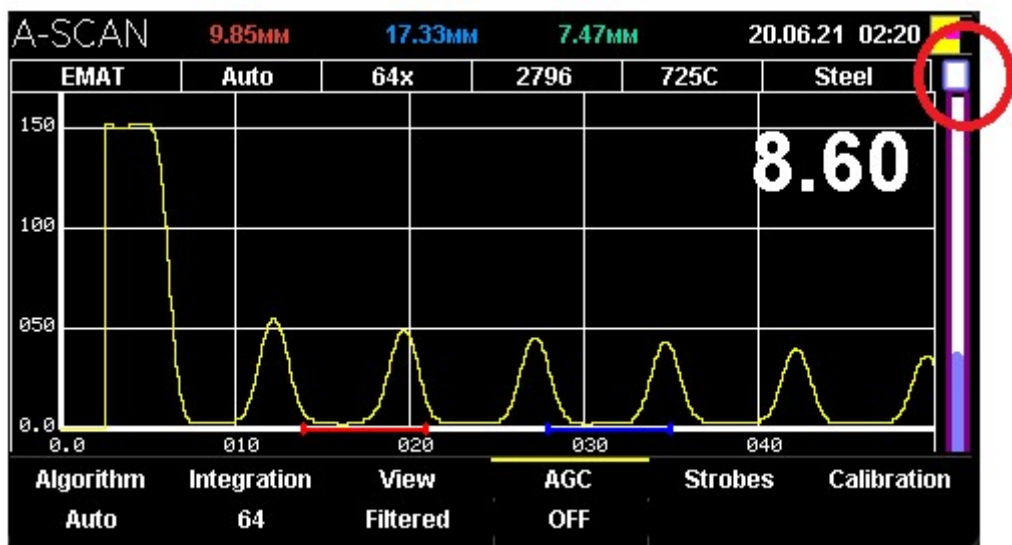
A-scan view change

Gain Control

The Device has manual and automatic gain control modes. By default, the Device uses automatic gain control. To change over to the manual control mode, do as follows:

- Select the setting Off in the AGC context menu .
- Enter the gain control mode by pressing the  button.

The Device will change over to the manual gain control mode. The upper part of the gain level indicator will change its color from blue to white.



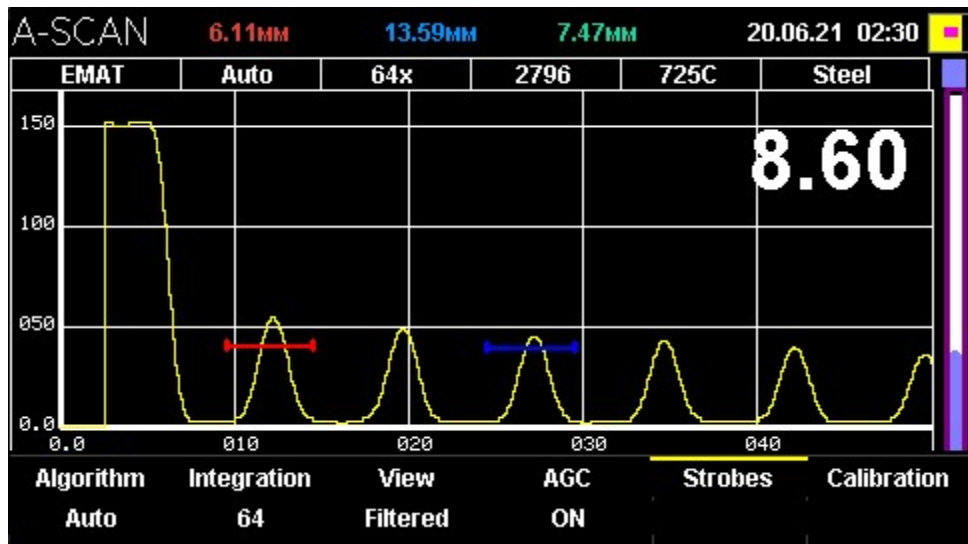
Gain level indicator position


In the manual mode, the gain level is controlled using the  and  buttons.

To return to the automatic gain control mode, select the setting On in the AGC context menu/ The upper part of the gain control indicator will become blue again.

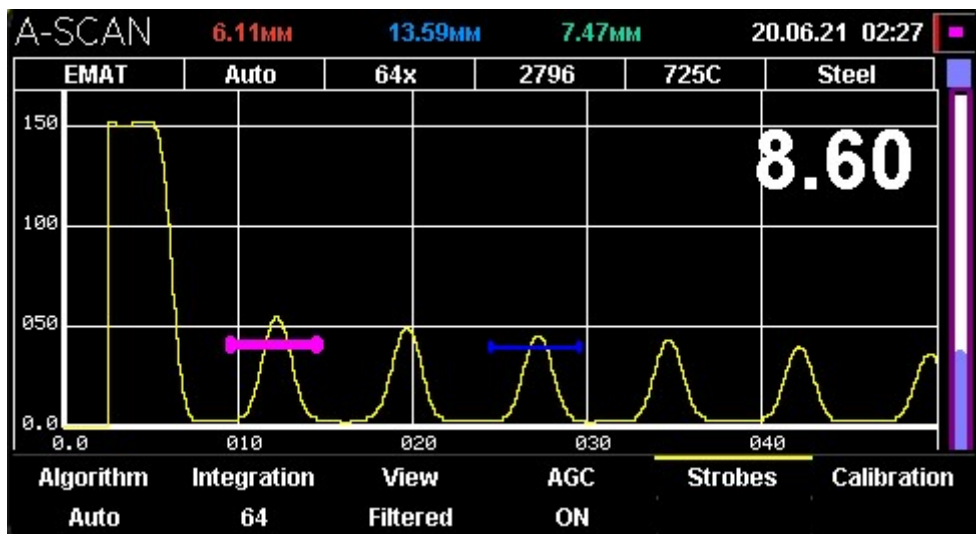
Strokes






The Device can operate with two strokes (red and blue). Each stroke is a selected time interval in which the maximum value is calculated. The top of the thickness gauge screen displays the maximum position of the blue stroke, the maximum position of the red stroke, the difference between the maximum positions of the red and blue strokes.

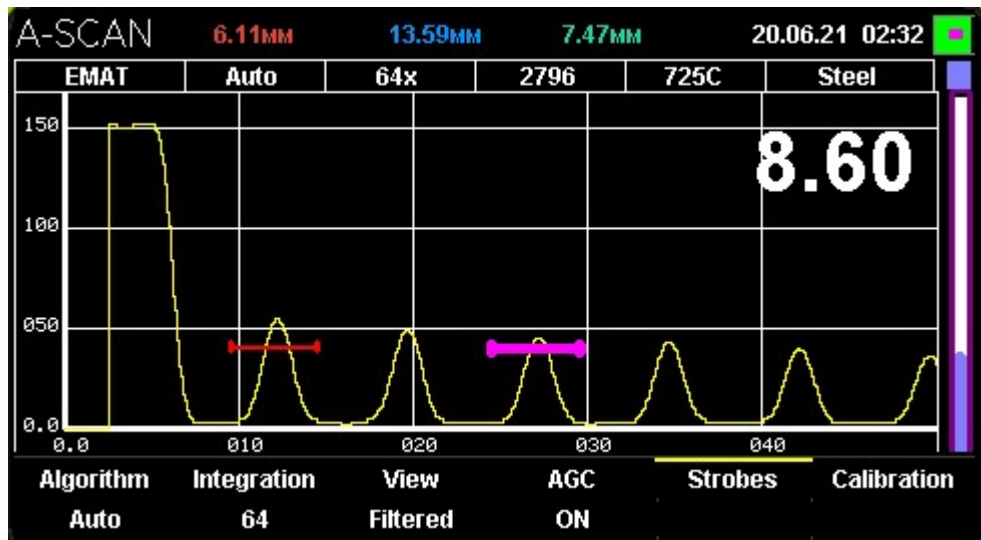
*Strobe information display*

The position and length of each strobe can be changed. To do this, open the Strokes menu by pressing the  button.






