EM5000

Electromagnetic Acoustic Thickness Gauge

User Manual

Saint Petersburg

Content

List of Abbreviations

Device – EM5000 Electromagnetic Acoustic Thickness Gauge

EMA – ElectroMagnetic Acoustic

Introduction

This user manual is a mandatory document for persons who operate and maintain the EM5000 Electromagnetic Acoustic Thickness Gauge.

Keep this user manual in a safe, accessible location.

This user manual contains complete and essential information on how to use the Device safely and effectively.

Before using the Device, thoroughly review this user manual. Use the Device as instructed.

Persons who use and maintain the Device must undergo periodic safety training.

IMPORTANT

Some of the details of components and/or software images in this user manual may differ from your Device's components or software display. However, the principles remain the same.

1 Device Description and Operation

1.1 Intended Use

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:

- non-contact EMA transducers with a pulsed electromagnet;
- non-contact EMA transducers with a permanent magnet.

Thickness is measured without the use of couplant and without preliminary surface preparation, with a working a gap between the transducer and metal. The gap can be a layer of rust, a layer of salt deposits or other non-conductive coating (paint, varnish, enamel, plastic etc.).

The Device can be connected to any Android tablet or other devices with the “ScanView” program installed via Bluetooth.

1.2 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 to EMA transducers with a pulsed electromagnet and to EMA transducers with a permanent magnet.

A special data processing algorithm designed by Oktanta company 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.

1.3 Technical Specifications

Parameter	Value
Range of operating ambient temperature, °C	-20 to +50
Duration of continuous work without battery recharge, hours	5
Battery (Device power supply): – type – voltage, V	 18650 3.6
Range of sound velocity setting, m/s	1000 to 9999 with 1 m/s step
Highest number of measurements per second	16
Dimensions, mm	186 x 34 x 43
Weight, kg, no more	0.3
Range of measured thickness for steel, mm	2 to 600 (to 100 mm for EMT50003P)
Thickness measurement error (for steel), mm – in the range from 0.5 to 25 mm inclusive – in the range from above 25 to 200 mm	 ± (0.08 + 0.001·H*) ± (0.1 + 0.005·H*)
Permissible clearance between the transducer and test object, mm – EMT50003P transducer – EMT50001 transducer – EMT50004T transducer	 to 2 to 5 to 3
Permissible transducer skew, °	± 25
Lowest permissible radius of curvature of the test object surface, mm	≥10
Device operating frequency, MHz	4
Range of operating temperature on the test object surface, °C	-20 to +80 (-20 to +750 for EMT50004T**)

* H – measured thickness value, mm.
** The EMT50004T transducer is not included in the basic package of the Device.

1.4 Device Description

The Device appearance is shown in Figure 1.1.

Figure 1.1 – The Device appearance

The Device front panel features a color liquid crystal display for displaying measurement results and a keyboard for controlling the Device. Table 1.1 lists the key functions available from the Device keyboard.

On the side of the Device, there are the USB-C connector (DC power connector, under the protective cover) and the strap fastening. The Device comes with a hand strap.

The Device has a replaceable transducer, which is fixed with 4 screws.

Table 1.1

Button	Brief description	Function
	OK	Switch on/off the Device, change the Device settings
	Save	Save measurement results to the Device memory

Button	Brief description	Function
	Up	Switch between the Device modes and settings, adjust settings
	Down	Switch between the Device modes and settings, adjust settings
	Back	Return to previous configuration steps, exit from editing settings, "freeze" the Device readings during auto thickness measurement

On the back of the Device, there are the battery compartment door and information about the Device (Device name, serial number, manufacturer).

1.5 User Interface

The Device has 4 modes:

- Auto thickness measurement – simple measurements for the test objects with quite good surface quality or in the presence of slight corrosion (see paragraph 3.1);

- A-scan – thickness measurement and A-scan display for the test objects that has complex shape, made by casting, as well as for the test objects prone to severe corrosion (see paragraph 3.2). It can also be used in cases where the user wants to double-check the Device auto thickness measurements;

- operation with saved data (see paragraph 3.3);

- Device setting (see paragraph 2.6).

To switch between the modes, use the  and  buttons. The sequence of mode switching and window appearance are given in Figure 1.2.

Additionally, the Device allows the user to enter the required settings of the test object (see paragraph 2.4) and calibrate the transducer (see paragraph 2.5).

