

PEC Flaw Detector PE1437



Operation Manual

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CONTENTS

PURPOSE	4
PRINCIPLE OF OPERATION.....	7
TECHNICAL SPECIFICATIONS.....	8
OPERATION DESCRIPTION	9
Device appearance.....	9
Device switching on and off.....	11
Selection of information display mode	12
Thickness window	14
Calibration	15
Sensor selection	16
Change of number of accumulations	16
A-scan window.....	17
Scale change	18
Calibration	19
Sensor selection	20
Change of number of accumulations	20
C-scan window.....	21
Start measurements.....	23
Open C-scan.....	28
Continue measurements	29
User menu	29
Thickness measurement and faults detection.....	33
Sensor selection	33
Thickness measurement.....	37
C-scan filling mode	39
Data transfer to PC.....	42
Device operation features.....	43
Battery charge	44
MAINTENANCE.....	45
Transducer replacement	45

PEC Flaw Detector PE1437.
Operation Manual

Battery replacement	45
TRANSPORTATION AND STORAGE.....	46
SCOPE OF SUPPLY	46
MANUFACTURER WARRANTY	47
INFORMATION ABOUT REPAIR.....	48

PURPOSE

The Pulsed Eddy Current Flaw Detector PE1437 (PEC Flaw Detector PE1437) is designed to detect corrosion under insulation, through a thick layer of paint, and through a layer of corrosion deposits and mud.

Device application examples:

- Corrosion detection on pipes and pipelines with a 3-layer polypropylene coating



- Corrosion detection on pipes and pipelines in polyurethane foam insulation



- Ultimate thinning detection on objects sensitive to strong corrosion



- Corrosion detection through a thick layer of epoxy paint aboard ships



- Corrosion detection on pipes and pipelines with inner coating, for example, concrete or cement one (with access from the inner side of the test object).



- Corrosion detection in different steel supports, for example, street lamp supports or electrical grid supports

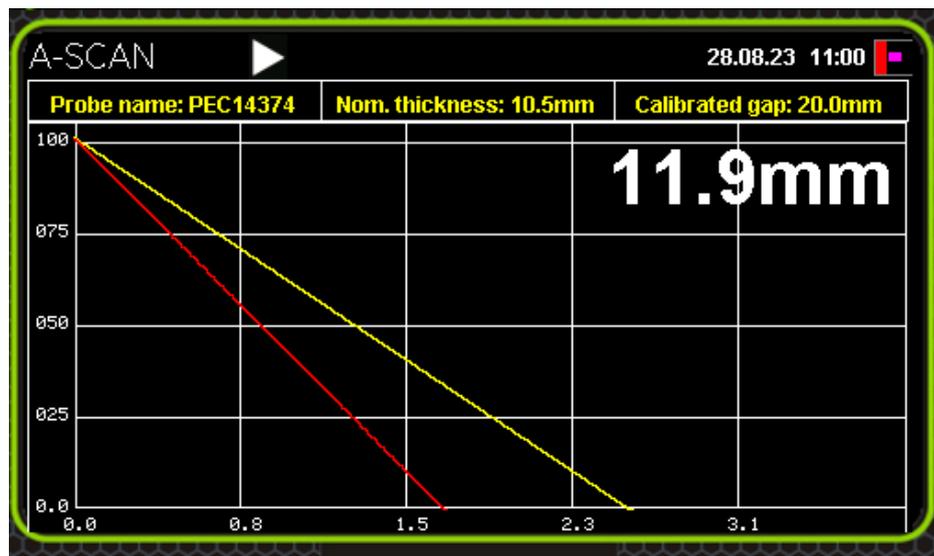


The Device allows testing without preliminary surface preparation or insulation removal. The insulation can be represented with any non-conducting coating, such as polyurethane, mineral wool, plastics, paint, air, concrete, mud, bitumen, stone, or corrosion deposits.

PRINCIPLE OF OPERATION

The Device operation is based on the pulsed eddy current technique of nondestructive inspection. A Device sensor generates a pulsed magnet field which magnetizes an area of the test object located beneath it. Time of magnetization and demagnetization of this area depends on the metal thickness.

The main tool that displays the demagnetization process is an A-scan shown in the Figure below:



A-scan

The greater is the metal thickness under the sensor, the longer is the demagnetization process on A-scan and vice versa, the smaller is the metal thickness under the sensor, the faster the demagnetization occurs. The Device analyses parameters of the demagnetization process and, based on this analysis, measures the mean metal thickness under the sensor.

The Device must be calibrated on the test object. For correct operation of the Device, you should know a nominal thickness of the test object and insulation thickness in the calibration point.

WARNING!

To perform the diagnostics on the test object, the Device shall be calibrated at one point of the test object after specifying the metal thickness and insulation thickness in this point. All further measurement will be carried out relative to the above point.

TECHNICAL SPECIFICATIONS

Measured thickness range for steel (for PEC143702)	0 to 12 mm
Measured thickness range for steel (for PEC143703)	0 to 18 mm
Average thickness measurement error	10%
Insulation thickness range (for PEC143702)	0 to 30 mm
Insulation thickness range (for PEC143703)	0 to 100 mm
Minimum diameter of tested pipes	25 mm
Temperature of test object metal	-20°to +100°C
Temperature of test object surface in sensor installation location	-20°to +60°C
Ambient temperature operating range	-20 to +50°C
Time of continuous operation without battery recharging	8 hours
Cable length	1.5 m
Overall dimensions	232 x 135 x 44 mm
Weight	0.8 kg

OPERATION DESCRIPTION

Device appearance



Device Appearance

On the top of the Device, there is a sensor connector. The measurement results are displayed on a color liquid crystal display. The Device is controlled by a membrane keyboard. On the bottom, there are a recharger connector and USB connector for data reading from the Device.

Functions of the control buttons are described in the table below.

	The On/Off button switches on/off the Device
	The Back button returns you to the previous menu items
	The Menu button opens/closes the Device menu
	The Up button is used to navigate through the Device menu and to control zoom
	The Down button is used to navigate through the Device menu and to control zoom;
	The Right button is used to navigate through the Device menu and to control zoom
	The Left button is used to navigate through the Device menu and to control zoom;
	Press this button to measure metal thickness.
	Press this button to measure in continuous mode. Repeat pressing this button to stop this function.
	The "OK" button sets the parameter selected in the Device menu

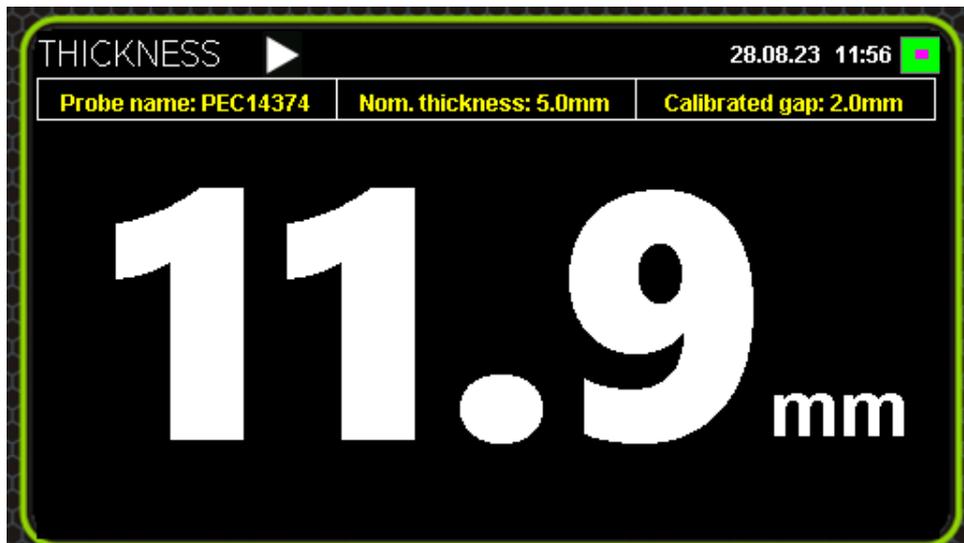
Device switching on and off

To switch the Device on, press and hold the  button during several seconds. Then, the Device will switch on and its display will show a window with information about the Device software version during several seconds.

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 during several seconds.