Then, the red strobe is highlighted on the display

*Red strobe selection*

Use the  and  buttons to change the strobe position and the  and  buttons to change the strobe length. Upon selection of the position and length of the red strobe, press the  button. Then, the blue strobe is highlighted on the display.

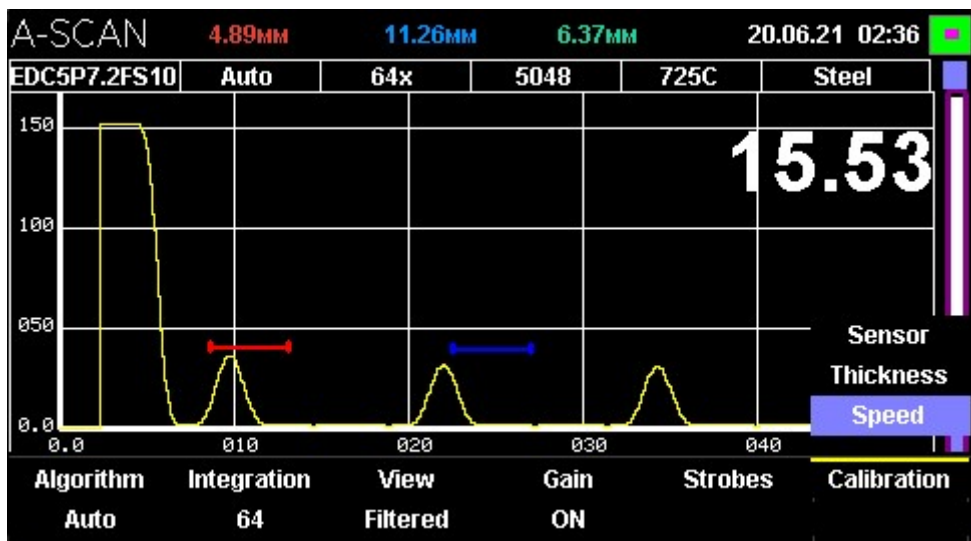


Blue strobe selection

You can set the position and length of the blue strobe in the same way as those of the red strobe by pressing the , , , and  buttons. Upon selection of the position and length of the blue strobe, press the  button.

Calibration

The calibration window appearance is shown in Figure below:

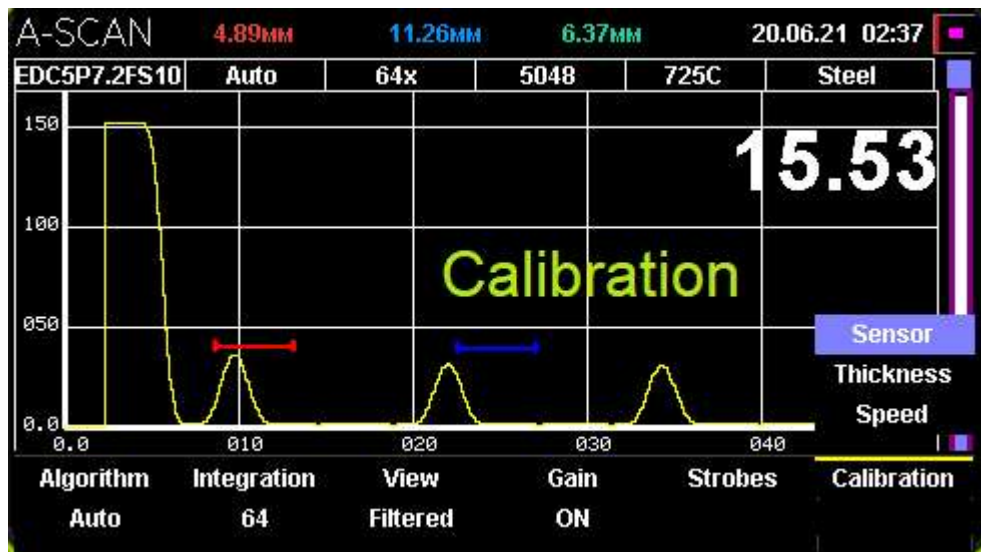


Calibration

The Calibration menu has three items:

- **Sensor** This item is available when one of three piezoelectric transducers is selected. The front cover of the Device includes the calibrations sample (see "Device Appearance") The piezoelectric transducers shall be calibrated prior to operation start

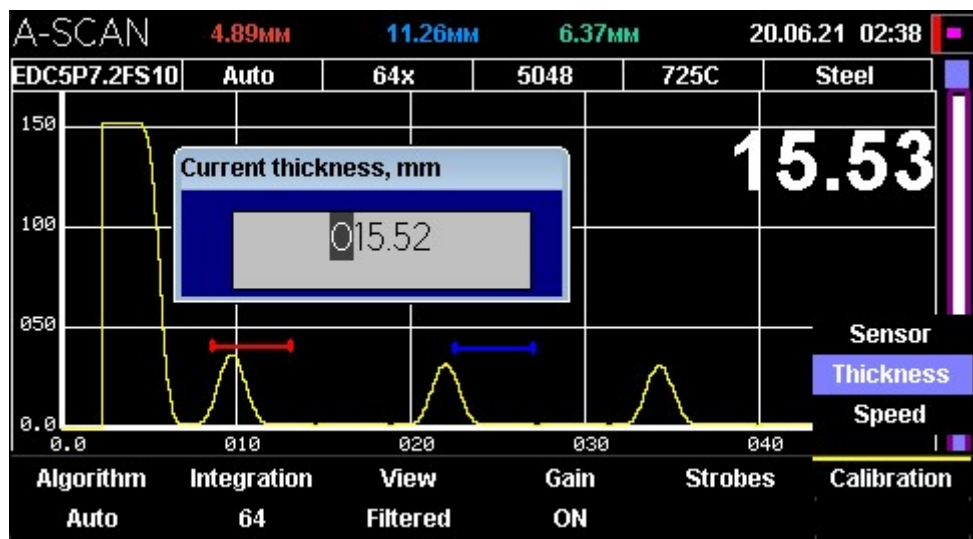
by calculating delay in prism which sizes constantly decrease as the transducer wears out. When this item is selected, the Device window will be as follows:








Sensor calibration

When the Calibration text appears on the screen, put the sensor on the calibration sample coated with contact liquid. Then, the Device will calculate the delay in prism and will measure the thickness of this sample as 3 mm.