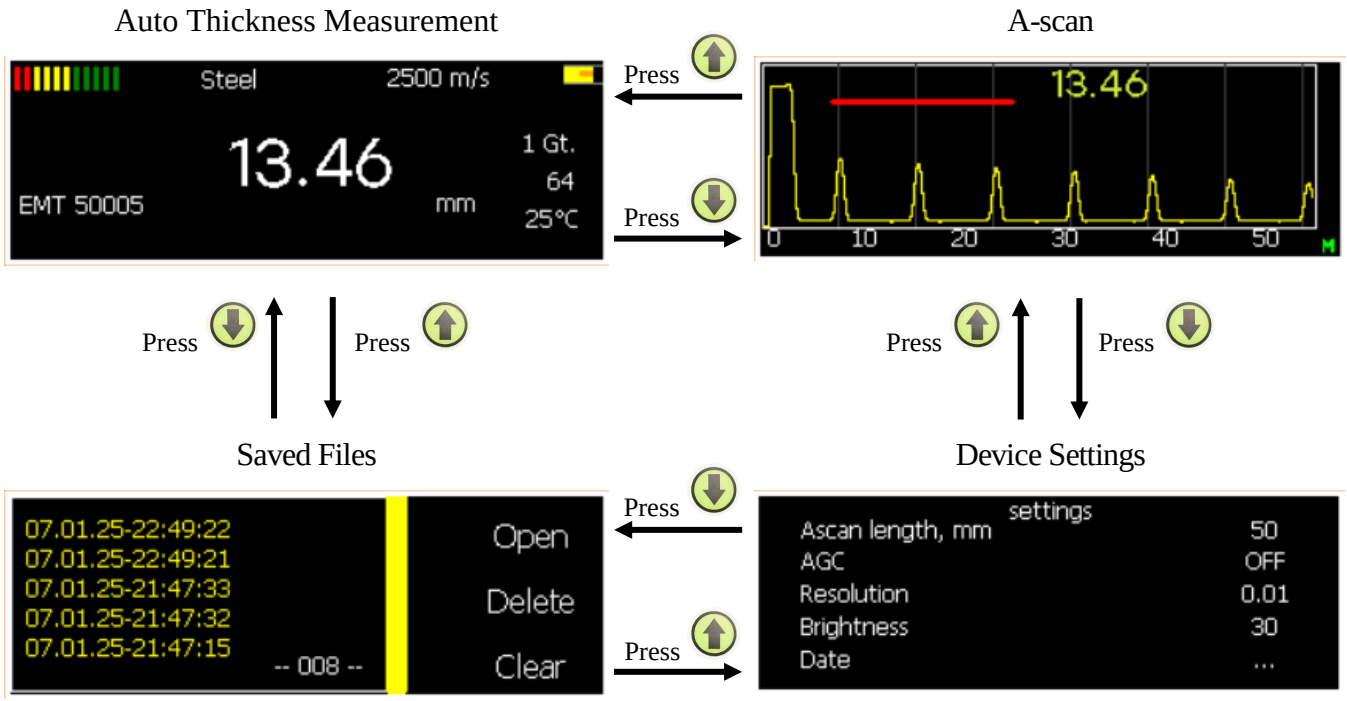

Figure 1.2 – Device mode switching

2 Preparation for use

2.1 Transducer Selection

2.1.1 The transducer is selected based on the test object temperature, base thickness, surface quality, etc. The characteristics of all applicable transducer are given in the comparative Table 2.1.

CAUTION!!!
Replace the transducer when the Device is OFF.

2.1.1 The replacement of the transducer is described in paragraph 4.1.

2.1.2 It is recommended to install the CAP40001 protective cap on the standard transducer when operating with the test objects with quite good surface quality or in the presence of slight corrosion to extend the service life of the transducer.

Note – If during operation it turns out that the sensitivity of the transducer is insufficient, remove the protective cap and continue working without it.

2.1.3 The EMT50004T transducer does not allow heating to temperatures exceeding 300 ºC while operation. Therefore, while operating with the objects heated to the temperatures exceeding 300 ºC, it is necessary to observe time intervals in accordance with Table 2.2.

Table 2.1 – Comparative table for transducer selection

Transducer	Test object temperature range, °C	Thickness range, mm	Oper-ating gap, mm	Description
EMT50003P	-20 to +80	2 to 100	0 to 2	The transducer is equipped with a pulsed electromagnet that operates only during the measurement. After the measurement, the electromagnet is switched off, dirt is not attracted to the transducer, no cleaning required. At the same time, the power of the sound wave for such a transducer is less than that of the EMA transducer with a permanent magnet. The transducer is used for the test objects with quite good surface quality or in the presence of slight corrosion
EMT50001	-20 to +80	2 to 600	0 to 5	Suitable for most of applications
EMT50004T	-20 to +750	2 to 200	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

Table 2.2 – EMT50004T

Temperature range, ºC	Measurement duration, seconds
0 – 300	continuously
300 – 750	0 – 5 (time interval between measurements:15 seconds)

2.2 Device Switching On

2.2.1 To switch the Device on, press and hold the OK button for 3 seconds. A window with information about the Device including the software version appears on the screen (Figure 2.1).