Selection of Information Display Mode

The Device has three main options to display information: Thickness display mode which displays only the measured thickness of the test object; A-scan display mode enabling the user to monitor a shape of the demagnetization process curve; and C-scan display mode enabling to measure test object area with saving the data in the

matrix format. To change over between the display modes (windows), use the

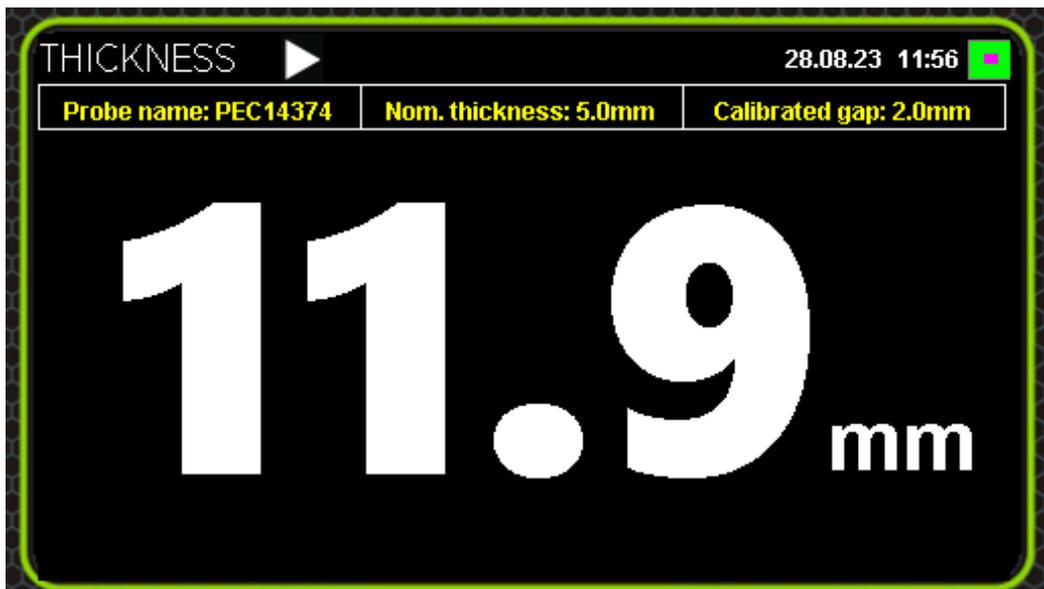


and



buttons.

When you switch on the Device, the display automatically shows the Thickness display mode.

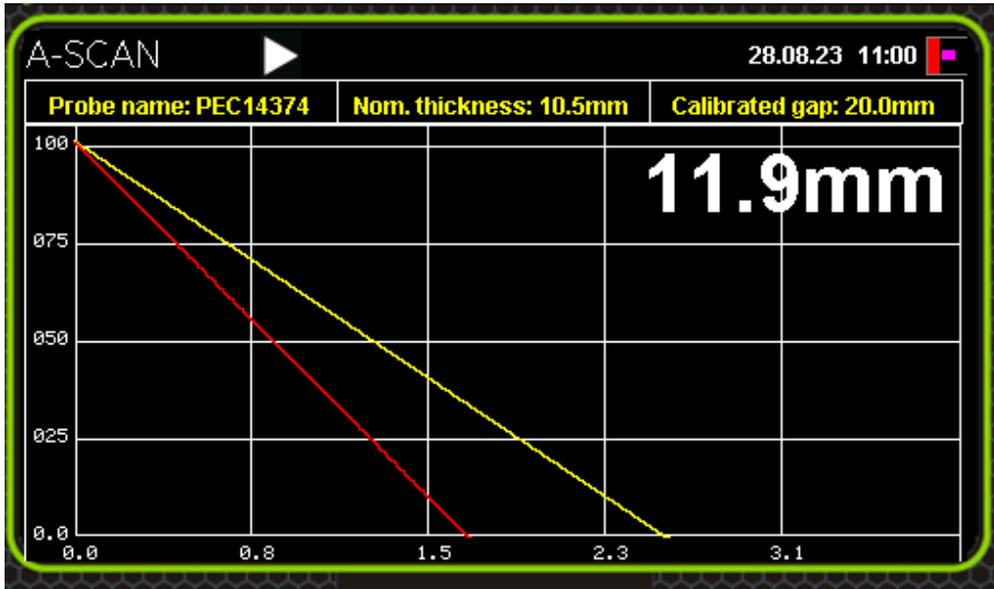


Thickness display mode

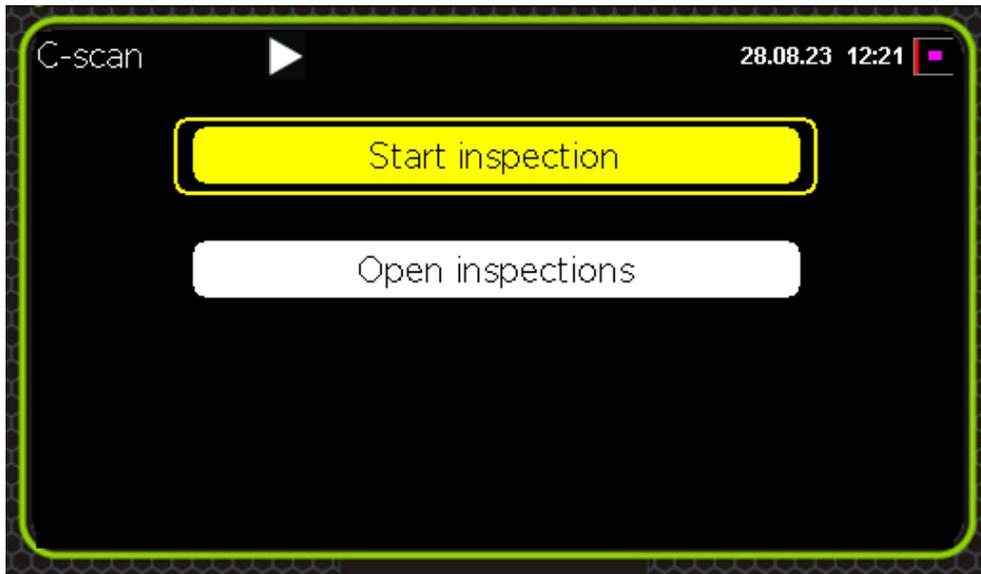
To change over to the A-scan display mode, press once the button



A-scan display mode



With double pressing the button you can change over to the C-scan display mode.



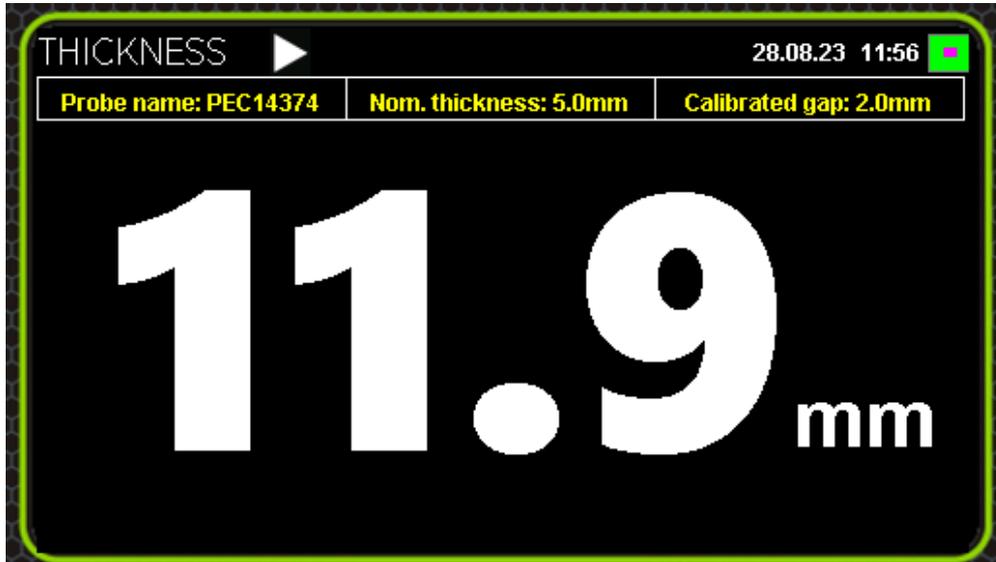
C-scan display mode



To return the Device to the Thickness display mode, press the button again.

Thickness window

The Figure below shows the Thickness window.