- **Thickness** This calibration enables to calculate the acoustic speed in automatic mode according to the known thickness. To calibrate according to the known thickness, place the sensor on the object with known thickness and select this calibration item. Then, the following window will display:

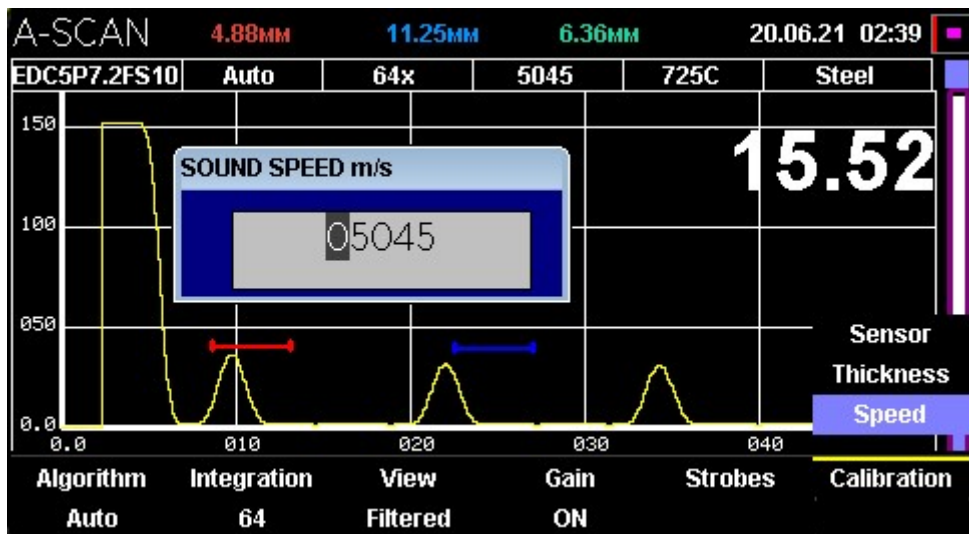


Calibration according to known thickness






In the opened window, press the , , , and  buttons to specify the known thickness value; then press the  button.

- Speed. This item enables to specify the acoustic speed.

The acoustic speed setting window is shown below:



Acoustic speed setting

In this window, press the , , , and  buttons to specify the known acoustic speed value; then press the  button.

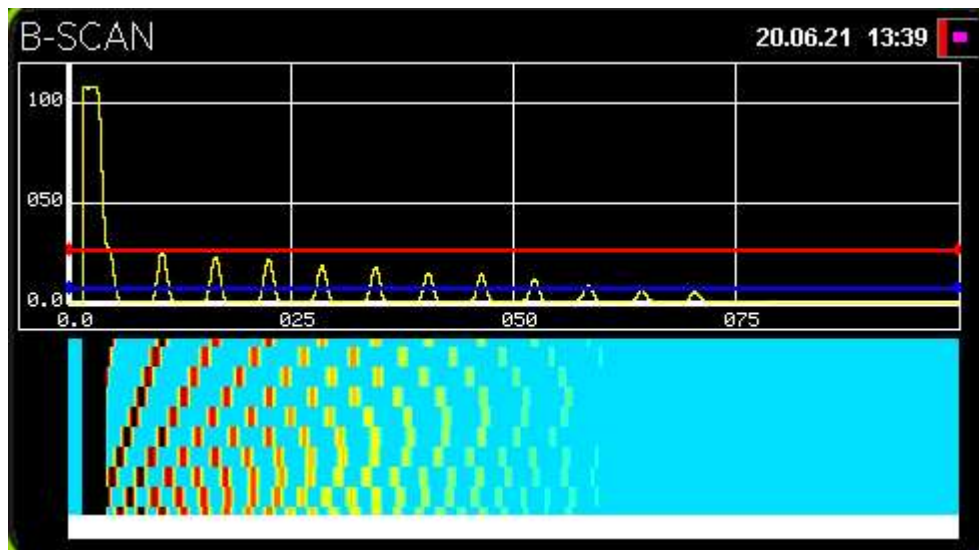
WARNING!

All EMA transducers intended for this Device use transverse ultrasonic wave. The typical speed of the transverse wave for the steel is 3250 m/s.

All PE transducers intended for this Device use longitudinal ultrasonic wave. The typical speed of the longitudinal wave for the steel is 5950 m/s.

B-scan Window

The B-scan window appearance is shown in Figure below:



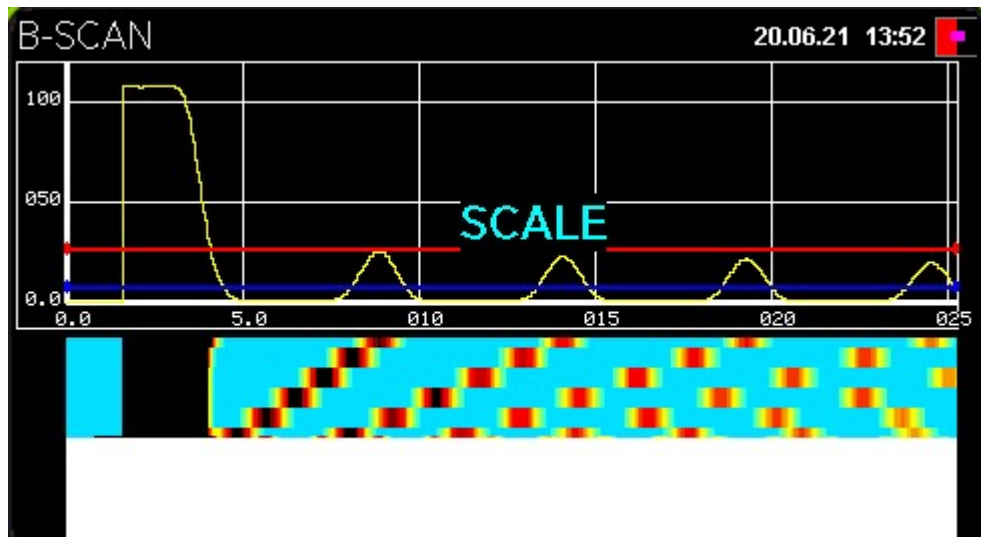
B-scan window appearance

At the top of this window, the A-scan with two thresholds (blue and red) is displayed. At the bottom, the B-scan is displayed. All A-scan points which values are lower than the blue threshold position are displayed on the B-scan in light-blue. All A-scan points which values are higher than the red threshold position are displayed on the B-scan in black. All A-scan points which values are between two thresholds are displayed with gradient. The user can change the thresholds position, change the scale, speed up or slow down filling of the B-scan, select appearance (view) of the B-scan window as well as select the B-scan filling mode between the continuous and single-time.





B-scan Scale Change



To change the scale, press the  button or the  button while being in the B-scan window.

In this case, SCALE appears on the screen






B-scan scale change mode


In this mode, you can change the B-scan scale using the  and  buttons you can also change the display area using the  and  buttons.