Figure 2.1 – Window with information about the Device

2.2.2 When the Device is loaded, a window with measured thickness appears (Figure 2.2).

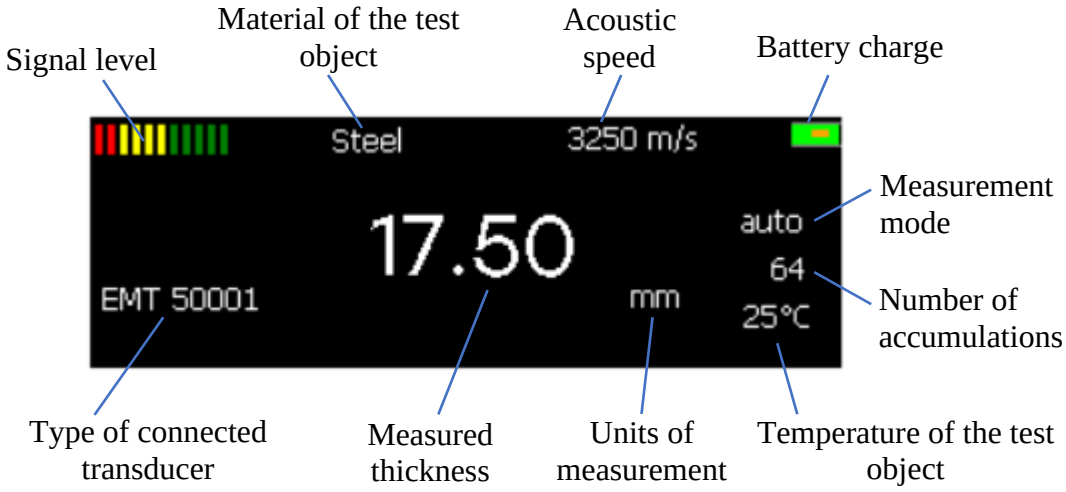

Figure 2.2 – Window with measured thickness

2.2.3 Check the battery charge level in the upper right corner of the screen:

-  (green color) – the battery is fully charged (90 to 100 %);
-  (yellow color) – the battery is low, charge the battery (50 to 80 %);
-  (red color) – the battery is discharged, charge the battery urgently (10 to 40 %).

If necessary, charge the battery (see paragraph 3.6).

2.3 Device Switching Off

2.3.1 Press and hold the OK button for 3 seconds.

2.4 Setting up for Test Object

2.4.1 The following current Device settings are displayed in the window with the measured thickness (Figure 2.3):

- type of connected transducer (see paragraph 2.1);
- thickness measurement mode (auto, one gate or two gates, see paragraph 3.2);
- averaging number used in the Device;
- acoustic speed depends on the material and temperature of the test object;
- selected temperature of the test object;
- selected material of the test object.

2.4.2 To change the settings, press the OK button. One of the fields will be highlighted with a grey color, as shown in Figure 2.3.