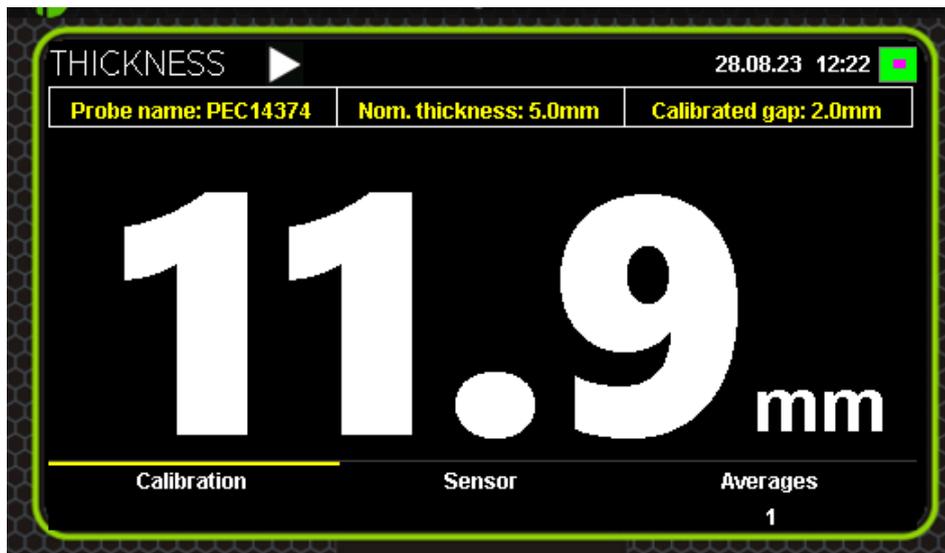
Thickness window

The top of the screen displays the following information:

- Sensor name;
- Metal thickness specified during Device calibration;
- Insulation thickness (gap) specified during calibration.



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



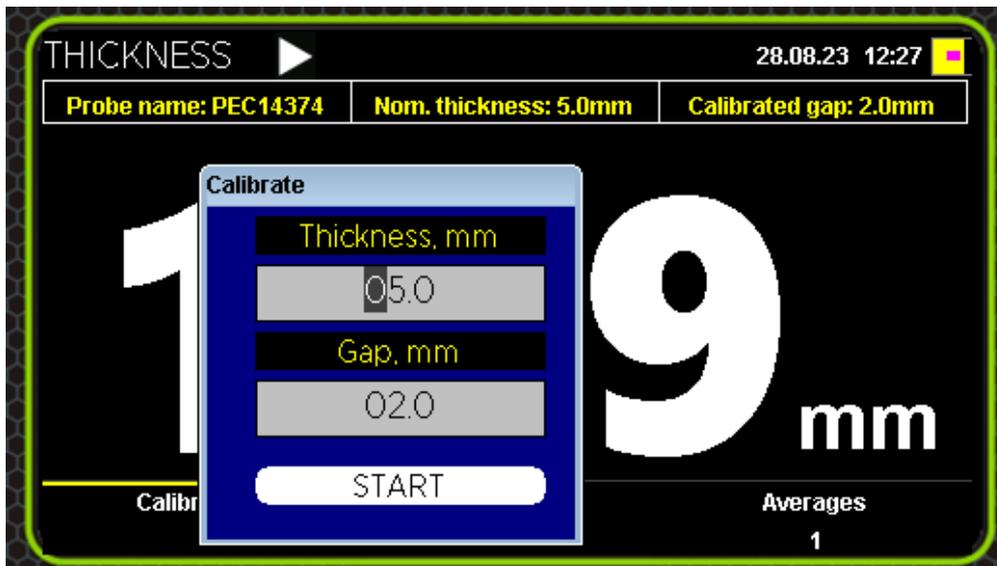
Submenu

With this submenu, the user can calibrate the Device, change the sensor and select the number of accumulations. To navigate between the parameters in the

Thickness window, you can use the  and  buttons. To confirm the selected parameter, press the  button. To quit the menu, press the  button.

Calibration

The calibration window is shown in the Figure below:

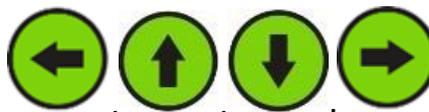


Calibration

To calibrate the Device, do as follows:

- Install the Device sensor on the test object in the point where you know the metal thickness and insulation thickness;
- In the Calibrate window, enter values of the metal and insulation thicknesses. To

enter the values, use the



buttons.

- To save the specified parameters, use the



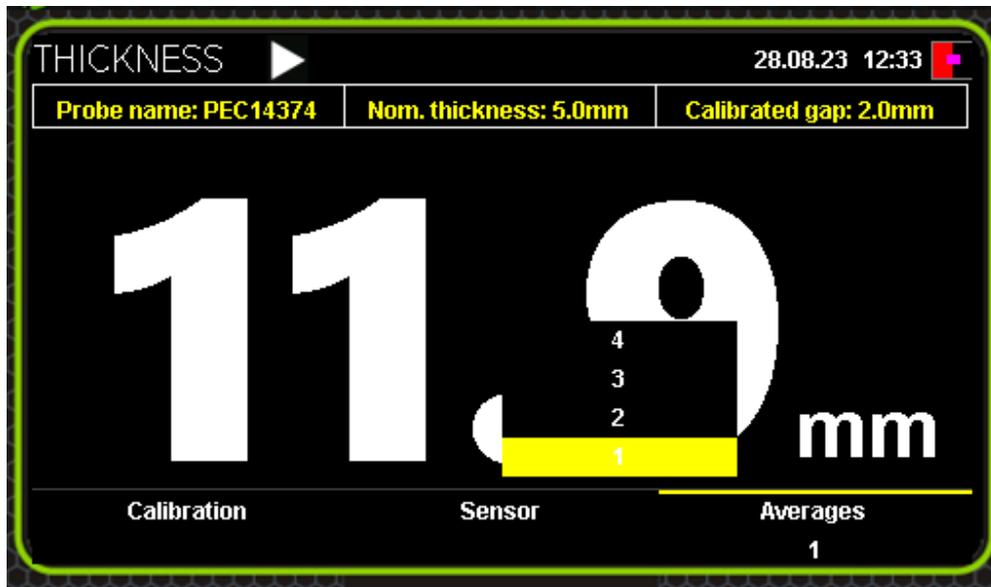
After pressing the  button, hold the Device sensor motionless relative to the test object for several seconds during calibration.

Sensor selection

With the Sensor submenu, the user can change the sensor type. The number of the sensors depends on the Device scope of supply.

Change of number of accumulations

The user may select the required number of accumulation for the Device operation. The accumulations enable increasing the accuracy of measurements, however, they reduce the Device operation speed. The Figure below shows the window for selecting the number of accumulations



Change of number of accumulations



To select the required number of accumulations, use the  and  buttons; then,



confirm your selection by pressing the **OK** button. By default, the Device use only one accumulation.

For example, if three accumulations are selected for the Device, it will take three demagnetization curves at one point of the test object and plot the new averaged curve. The metal thickness will be calculated based on this averaged curve.

A-scan window

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



A-scan window

This window shows the demagnetization curve for metal under the sensor. By default, this curve is green. The greater is the metal thickness under the sensor, the longer is the demagnetization process and vice versa, the smaller is the metal thickness, the shorter the demagnetization occurs. In addition to the current curve, the A-scan always displays the curve taken during the Device calibration. If the current curve is located to the right of the calibration curve (see Figure above), the current metal thickness is bigger than the thickness during calibration. If the current curve is located to the left of the calibration curve, the current metal thickness is smaller than the thickness during calibration.

Scale change

The user can change the scale of the A-scan display. To change the scale, press the

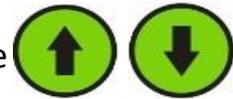


button while being in the A-scan window. Then, a word “SCALE” will appear in the A-scan window.



A-scan scale change mode

After appearance of the word “SCALE” on the screen, use the



buttons

and



and



buttons to change the size and position of the scalable A-scan area.

Press the



button to save the selected scalable area. To return to the default

scale press the

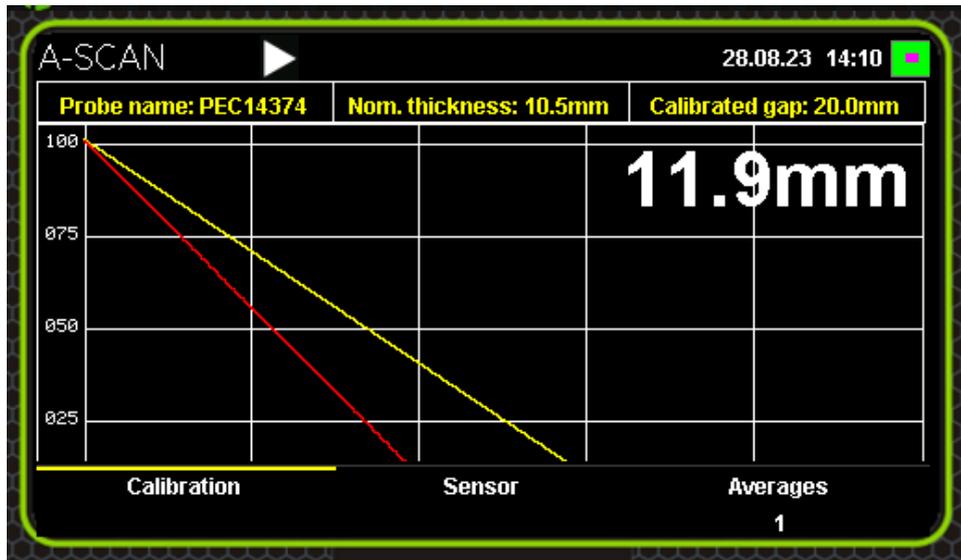


button.