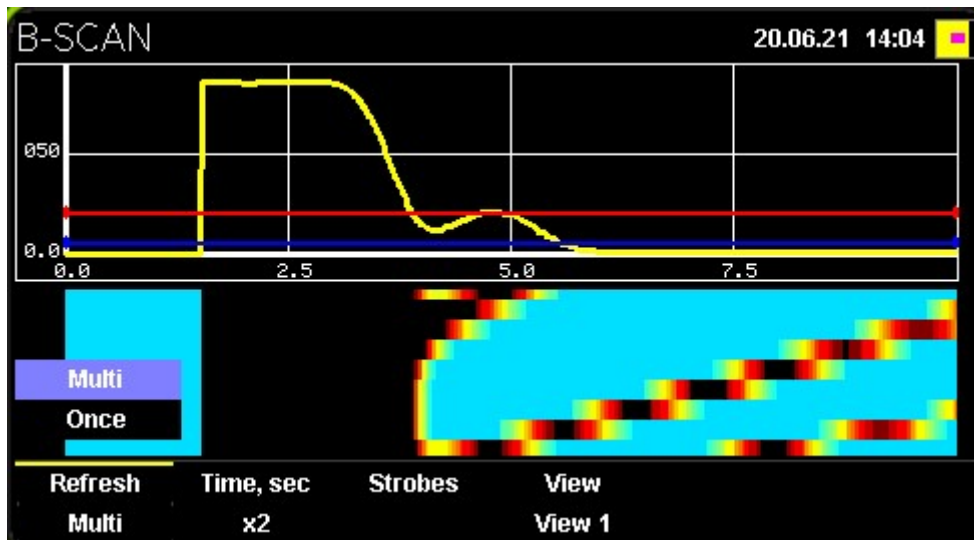
Upon selection of the position and size of the scaled area, press the  button or the  button.

Context Menu


To operate with the B-scan, the special context menu is used. To open the context menu, press the  button. Then, a menu consisting of four items will appear at the screen bottom. You can navigate through the menu items using the  and  buttons

B-scan filling mode

To select the B-scan filling mode, select this item in the context menu and press on the  button. The B-scan filling mode selection window is shown in the Figure below:




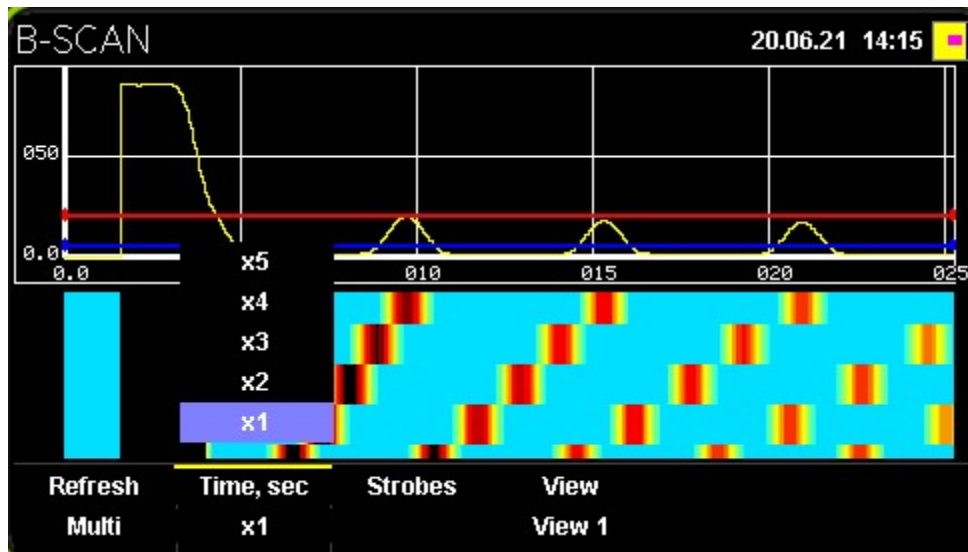
B-scan filling mode selection

You can select two options in this window: stand-by mode and continuous mode. When the standby mode is selected, the B-scan will not be updated until the user presses the  button. In this case, "Press + to start up" will be at the top of the Device screen.

If the continuous mode of B-scan filling is selected, the B-scan will be filled and updated continuously.

Screen Filling Time




This setting enables to increase or decrease time during which the B-scan is fully filled. To select the B-scan filling time, select this item in the context menu and press on the  button. The B-scan filling time selection window is shown in the Figure below:

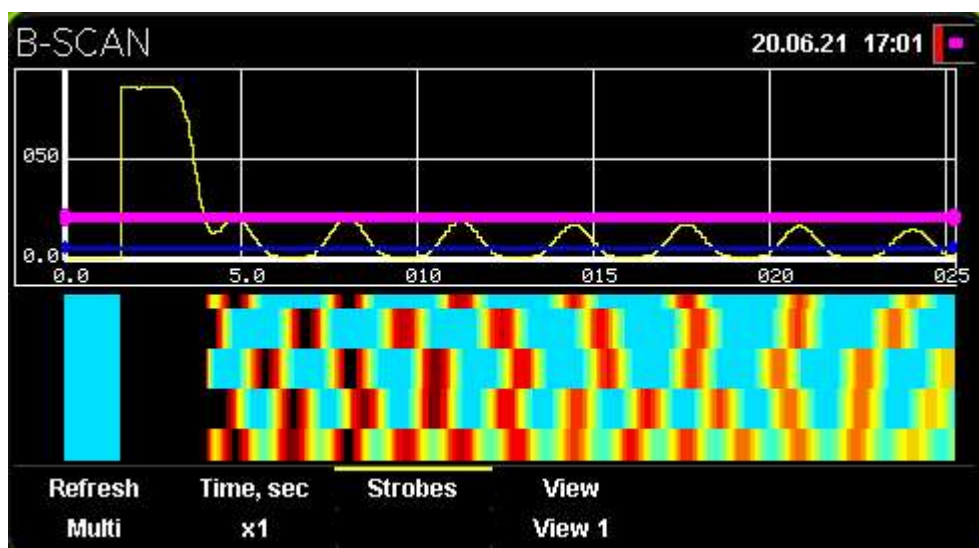


B-scan filling time selection






The user can select in what number of times the time of B-scan updating is greater than the standard value.

Thresholds

The Device has two adjustable thresholds. To adjust the thresholds position, select the appropriate item of the context menu using the ,  buttons and press the  button. The red threshold will be highlighted. The appearance of the window with highlighted red threshold is shown in Figure below:






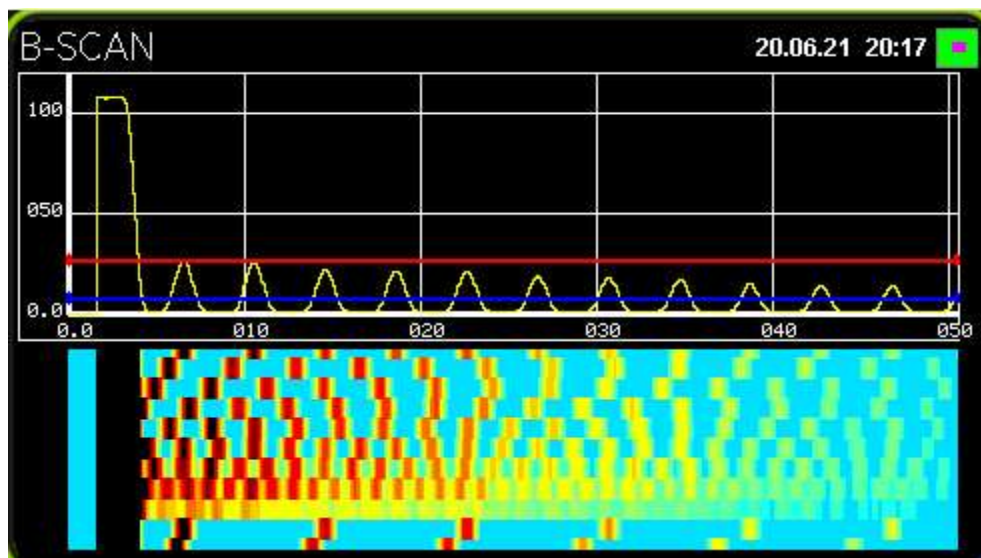
Red threshold highlighting

You can move the highlighted threshold using the  and  buttons. When you press the  button once again, the blue threshold will become highlighted instead of the red one. Its position can be adjusted as well using the  and  buttons.