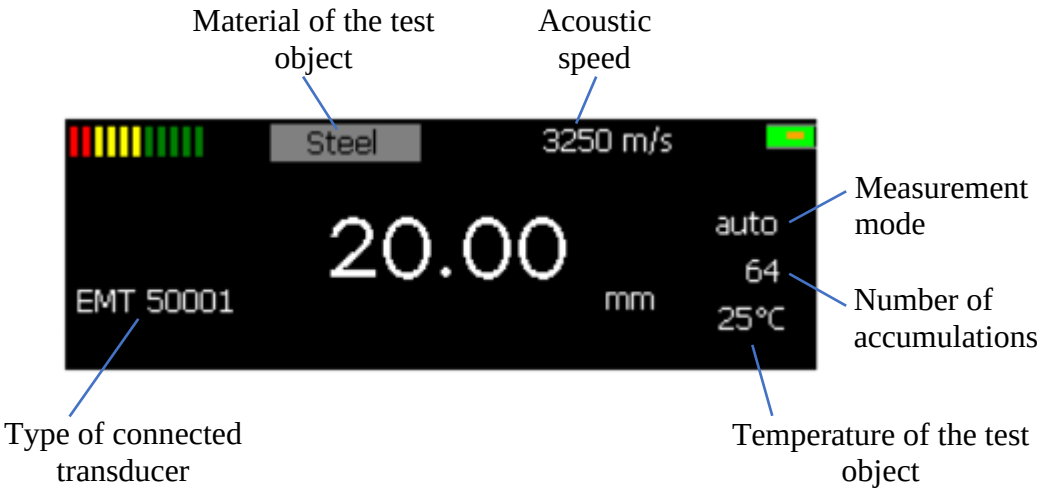

Figure 2.3 – Selecting the field to edit

2.4.3 Select the desired setting by pressing the ▲ and ▼ buttons.

2.4.4 To start editing the value of the selected field, press the OK button. The color of the text in the selected field will change to a darker one, as shown in the Figure 2.4.

Figure 2.4 – Field value editing

2.4.5 Set the desired value by pressing or holding the and buttons.

2.4.6 After finishing editing the field, press the button to save the value and to exit the setting changing mode or press the OK button to save the value and to return the field selection mode.

2.4.7 Press the button to exit the setting changing mode.

The description of the Device settings for the test object is given in the Table 2.3.

Table 2.3

Field (see Figure 2.2)	**Description**
Type of connected transducer	Select the type of the connected transducer (see paragraph 2.1)

Field (see Figure 2.2)	**Description**
Number of accumulations	By default, the Device uses 128 accumulations of the useful signal. Thus, the final thickness measurement is performed using 128 measured values by averaging them: – when the Device measures thickness of a test object with poor surface quality and across a wide gap, it is recommended to increase number of accumulations up to 256 – 512; – when the Device measures thickness of a test object without coatings and without corrosion, the number of accumulations can be reduced to 32 – 64. **Increasing of the number of averages increases the reliability and accuracy of measurements, but also increases the measurement time**
Material of the test object	Select the material of the test object. The Device will automatically set the acoustic speed value and the function of the dependence of acoustic speed on temperature. Depending on the characteristics of the metal of the test object, acoustic speed may differ slightly from the one set in the Device, so it is recommended to calibrate the transducer (see paragraph 2.5)
Temperature of the test object	Select temperature of the test object The acoustic speed depends on the temperature of the material, so different acoustic speeds must be used for different temperatures. The Device automatically adjusts the acoustic speed depending on the specified temperature of the test object
Acoustic speed	When the user selects a material of the test object, the acoustic speed is automatically set from the default values for that material. The user can set any value of the acoustic speed if it is known more precisely (the Device uses a transverse acoustic wave) (see paragraph 2.5)

2.5 Calibration

2.5.1 Calibration of transducers using a known thickness or acoustic speed is performed as needed to adjust the Device for operation with a specific test object.

2.5.2 To calibrate the transducer using a known acoustic speed, set the known exact value of the acoustic speed of a specific test object according to paragraphs 2.4.2 - 2.4.7.

2.5.3 To calibrate the transducer using a known thickness of the test object:

2.5.3.1 Place the transducer on the test object surface.

2.5.3.2 Set the known exact value of the test object thickness according to paragraphs 2.4.2 - 2.4.7 (Measured thickness field in Figure 2.2).

2.5.4 The Device automatically recalculates acoustic speed.

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.

2.6 Setting up Device Interface

2.6.1 To edit the Device settings, select this mode (Figure 2.5) by pressing the  and  buttons.

Figure 2.5 – Appearance of the Device settings

2.6.2 To change the settings, press the  button. One of the settings will be highlighted with a grey color.

2.6.3 Select the desired setting by pressing the  and  buttons.

2.6.4 To start editing the value of the selected field, press the  button. The color of the text in the selected field will change to a darker one.

2.6.5 Set the desired value by pressing the  and  buttons.

2.6.6 After finishing editing the field, press the  or  button to save the value to return the setting editing mode.

2.6.7 Press the  button to exit the setting editing mode.

The description of the Device interface settings is given in the Table 2.4.

Table 2.4

Menu item	Description
Ascan length, mm	Set the maximum length of the A-scan displayed on the screen in the A-scan mode
AGC	Enable/disable automatic gain control mode in A-scan mode. In most cases, it is recommended to use this setting “on”
Resolution	Determine how many decimal places are displayed on the screen when measuring the thickness
Brightness	Set the screen brightness (in percent)
Date	Set the current date
Time	Set the current time
Language	Select the Device interface language. Available options are Chinese, English, and Russian
Units	Select the measurement units. Available options are millimeters and inches

3 Basic Operation

3.1 **Thickness Measurement**

3.1.1 Prepare the Device for use in accordance with paragraph 2.

3.1.2 Switch on the Device. When no test object is near the transducer, the thickness values on the Device screen can change randomly.