In the A-scan window, the user can calibrate the Device, change the sensor type and the number of accumulations. These parameters can be changed in the submenu

which appears with pressing the  button in the same way as described for the Thickness window.

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



Submenu

With this submenu, the user can calibrate the Device, change the sensor and select the number of accumulations. To move between the parameters in the Thickness

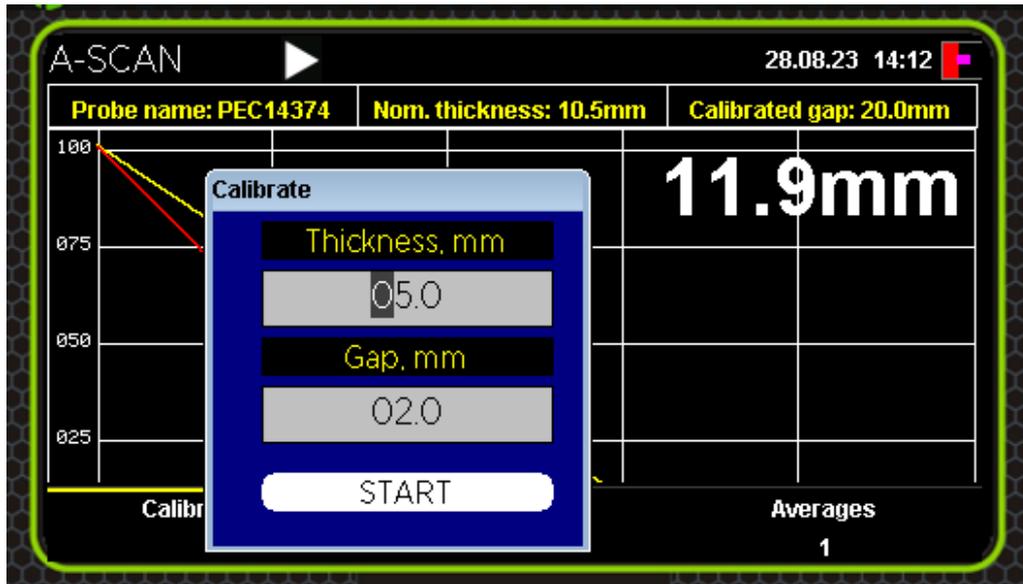
window, you can use the  and

 buttons. To confirm the selected parameter, press the

 button. To quit the menu, press the  button.

Calibration

The calibration window is shown in the Figure below:



Calibration in A-scan mode

To calibrate the Device, do as follows:

- Install the Device sensor on the test object in the point where you know the metal thickness and insulation thickness;
- In the Calibrate window, enter values of the metal and insulation thicknesses. To

enter the values, use the



buttons.

- To save the specified parameters, use the



button.



After pressing the  button, hold the Device sensor motionless relative to the test object for several seconds during calibration.

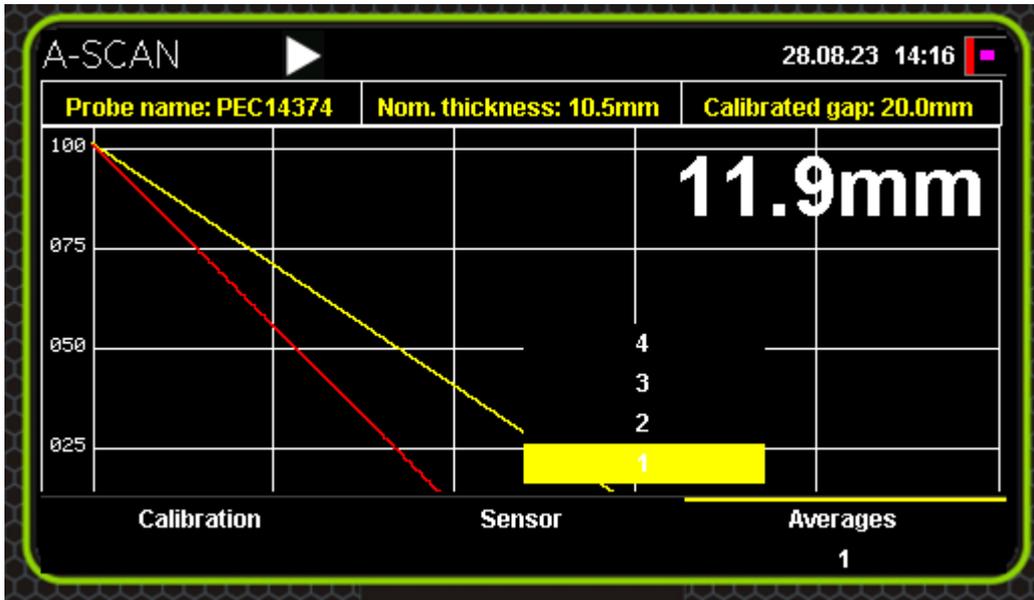
Sensor selection

With the Sensor submenu, the user can change the sensor type. The number of the sensors depends on the Device scope of supply.

Change of number of accumulations

The user may select the required number of accumulations for the Device operation. The accumulations enable increasing the accuracy of

measurements, however, they reduce the Device operation speed. The Figure below shows the window for selecting the number of accumulations



Selection of number of accumulations in A-scan window

By using the  and  buttons, the user can change the number of accumulations To confirm changes, press the  button.

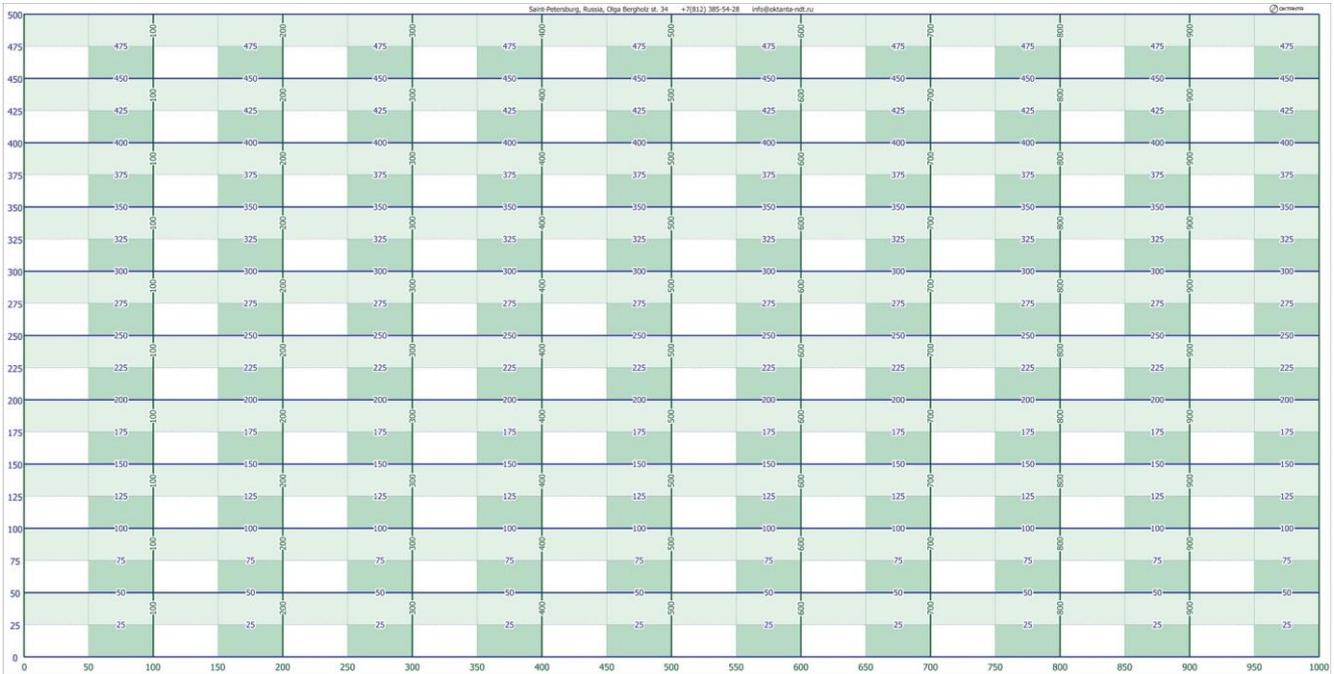
By default, the Device use only one accumulation. For example, if three accumulations are selected for the Device, it will take three demagnetization curves at one point of the test object and plot the new averaged curve. The metal thickness will be calculated based on this averaged curve.