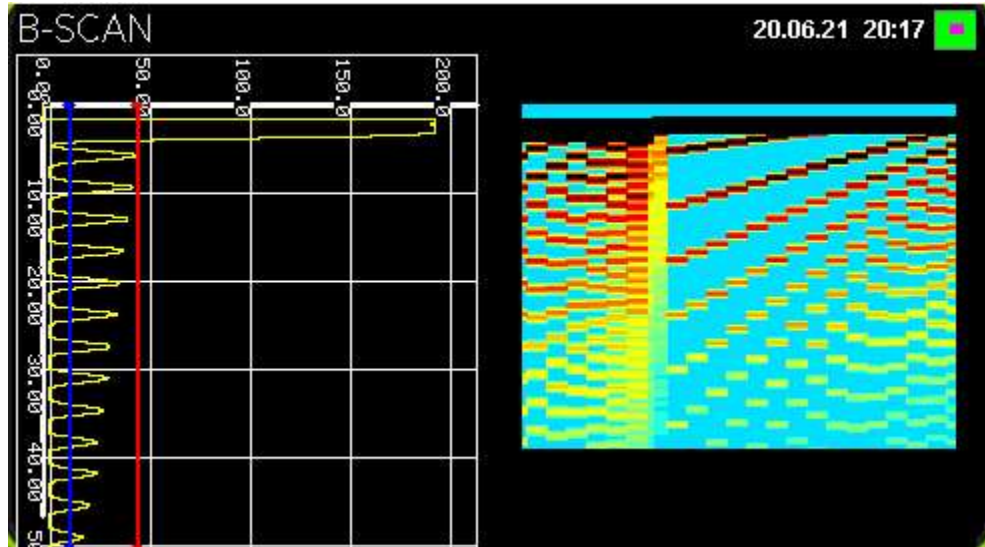
The thresholds position influences the B-scan appearance. Data which are higher than the red threshold are displayed on the B-scan in black. Data which are lower than the blue threshold are displayed on the B-scan with light-blue.

B-scan Appearance

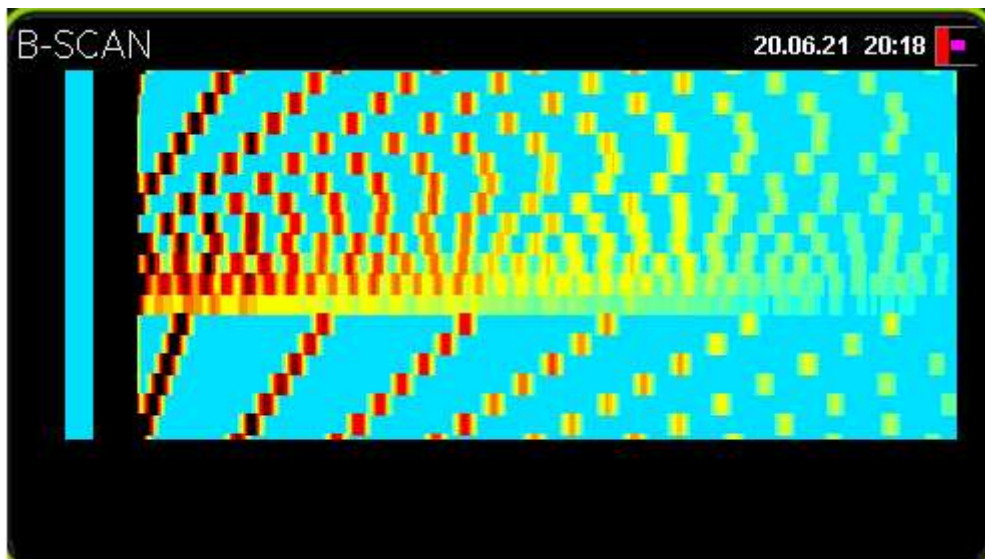
The Device can change the B-scan window appearance (view). To select the B-scan appearance, select the appropriate item of the context menu using the  and  buttons and press the  button. The appearance of three options of the B-scan is shown in the Figures below:



B-scan appearance, option 1



B-scan appearance, option 2



B-scan appearance, option 3

C-scan Window

The Device can save data as the C-scan. The C-scan window appearance is shown in the Figure below:







C-scan window appearance

This window consists of three items:

- Start inspection;
- Open inspections;
- Continue inspection.

To navigate through these three items, use

the ,  and  buttons. To return from any selected item, press on the  button.

Start inspection

The appearance of this window depends on the test object selected. If the user selects the "Pipe" test object, then the appearance of this window will be as shown in the Figure below.

The screenshot shows the 'C-SCAN' window with the following settings:

| | | |
|-------------------|------------|--------------------------|
| Object type | Pipe | |
| Object name | OBJECT #01 | |
| Points along pipe | 20 | Points on ring 5 |
| Order | Along pipe | |
| Min thickness | 5.00 | Base thickness, mm 20.00 |

At the bottom is a 'Start inspection' button.

Start Inspection window appearance, Pipe test object





If the user selects "Matrix" as the test object, then the appearance of this window will be as shown below:




The screenshot shows the 'C-SCAN' window with the following settings:

| | | |
|---------------|------------|--------------------------|
| Object type | Matrix | |
| Object name | OBJECT #01 | |
| Points by X | 20 | Points by Y 5 |
| Order | Horizontal | |
| Min thickness | 5.00 | Base thickness, mm 20.00 |

At the bottom is a 'Start inspection' button.

Start Inspection window appearance, Matrix test object

You can navigate through this window using the  and  buttons. You can change the settings using the  and  buttons.

To enter the name of the object, select this item using the ,  buttons and press the  button. In this case, the window shown in Figure below will open:

C-SCAN 20.06.21 21:05

Object type Matrix

Object name OBJECT #01






Points 5

Order horizontal

Min thickness 5.00 Base thickness, mm 20.00



Start inspection



Test object name entering

To enter symbols, letters, and numbers in this window, use the , , , and  buttons. Upon completion, press the  button.


For the object of the "Pipe" type, set the necessary number of the measured points in one ring as well as number of rings along the pipe.

For the object of the "Matrix" type, set the number of the measured points in horizontal plane and the same in the vertical plane.