3.1.3 Place the transducer 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.

Note – If the 1 or 2 gate thickness measurement mode is selected, the thickness measurement is not performed automatically, but is made taking into account the gates configured in the A-scan mode (see paragraph 3.2).

3.1.4 Use the signal level indicator to check the quality of the signal at the measurement point (the more stripes the indicator has, the stronger the useful signal). If the indicator only shows yellow or red stripes, move the transducer 5 - 10 mm to the side and repeat the measurement.

3.1.5 If the quality of the surface of the test object does not allow thickness measurement, it is recommended to move the transducer 5 - 10 mm to the side and repeat the measurement.

3.1.6 For the test objects prone to severe corrosion, it is recommended to increase the number of accumulations (see paragraph 2.4).

3.1.7 To "freeze" the Device readings, press the  button. The readings on the screen will freeze and appear in blue. To return to the measurement mode, press the  or  button.

3.2 Thickness Measurement with A-scan Display

3.2.1 The A-scan mode (Figure 3.1) is used for the test objects that has complex shape, made by casting, as well as for the test objects prone to severe corrosion.

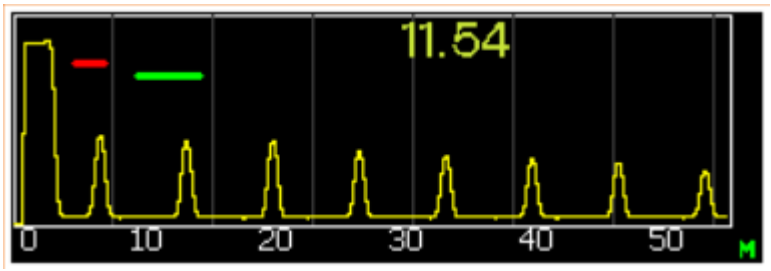

Figure 3.1 – A-scan appearance

3.2.2 Before starting operation in the A-scan mode, open the Auto thickness measurement mode and set the measurement mode (similar to paragraphs 2.4.2 - 2.4.6): Auto (most measurements, without operator intervention, see paragraph 3.1), 1 gate (for the test objects with a thickness greater than 6 mm), 2 gates (for the test objects of any thickness).

Notes:

1 The Device has three thickness measurement modes:

– the automatic mode is suitable for most applications and allows you to obtain the thickness value without operator intervention;

– the “one-gate” mode calculates the position of the maximum in the first (red) gate and recalculates the found value into the thickness. The position of the first gate and its length are set by the operator;

– the “two-gate” mode calculates the position of the maximums in two gates. The difference between the maximum position in the first (red) gate and the maximum position in the second (green) gate is used to calculate the thickness. The position of the gates is set by the operator.

2 Each gate is a selected time interval in which the maximum value is calculated.

3.2.3 Follow the steps in paragraphs 3.1.1 - 3.1.3.

3.2.4 In A-scan mode, the following information is displayed on the Device screen:

- measured thickness;

- A-scan and gates;

- gain control mode (in the lower right corner of the screen): A – auto, M – manual (setting the mode according to paragraph 2.6).

The horizontal axis on the A-scan is measured in millimeters or inches, depending on the units of measurement selected in the Device settings (see paragraph 2.6).

3.2.5 Set A-scan view (scale, offset), gain and gates:

3.2.5.1 To start the setup, press the OK button. The “scale” message will appear on the screen. (Figure 3.2).

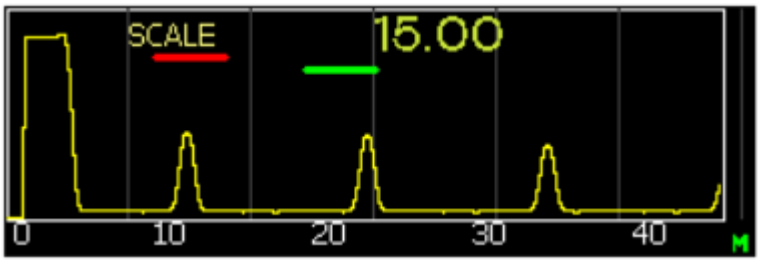

Figure 3.2 – A-scan scaling

3.2.5.2 Zoom in or out by pressing and buttons.

3.2.5.3 Then sequentially switch between the settings by pressing the OK button, and set the settings by pressing or holding the and buttons:

- offset – move along the enlarged A-scan and select the necessary part of it;

- gain (if the automatic gain control (AGC) mode is disabled in the Device settings, see paragraph 2.6) – change the gain of the Device. The gain level indicator is displayed on the right side of the screen. (Figure 3.3);

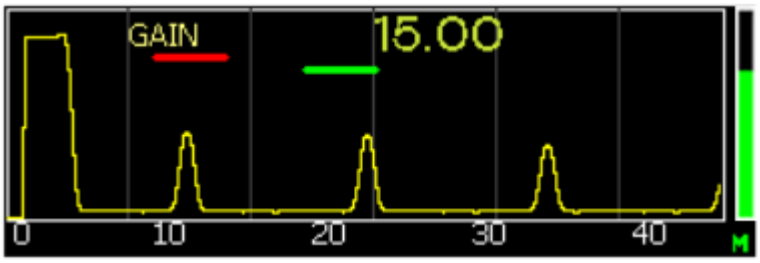

Figure 3.3 – A-scan. Manual gain mode

- Gate 1, Gate 2 – change the position of gates depending on the selected thickness measurement mode: 1 gate (red) should be above the first bottom signal (Figure 3.4) or

above the multiple bottom signals when measuring in “one-gate” mode (Figure 3.5), 2 gate (green) should be above the second bottom signal (Figure 3.6). When measuring in “one-gate” mode, adjust the gate length (Figure 3.5).

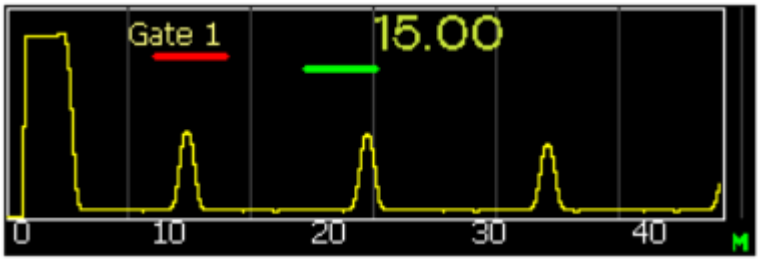

Figure 3.4 – Setting the position of the 1 (red) gate (above the bottom signal)

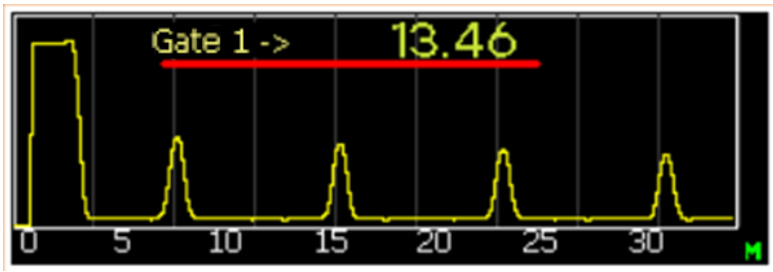

Figure 3.5 – Setting the length of the 1 (red) gate (above the multiple bottom signals)

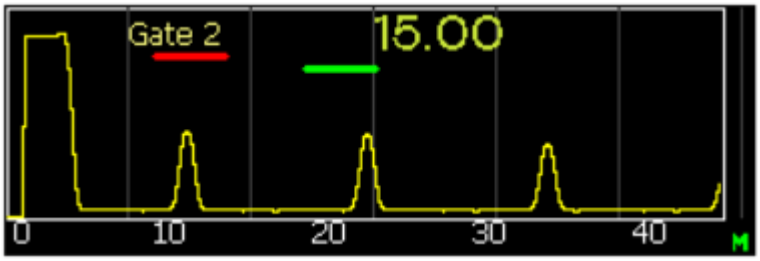

Figure 3.6 – The location of two gates above the bottom signals

3.2.5.4 To exit the setting of the A-scan view, gain and gates, press the button.

3.2.6 To set the default A-scan scale, press and hold the button for 3 s.

3.2.7 To save the current measurement to the Device memory, press the button. Each measurement is recorded in a file, the name of which includes the date and time of file creation.