C-scan window

When you need not only to estimate the thickness of the test object in some points, but to measure a certain area completely, then you shall use the C-scan mode. For this mode, you shall apply a special grid on the test object to perform

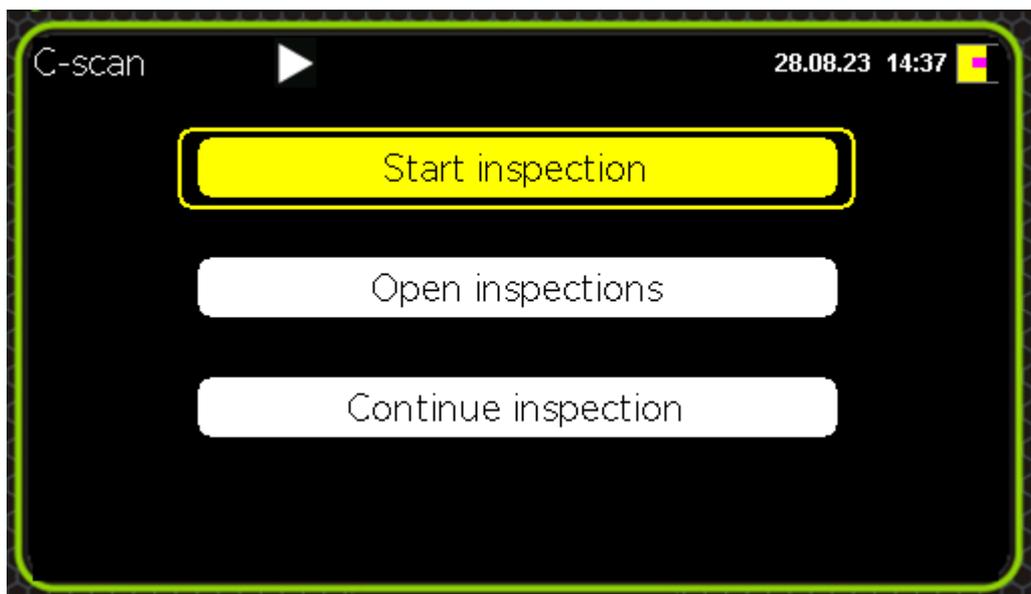
measurements in the grid nodes. We produce the special self-adhesive grid which can be attached to the test object. The example of such grid is shown in Figure below:

Example of self-adhesive grid produced by Oktanta



You can manually draw the grid on the test object using a ruler and a marker, however, we do not recommend this method as it requires a lot of time.

The C-scan window is shown in the Figure below:



C-scan window

This window consists of three menu items:

- **Start measurements.** This menu item is used to start filling of the new C-scan.
- **Open C-scan.** This menu item is used to open the saved C-scans.
- **Continue measurements.** This menu item is used to return to the current C-scan.

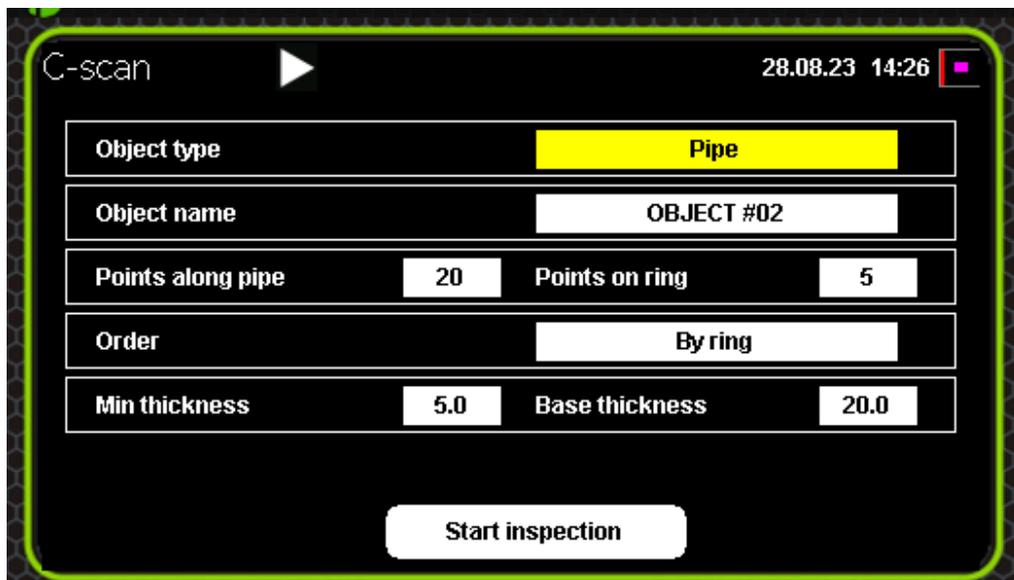
You can navigate through these menu items using the



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

Start measurements.

When you select this menu item, the window with the C-scan parameters will appear (see the Figure below):

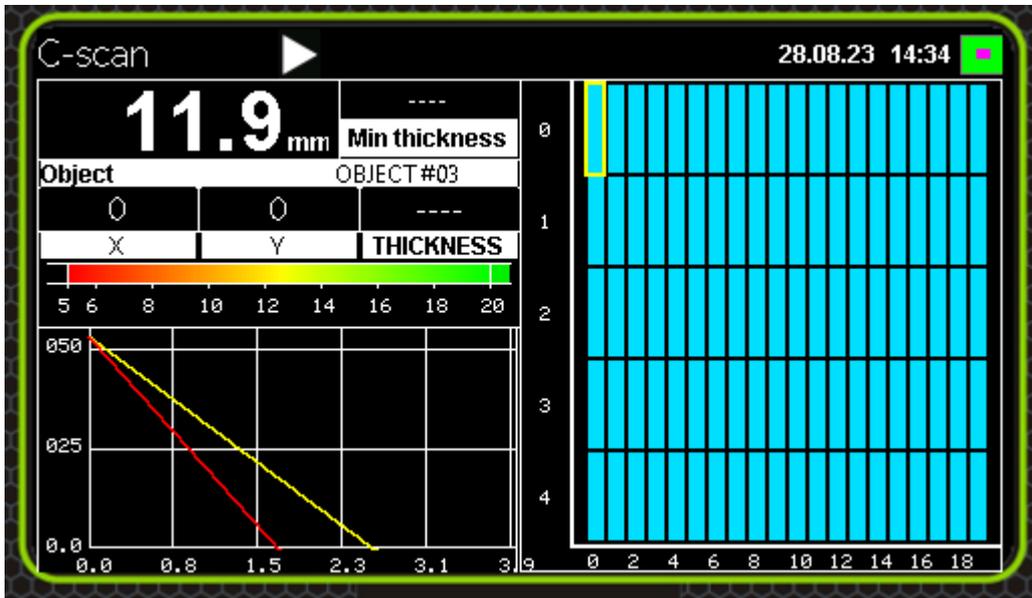


C-scan initial parameters entry

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

Object selection

The device has objects of two types: a grid and a pipe. The difference between them is as follows: the pipe-type object is extended along the horizontal axis and the grid-type object occupies a square-like area. For the objects at which the number of measurements along the horizontal axis significantly exceeds the number of measurements along the vertical axis, we recommend to use the pipe-type object. For the objects at which the number of measurements along the horizontal and vertical axes is approximately the same, we recommend to use the grid-type object. The C-scan windows for the pipe-type and grid-type objects are shown in the Figures below:



C-scan for grid-type object



C-scan for pipe-type object

Object name entering

To enter the name of the object, select this menu item using the



buttons and press the



button. In this case, the window shown in Figure below will open:



Test object name entering

To enter symbols, letters, and numbers in this window, use the



buttons. To enter the selected symbol, letter,

digit, press the



button. To save the object name,

select the "Enter" symbol on the soft keyboard and press the



button.