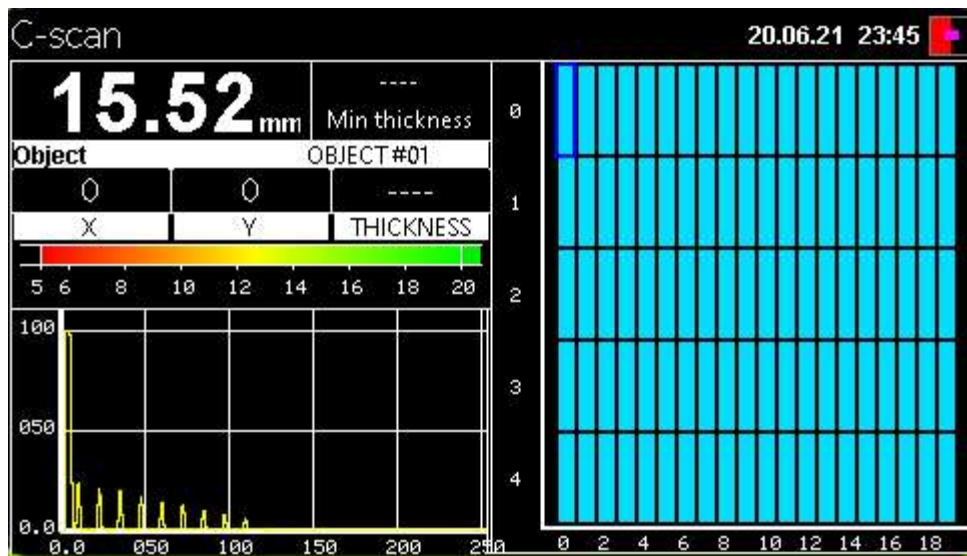
Enter these values using the  and  buttons.

The data in the C-scan can be filled both from top to bottom (vertical lines) and from left to right (horizontal lines). The user can select the order of filling the C-scan in the "Order" item using the  and  buttons.

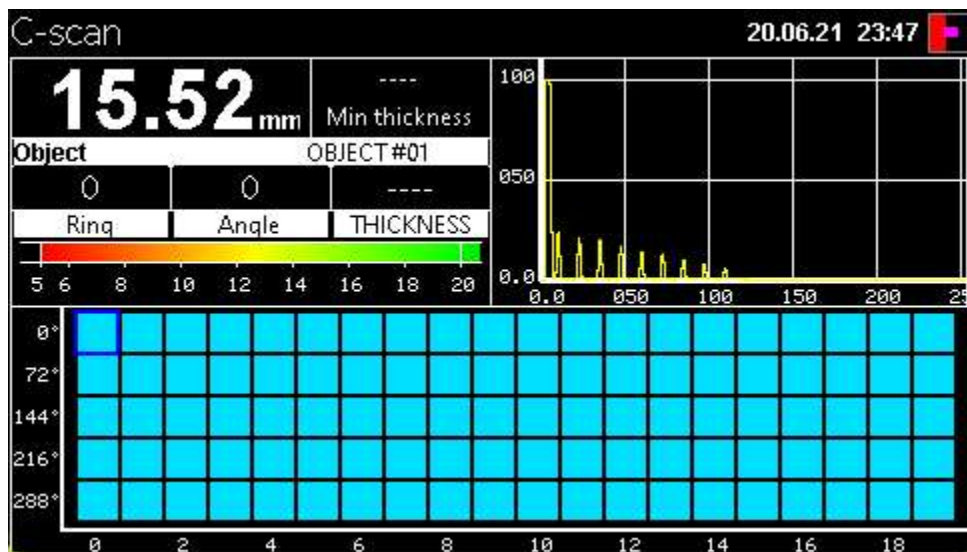
The user shall enter the base thickness of the test object and minimum permissible thickness of the test object. In the course of the C-scan filling, all points with thicknesses less than the minimum permissible thickness will be displayed in black. Such points are visible very well on the background. The points with thicknesses higher than the base thickness will be displayed in green. The points with thicknesses between the minimum and base values are displayed on the C-scan with gradient.

Upon entering all settings, select item "Start inspection" to start the C-scan filling and press the  button.

Then, the window appearance will be as shown in the Figures below:




C-scan filling mode for "Matrix" test object



C-scan filling mode for "Pipe" test object

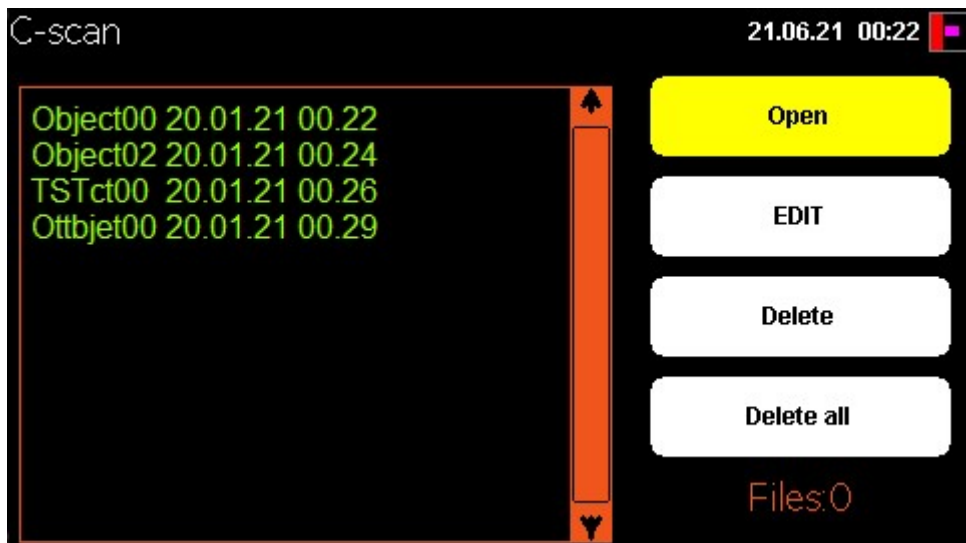
This window shows the A-scan, C-scan, current value of the measured thickness, current coordinate, as well as the minimum thickness which was found during the whole time of C-scan filling.

The current position is highlighted with blue square cursor on the C-scan. Prior to the inspection start, this square cursor is at the point with coordinate (0.0).

To fill the C-scan, the user installs the Device sensor in the required point and presses the  button; the cursor coordinate increases by one increment and the procedure repeats.

Open inspections

This item enables to open the previously saved inspection results. If necessary, the user can repeat measurements for any point in the previously saved archive. The previously saved archive selection window is shown in the Figure below:



Open inspections window

You can navigate through the menu items using the  and  buttons. To select the appropriate menu item, press on the  button.

This window contains the following items:

Open

This item enables to select and open the previously saved archive.

Edit

This item enables to select and open the previously saved archive for editing.

Delete

This item enables to select and delete the previously saved archive.

Delete all

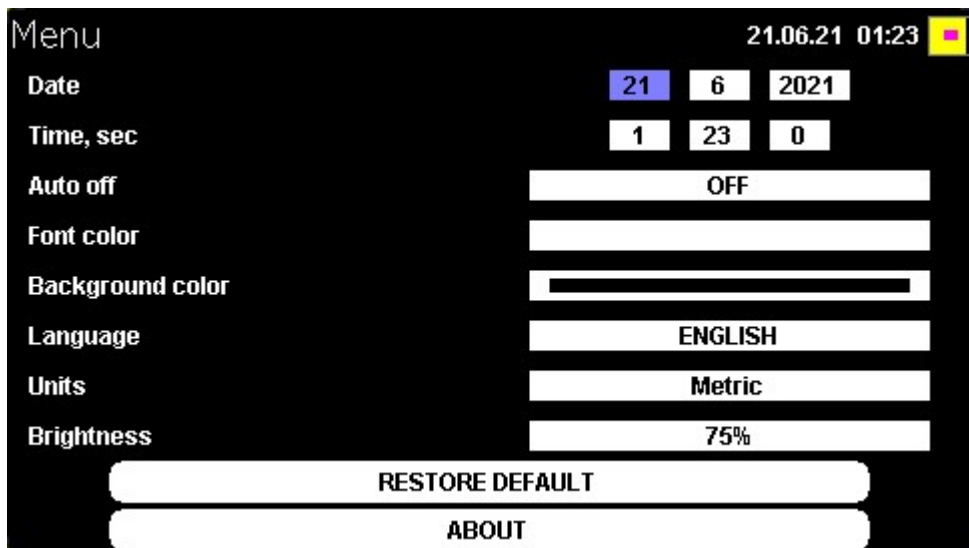
This item enables to delete all archives saved in the Device memory.