3.3 Operation with Saved Files

3.3.1 The Device allows the user to view and delete previously saved measurements (Figure 3.7).

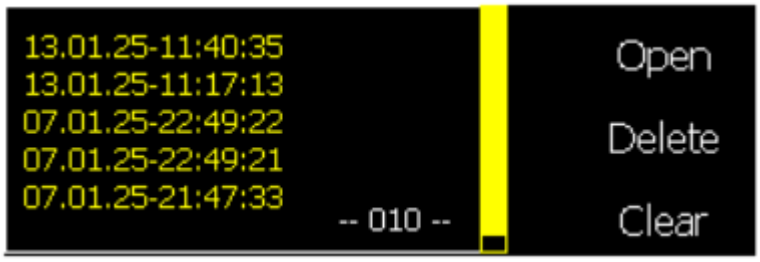

Figure 3.7 – Operation with saved files

3.3.2 To start operations with the files, press the OK button. One of the files will be highlighted (Figure 3.8).

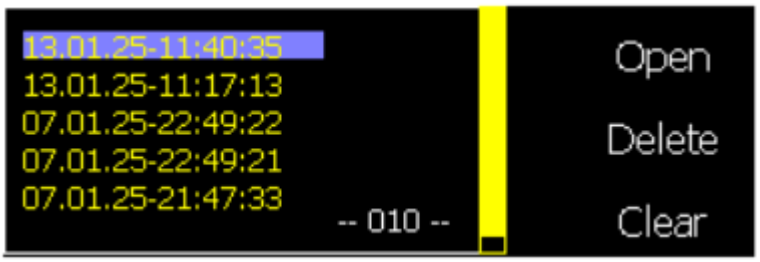

Figure 3.8 – Operation with saved files (file selection)

3.3.3 Select the required file by pressing the and buttons, and press the OK button. One of the buttons on the right side of the screen will be highlighted.

3.3.4 Select the required operation with the file by pressing the and buttons, and press the OK button. The description of operations with files is given in Table 3.1.

3.3.5 To exit the mode, press the button the required number of times.

Table 3.1

Menu item	Description
Open	Select and open the previously saved file
Delete	Select and delete the previously saved file
Clear	Delete all file saved in the Device memory

3.4 Operation with Tablet

3.4.1 The Device can be connected to any Android tablet or other devices with the ScanView program installed.

3.4.2 The Device automatically connects to the tablet via Bluetooth after starting the “ScanView” program.

3.4.3 The “ScanView” program allows the user to:

- operate in real time with the Device, setting and display A-scans, B-scans and C-scans;

- use the Device as a flaw detector for searching for pitting corrosion;

- save files with measurements in tabular form in “.csv” format or as images in “.png” format;

- calibrate the transducer using a known thickness or acoustic speed.

3.4.4 A description of the “ScanView” program is given in the User Manual for this program.

3.5 Device Operation Features

3.5.1 The Device has the electromagnetic-acoustic transducer with a permanent magnet or a pulsed electromagnet that introduces a number of requirements for operation with the Device:

- 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;

- When placing the transducer on an unattached relatively light test object, hold the test object by hand;

- The transducer can disable magnetic cards if it is placed near them;

- 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;

- 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.

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

CAUTION!

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

3.6 Battery Charge

3.6.1 The battery must reach full charge on a regular basis for proper capacity and cycle-life maintenance.

3.6.2 To charge the battery, connect the Recharger and USB-C cable supplied with the Device to the DC power connector of the Device and to an appropriate power outlet.

3.6.3 It takes at least four hours to charge a fully discharged battery to 100%.

3.6.4 It is recommended to charge the Device when it is off. When the Device is charging in the off state, the battery charge level is displayed on the screen.

CAUTION!

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.

4 Maintenance

4.1 Transducer Replacement

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

CAUTION!!!
Replace the transducer when the Device is OFF.