Entering number of points on C-scan

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

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

To navigate between the parameters, use the



and buttons.

To enter these parameters, use the



and buttons.

Order of measurements

The measurements in the C-scan can be carried out 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 of measurements" menu item using the



and



buttons.

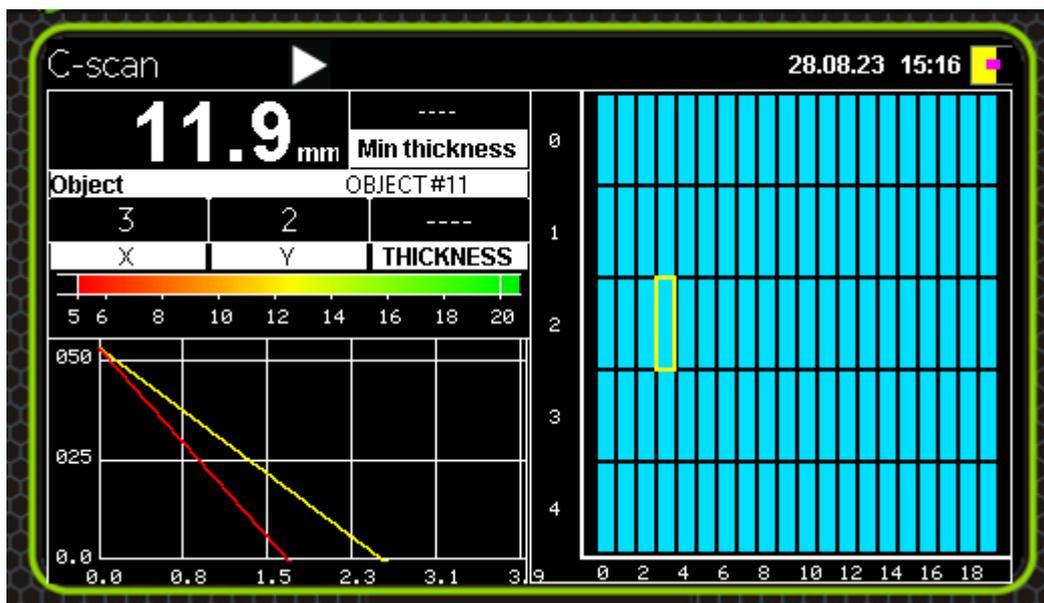
Minimum thickness and nominal thickness

The user must enter the nominal 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 larger than the nominal thickness will be displayed in green. The points with thicknesses between the minimum and nominal values are displayed on the C-scan with gradient.

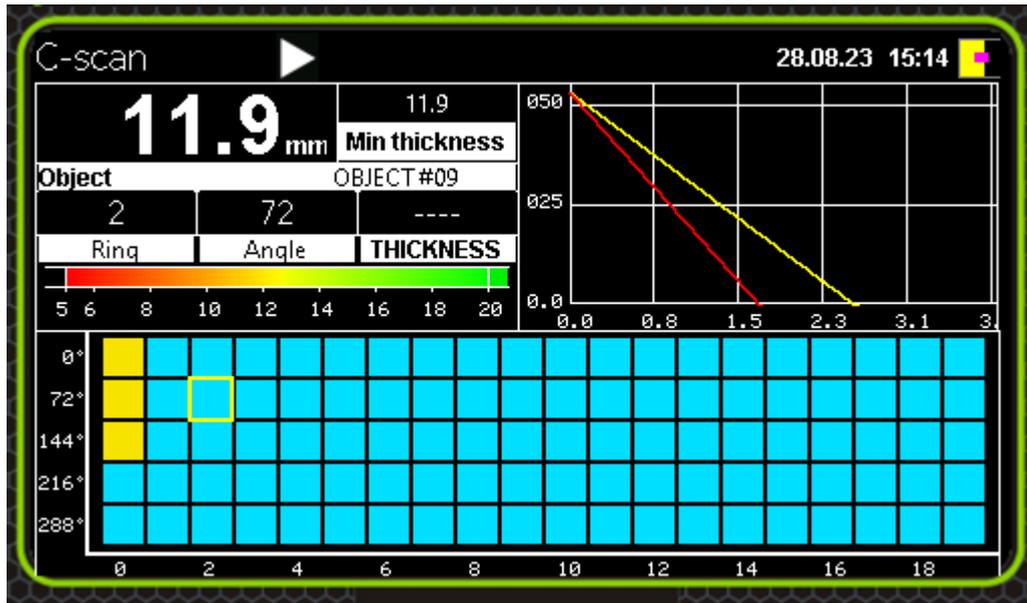
Upon entering all parameters, select the "Start measurements" menu item to

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 grid-type object



C-scan filling mode for pipe-type 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 yellow square cursor on the C-scan. Prior to the start of C-scan filling, 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 C-scan

This window can be used to open, edit or delete the previously saved C-scans. If necessary, the user can delete data of all previously saved objects.

The previously saved archive selection window is shown in the Figure below:



Open C-s window

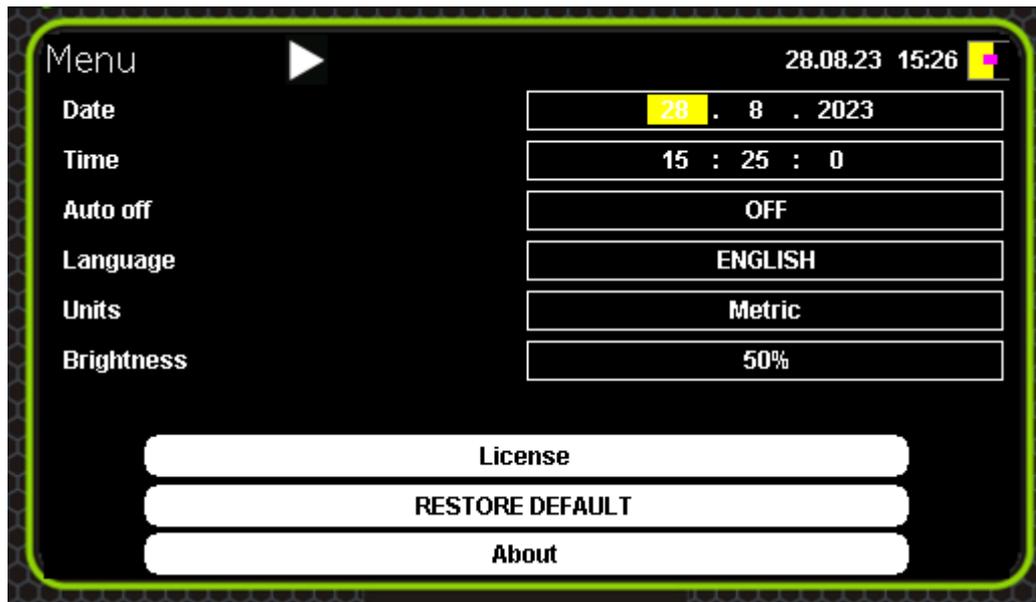
You can navigate through the menu items using the , , ,  buttons. To select the appropriate menu item, press the  button.

Continue measurements

This menu 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 menu item is selected, the Device returns to the previously started inspection.

User menu

To open the user menu, press the  button. The user menu window is shown below:



User menu

To navigate through the menu items, use the  and  buttons.

Date

Set the current date using the  and  buttons. **Time**

This menu item enables to set the current time. To change the value, use the

 and  buttons.

Auto off

This function enables to set the time period for the Device switching off unless

the measured thickness data are updated. To change the value, use the  and  buttons.

Language

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

Units

To change the measurement units, use the  and  buttons. Available options are millimeters and inches.

Brightness

The screen brightness can be set as percentage value. To change the value, press the  and  buttons from 10 % to 100 %.

Restore default

This menu item enables to restore all defaults of the Device.

To select this menu item, press the  button.