Continue inspection

This item becomes active when the user has started the inspection earlier and has terminated it by switching to the other windows of the Device. When this item is selected, the Device returns to the previously started inspection.

User menu



To open the user menu, press the  button. In this case, the following window will appear:





User menu

This menu contains the following menu items:



Date

This item enables to set the current date. To change the value, press the  and  buttons.

Time

This item enables to set the current time. To change the value, press the  and  buttons.

Auto off

This item enables to set the time period for the Device switching off unless the measured thickness data are updated. To change the value, press the  and  buttons.



Font color

This item enables to select the thickness color in the Thickness window. To change the value, press the  and  buttons.



Background color

This item enables to select the background color in the Thickness window. To change the value, press the  and  buttons.



Language

This item enables to select the Device interface language. Available options are Chinese, English, and Russian. To change the value, press the  and  buttons.


Units

This item enables to select the measurement units. Available options are millimeters and inches. To change the value, press the  and  buttons.


Brightness

This item enables to set the percentage screen brightness. To change the value, press the  and  buttons.

Restore default

This item enables to restore all defaults of the Device. To select this menu item, press on the  button.

About

This item enables to know the software version. To select this menu item, press on the  button.

Transducer Selection

The transducer is selected based on the test object temperature, base thickness, surface quality, etc. The characteristics of all applicable sensors are given in the Comparative table provide below:

Comparative table for transducer selection

| Transducer | Test object temperature range, °C | Thickness range, mm | Operating gap, mm | Description |
|------------|-----------------------------------|---------------------|-------------------|---|
| EMT14012 | from -20 to +80 | from 2 to 120 mm | from 0 to 4 | Compact transducer, suitable for most of applications. It is supplied together with the Device as standard scope of supply. |
| EMT14013 | from -20 to +80 | from 2 to 120 mm | from 0 to 6 | The transducer has the enhanced magnetic system and is used in such cases when operation with the maximum operating gap or on the objects with poor surface quality due to heavy corrosion is required. |

| | | | | |
|--------------|------------------|------------------|-------------|--|
| EMT14014T | from -20 to +750 | from 2 to 120 mm | from 0 to 3 | The transducer has a steel housing and special heat-resistant protector and is designed for operation with the objects heated up to 750 °C. |
| EDC10P5F3 | from -5 to +50 | from 0.5 to 20 | - | The transducer operates at 10 MHz and is designed for thickness measurements of the thin objects and small defects detection. |
| EDC5P7.2FS10 | from -5 to +50 | from 1 to 150 | - | The transducer operates at 5 MHz and is designed for thickness measurements of the medium thick objects and suitable for most of applications. |
| EDC5P10FS15 | from -5 to +50 | from 2 to 300 | - | The transducer operates at 5 MHz and is designed for thickness measurements of the thick objects and of the objects with poor surface quality. |

Note that, when using the EMT14014T transducer, it cannot be heated to the temperatures exceeding 300 °C. Therefore, while operating with the objects heated to the temperatures exceeding 300 °C, it is necessary to observe time intervals in accordance with the table below:


EMT14014T transducer measurement modes

| Temperature range, °C | Measurement duration, seconds |
|-----------------------|--|
| 0 – 300 | continuously |
| 300 – 700 | 0 – 5 (time interval between measurements: 15 seconds) |

Thickness Measurements using the Device

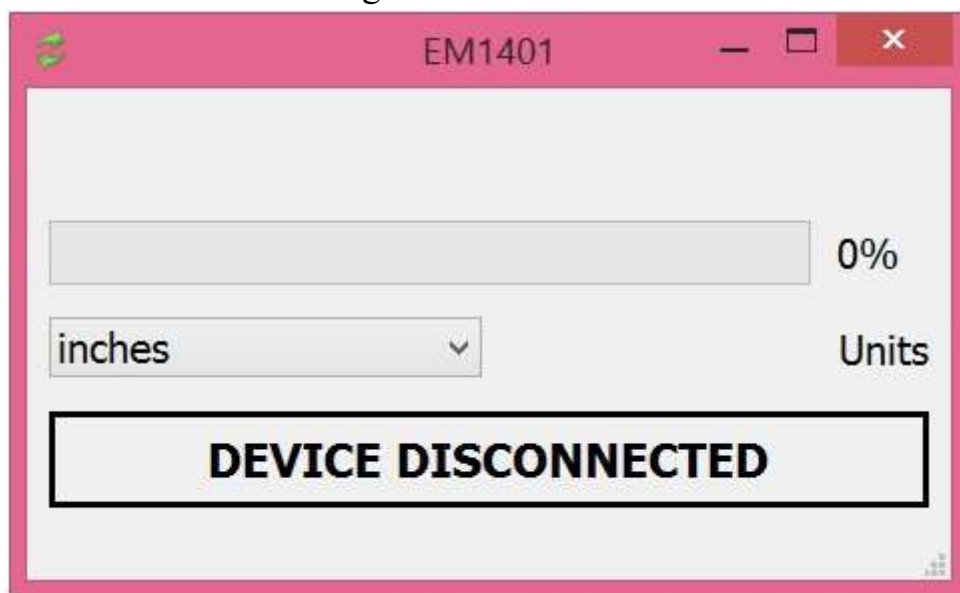
To measure the thickness, do as follows:

1. Select the transducer to operate with the thickness gauge as described in the previous item.
2. If necessary, clean the surface and apply contact liquid (when using the piezoelectric transducers).

3. Press the  button to switch the Device on. When no test object is near the transducer, the thickness values on the Device screen can change randomly.
4. If necessary, calibrate the Device (see section "Calibration", item "Thickness window")
5. Place the Device on the test object surface. Depending on the selected accumulation number, the Device will display the measured thickness in the time period from 100 ms to 3 s.

Data Transfer to PC

All saved archives with inspections (S-scans) are stored in the Device memory in .csv format. This format can be opened in Microsoft Excel. To transfer the files from the Device to the PC, use the EM1401_Downloader application. The application window appearance is shown in the Figure below:



EM1401_Downloader application appearance

To download the files, connect the Device to the PC with the installed EM1401_Downloader application, start up the application, switch on the Device, select the thickness measurement units and press the button in the top left angle of the application. Then, the application will read data from the Device and create *.csv files in the folder with the application installed.

Device Operation Features

The Device has the electromagnetic-acoustic transducer with a permanent magnet that introduces a number of requirements for operation with the Device

1. Be careful when moving the transducer near knives, forks, needles, and other sharp metal objects. These objects can be magnetized to the transducer casing and injure the user;
2. When placing the transducer on an unattached relatively light test object, hold the test object by hand;
3. The transducer can disable magnetic cards if it is placed near them;
4. In case of sharp inaccurate placement of the transducer on the test object, a stroke may occur due to additional acceleration caused by the magnetic field. It is recommended to place the transducer on the test object smoothly, without throwing and holding it by hand to increase the service life of the transducer;
5. It is recommended to place the transducer on the test object at an angle of 60°. After touching the test object surface by the transducer, the transducer should be straightened to a 90° angle.