4.1.2 To replace the transducer (Figure 4.1):

4.1.2.1 Unscrew 4 screws securing the transducer.

4.1.2.2 Remove the transducer.

4.1.2.3 Install a new transducer.

4.1.2.4 Tighten 4 screws to secure the transducer.

Figure 4.1

4.2 Battery Replacement

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

4.2.2 To replace the battery (Figure 4.1):

4.2.2.1 Switch off the Device and disconnect it from the charger.

4.2.2.2 At the back of the Device, unscrew the screw of the battery compartment door.

4.2.2.3 Remove the battery compartment door.

4.2.2.4 Carefully remove the battery.

4.2.2.5 Carefully install a new battery into the compartment, observing the polarity.

4.2.2.6 Reinstall the battery compartment door and tighten the screw.

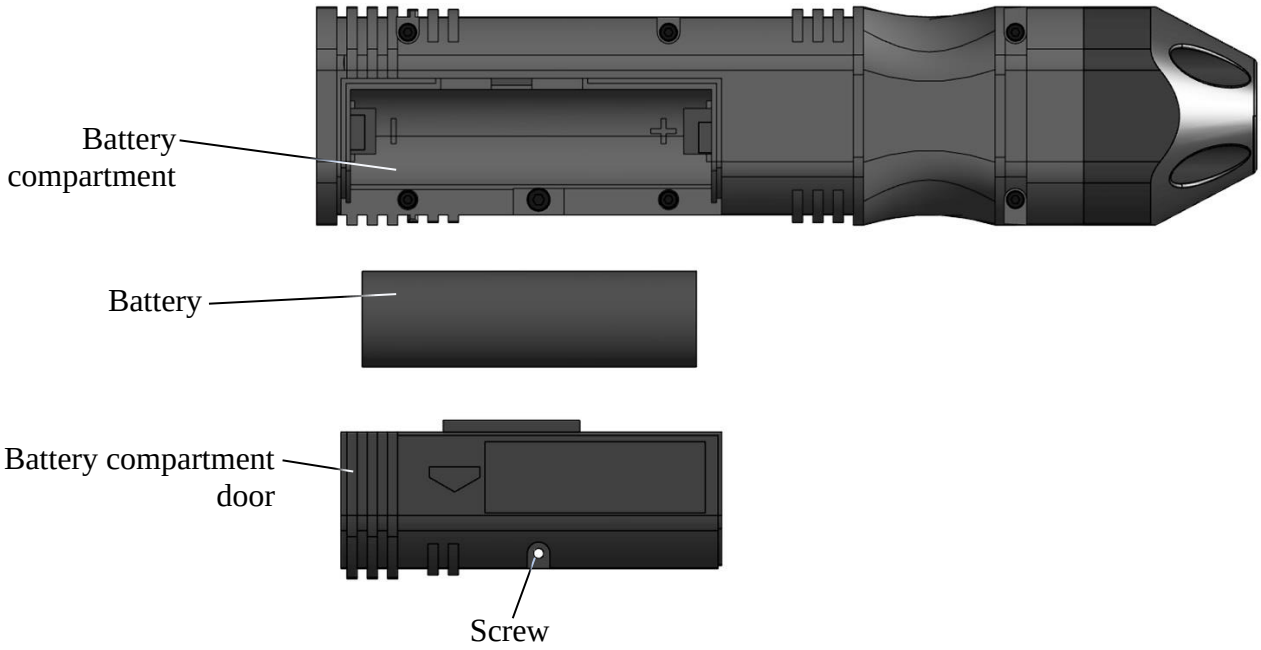

Figure 4.2

CAUTION!!!

Replace the battery only when the Device is switched off and is disconnect from the charger.

5 Transportation and Storage

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

- air temperature: from +5 to +30 °C;

- humidity: 80% at +25 °C.

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

Battery storage instruction:

- never store discharged batteries without a full recharge;

- 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 battery charge level and, if necessary, to recharge the battery (see paragraph 3.6).

6 Equipment Disposal

Before disposing of the Device, check your local laws, rules, and regulations, and follow them accordingly.

Before disposing of a battery, check your local laws, rules, and regulations, and follow them accordingly.

7 Scope of Supply

Basic configuration:

Name	Quantity
Thickness gauge	1 pc.
Storage case	1 pc.
Recharger	1 pc.
USB-C cable	1 pc.
EMT50003P EMA transducer (with a pulsed electromagnet)	1 pc.
EMT50001 EMA transducer (with a permanent magnet)	1 pc.
CAP40001 protective cap	1 pc.
Tablet with installed “ScanView” software	1 pc.
CP22101 SOP thickness sample	1 pc.
Screwdriver (for transducer replacement)	1 pc.
Screwdriver (for battery replacement)	1 pc.
User manual	1 pc.
“ScanView” program. User Manual	1 pc.

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

- High-temperature EMT50004T EMA transducer to work with objects with a surface heated up to 750 °C.

8 Manufacturer Warranty

8.1 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.

8.2 The Manufacturer may withdraw its warranty obligations when:

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

9 Warranty Certificate

Device	EM5000 Electromagnetic Acoustic Thickness Gauge
Serial Number	
Date of manufacture	
Warranty Period	
Manufacturer	Oktanta LTD 34 Olga Berggholz Street, Saint Petersburg 192148, Russia +7(812)385-54-28 info@oktanta-ndt.ru _____ signature, stamp

10 Information about Repair

Date of Application	Fault Type	Repair	Completed/Not Completed (Date, Signature, Stamp)

11 Information about Calibration Test

Date of calibration test	Valid till	Calibrator