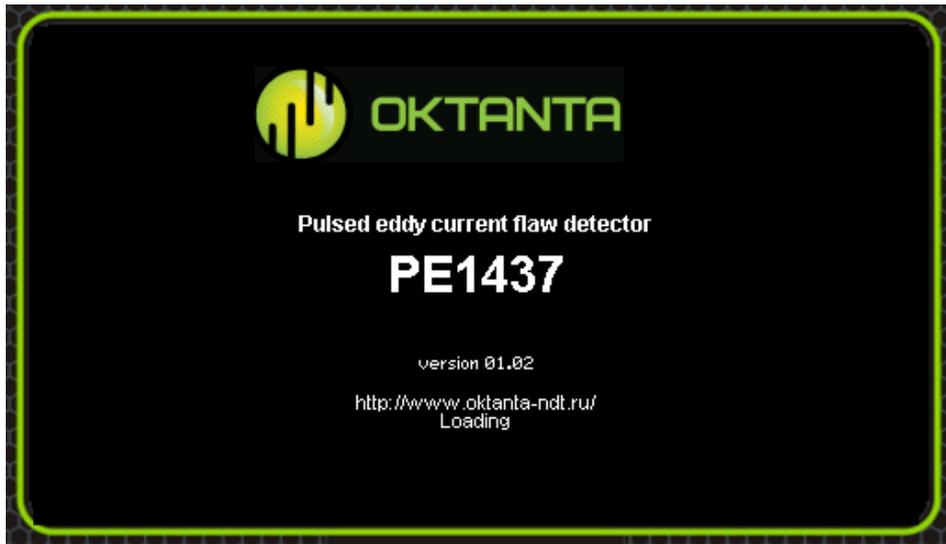
Restore default window

To change over between the “Yes” and “No” buttons, use the  and  buttons. To confirm your selection, press the  button.

About

This menu item displays the software version and name of the Device. To select this menu item, press the

 button. The Figure below show this window.



Information about Device

Thickness measurement and faults detection

The PEC Flaw Detector PE1437 can operate in two modes. They are the simple mode of thickness measurements and the C-scan filling mode.

The C-scan filling mode is used when it is necessary to test any expanded area of the test object. In this mode, you shall apply the special grid to the test object and sequentially save the thicknesses, measured in the grid nodes, in the Device memory.

When a large data array is not required and it is enough to measure only a few test points, then you can use the simple mode of thickness measurements.

Prior to operation beginning, select the sensor suitable for this test object.

Sensor selection

The PEC Flaw Detector PE1437 can operate with two main sensors: PEC143702 and PEC143703. The standard scope of Device supply includes one sensor PEC143702.

The sensor shall be selected depending on the thickness range to be tested and insulation thickness range.

The Figure below shows a diagram for sensor selection depending on the above parameters.

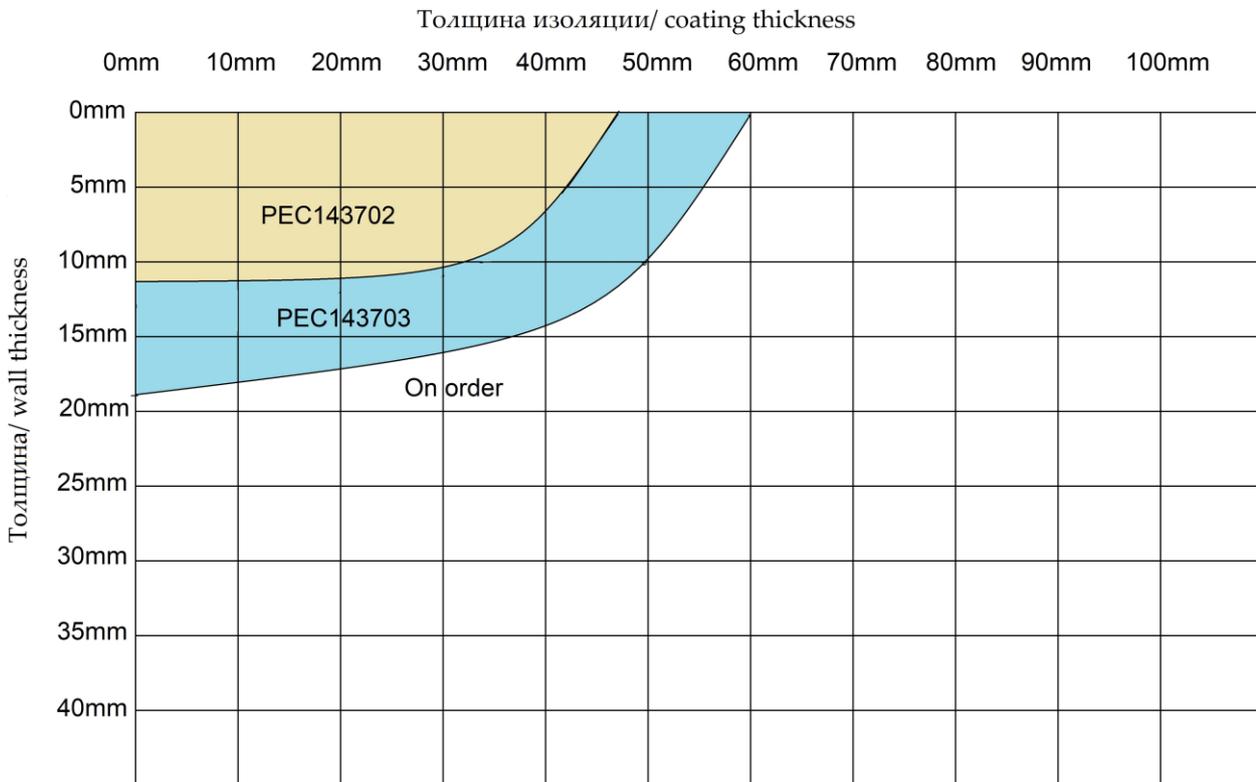


Diagram for sensor selection

The larger is the thickness range and insulation thickness range, the larger is the sensor. The sensor measures the averaged thickness beneath it, and therefore, the larger is the sensor, the larger is the area over which the averaging takes place and, accordingly, the larger is the minimum fault that the device can detect. Therefore, it is advisable to use as small sensor as possible.

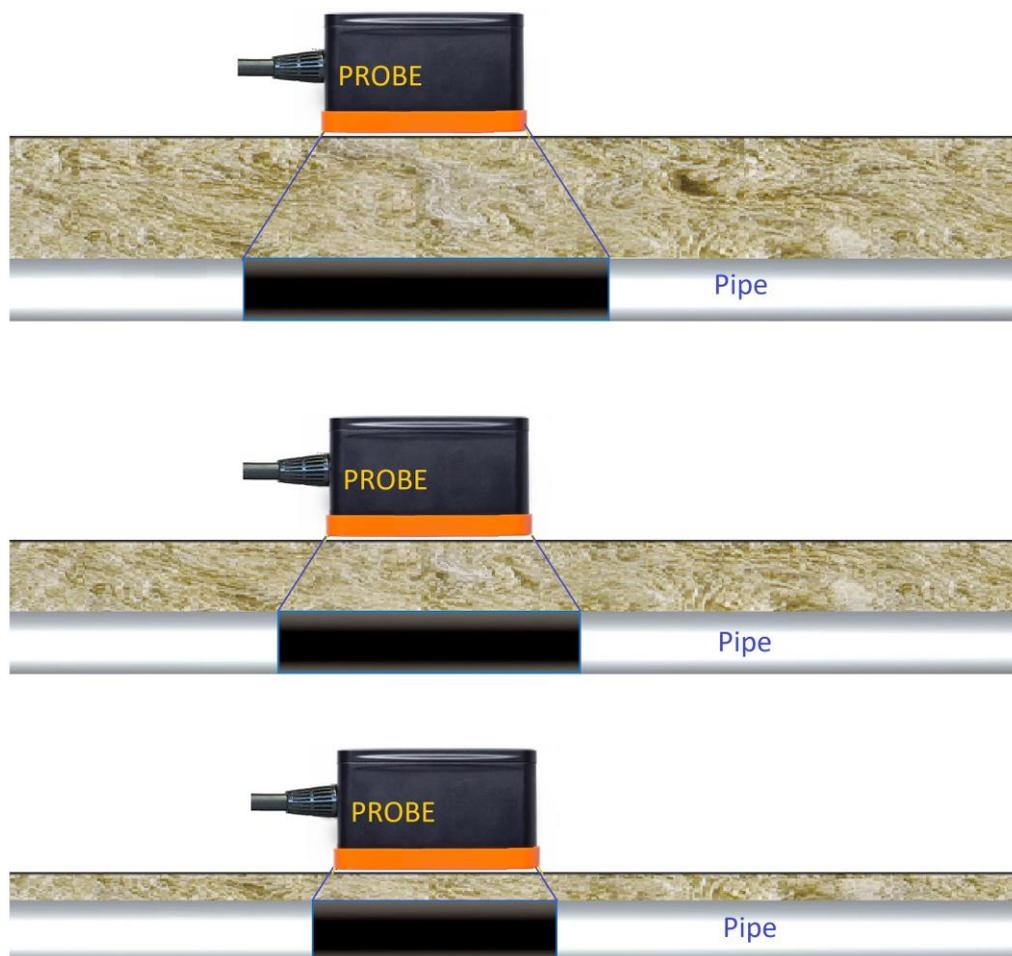
For example: suppose you want to test a pipe with 10 mm wall thickness and 12 mm insulation thickness. Then, according to the above diagram, you shall use sensor PEC143702. Sensor PEC143703 will also work in this case, however, its selection will not be reasonable as it has the greater area where the Device measures the average thickness.