It is necessary to monitor the integrity of the plastic or ceramic protector during the whole service life of the Device. If the plastic is damaged and the coil wires are out of the coating, it is necessary to replace the transducer.

WARNING!

Long-term operation of the product with a damaged sensor can lead to complete failure of the Device. The contact of the damaged sensor (when the coil wires are out of the coating) with the metal can lead to sparking.

Battery Charge

A battery charge indicator is displayed on the Device screen.



Battery charge indicator

It takes at least five hours to charge a fully discharged battery to 100%. Charge the Device when it is off.

WARNING!

Long-term storage of the Device battery in the fully discharged state can decrease battery capacity and reduce its service life. When the battery is completely discharged, charge it as soon as possible. Consider this requirement during long-term storage of the Device.

DEVICE CALIBRATION TEST PROCEDURE

The Device calibration test is carried out by the bodies of the Service of Legal Metrology or other authorized organizations accredited for carrying out such operations

The result of the calibration test is confirmation of the measuring instrument fitness or unfitness for use.

If the measuring instrument is found to be fit for use in the result of the calibration tests, then a calibration test mark is put in the Device documentation or a Calibration Test Certificate is issued.

With negative results of the calibration tests, the Device is not allowed for further operation and an unfitness mark is put in the Device documentation.

Calibration Test Procedure

During the calibration test, the following operations should be performed:

1. External examination;
2. Functional test;
3. Measurement error calculation.

In agreement with the bodies conducting the Device calibration test, the calibration test may be performed not in full.

Calibration Instruments

The calibration instruments shall have valid Calibration Test Certificates or marks.

The calibration test is performed using the following test samples:

1. A KYCOT-180 set of standard samples of the equivalent ultrasonic thickness or a KMT-176M-1 (KMTC-97) set of ultrasonic thickness control gauges;
2. A set of plane-parallel samples made of one steel blank with the following parameters:

| Thickness, mm | Roughness RZ, micron, less than |
|----------------|---------------------------------|
| 2 ± 0.01 | 10 |
| 10 ± 0.015 | 20 |
| 60 ± 0.03 | 20 |

The calibration instruments can differ from those mentioned above but their characteristics must not be inferior to those mentioned above and must be sufficient to obtain a reliable result. The use of such calibration instruments must be agreed with the Gosstandart bodies

Calibration Test Conditions

The calibration test shall be performed under the following climatic conditions:

| | |
|---------------------|---------------|
| Air temperature: | +5 to +30 °C |
| Humidity | 80% at +25 °C |
| Atmosphere pressure | 86 to 106 kPa |

Calibration Test Description

External examination

The following requirements are checked during the external examination:

1. The scope of the Device supply shall be as specified in the operation manual;
2. The marking and the serial number of the Device shall comply with the marking and the serial number specified in the operation manual;
3. The Device shall have no mechanical damages affecting its performance and worsening its technical specifications.

Functional test

The functional test of the Device shall be carried out in accordance with "Operation Description" and using a test sample from the scope of supply or another test sample that has the required certificate.

The functional test procedure is as follows:

1. Calibrate the Device using a test sample;
2. Measure the thickness of the test sample. The measured value of the sample thickness shall not differ from the actual value (10 mm) by more than 0.04 mm.

Measurement error calculation

The measurement error calculation is performed using a set of samples made of a single blank as follows:

1. Place the Device on a 2 mm thick test sample;
2. Calibrate the Device using a calibration method based on the known thickness of the test object;
3. Perform 5 thickness measurements at five different points of the 2 mm thick test sample;

4. Calculate the maximum measurement error (Δ) using the formula:

$$\Delta = \max(H_i - H_o)$$

where H_i is the result of the measurement; H_o is the thickness of the sample;

5. Repeat the operations specified in items 1 to 4 for 10 and 60 mm thick test samples.

The calibration test results are considered positive if the obtained values of the Device measurement error for all test samples do not exceed ± 0.04 mm.

MAINTENANCE

Transducer Replacement

When the plastic coating of the transducer is worn out, replace the transducer.

WARNING!

Replace the transducer when the Device is off.

Battery Replacement

The Device is equipped with a removable battery; the user can replace the battery for a new one, if necessary. Replace the battery once per three years.

TRANSPORTATION AND STORAGE

During storage and transportation of the Device, maintain the following climatic conditions:

Air temperature: +5 to +30 °C

Humidity 80% at +25 °C

Store and transport the Device only in a case from the scope of supply. Avoid any mechanical damages of the case and Device.

During long-term storage, the Device battery will discharge that can affect the Device further operation. So, we recommend to perform regular check (at least once per year) of the Device charge level and, if necessary, to recharge the battery (see "Battery Charge").



SCOPE OF SUPPLY

Basic configuration:

| | model EM1401 | model EM1401 UT |
|--|-----------------|--------------------|
| EMA thickness gauge | 1 pc. | 1 pc. |
| Protective cover | 1 pc. | 1 pc. |
| Storage case | 1 pc. | 1 pc. |
| Recharger (adapter and cable) | 1 pc. | 1 pc. |
| Operation manual | 1 pc. | 1 pc. |
| EMA transducer EMT14012 | 1 pc. | 1 pc. |
| Connecting cable for EMAT | 1 pc. | 1 pc. |
| Piezoelectric transducer EDC10P5F3 | - | 1 pc. |
| Piezoelectric transducer EDC5P7.2FS10 | - | 1 pc. |
| Piezoelectric transducer EDC5P10FS15 | - | 1 pc. |
| Connecting cable for piezoelectric transducers | - | 1 pc. |

Not included in the basic configuration, but can be ordered additionally:

- EMA transducer EMT14013 to work with a gap up to 6 mm
- High-temperature EMA transducer EMT14014T to work with objects with a surface heated up to 750 °C

MANUFACTURER WARRANTY

The warranty period is 24 months from the purchase date. Within the warranty period, the Manufacturer shall rectify faults of the Device provided that the housing is not damaged and the warranty seals are available.

The Manufacturer may withdraw its warranty obligations when:

1. The Device is used for purposes other than those specified in this operation manual;
2. The Device operation, storage, and transportation conditions and requirements specified in this operation manual are not met;
3. There are mechanical damages of the Device as a result of careless handling.

WARRANTY CERTIFICATE

| | |
|------------------------|--|
| Device | EM1401/ EM1401 UT EMA Thickness gauge |
| Serial Number | |
| Warranty Period | |
| Manufacturer | Oktanta LTD 22-34 Mayakovskogo Street, Saint Petersburg 191014, Russia +7(812)385-54-28 info@oktanta-ndt.ru <div style="text-align: right;"> _____ Signature, stamp </div> |

INFORMATION ABOUT REPAIR

| Date of Application | Fault Type | Repair | Completed/Not Completed (Date, Signature, Stamp) |
|----------------------------|-------------------|---------------|---|
| | | | |
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INFORMATION ABOUT CALIBRATION TEST

| Date of calibration test | Valid till | Calibrator |
|--------------------------|------------|------------|
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