For example: suppose you want to test a pipe with 17 mm wall thickness and 12 mm insulation thickness. Then, according to the

above diagram, you shall use sensor PEC143703, and sensor PEC143702 will not be suitable in this case.

Average thickness measurement area

The Device measures the average thickness in a certain area under the sensor. The dimensions of this area depend on the sensor size as well as on the insulation thickness. The Figure below shows the sensor located over the steel sheet.



Dependence of magnetization area size on insulation thickness

As we can see, the metal magnetization area (highlighted in black) increases its size according to increase of the distance between the sensor and the sheet. When distance between the sensor and the metal is small, the size of the magnetization area is minimum. When the sensor is lifted above the sheet surface to the maximum height, the size of the metal magnetization area under the sensor is maximum. The device calculates the average thickness in the magnetization

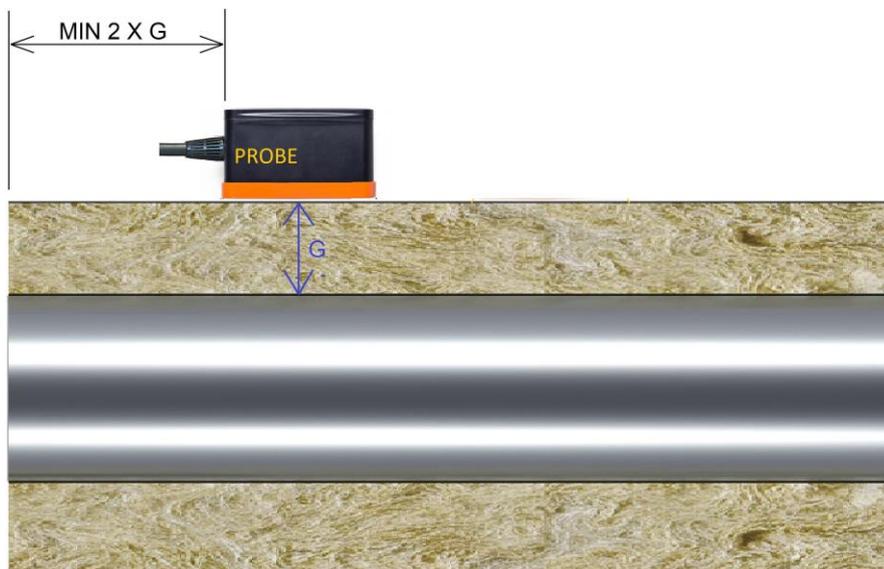
area. This effect shall be taken into account. The size of the thickness averaging area depending on the sensor type and insulation thickness is shown in the Table below.

Size of averaging area

Sensor name	Insulation thickness, mm						
	0	10	20	30	40	47	60
PEC143702	35mm x 20mm	40mm x 23mm	44mm x 26mm	48mm x 28mm	52mm x 30mm	56mm x 32mm	
PEC143703	55mm x 30mm	62mm x 34mm	69mm x 38mm	76mm x 41mm	83mm x 45mm	88mm x 48mm	93mm x 52mm

Edge effect

The pulsed eddy current technique of inspection is characterized by an edge effect which consists in the fact that the thicknesses measured near the pipe end can be very much reduced. For correct operation of PE1437, select measurement area located from the edge at a distance equal to double insulation thickness or more. The example of such sensor location is shown in the Figure below.

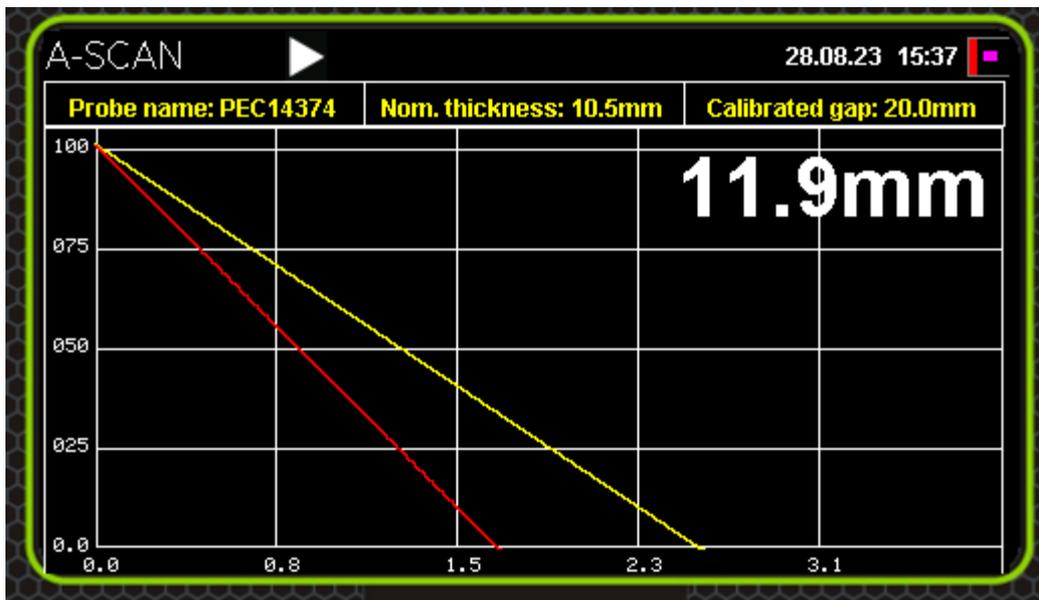


Locate sensor at distance equal to double insulation thickness or more

Besides the pipe end, the Device readings can be affected by fasteners, supports, metal structures immediately adjacent to the test area. Keep the distance of 2 x G from each of the above items.

Thickness measurement

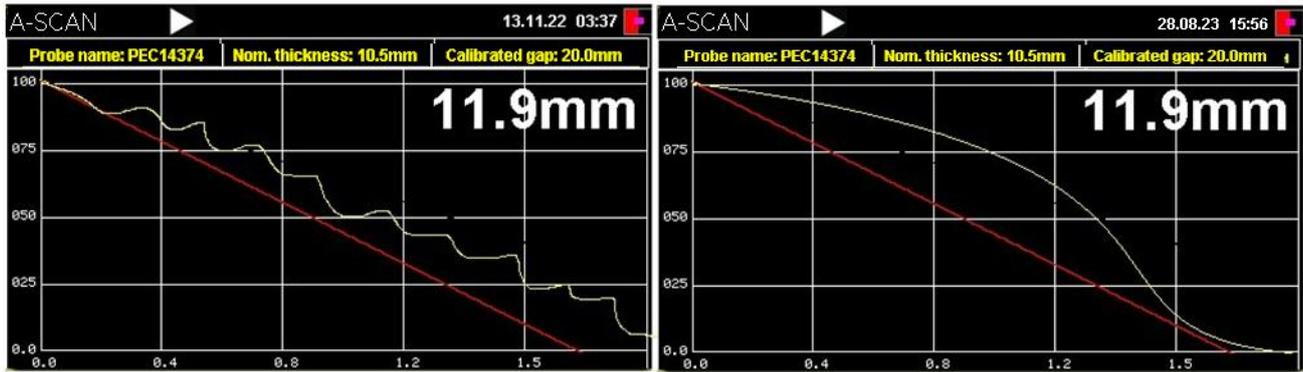
The PE1437 measures thicknesses by analyzing the metal demagnetization speed under the sensor. The demagnetization process is displayed on A-scan. An example of A-scan is shown in the Figure below



Example of A-scan

The demagnetization time is the point of the signal amplitude drop below the threshold level; the Device shows this point as intersection of the curve with the horizontal axis.

We also recommend to ensure that, before intersection with the horizontal line, the demagnetization process is monotonous, close to the line. There can be situations when the signal waveform on the A-scan can become non-monotonous with a variable component. Such example of A-scan is shown in the Figure below.



Fluctuations on A-scan

With such signal waveform, the thickness measurements will be most likely incorrect. At points with a similar A-scan, it is required to re-measure the thickness. This signal waveform can occur when there are interference sources near the test object or when the sensor jerks during measurements. To avoid interferences, the interference sources shall be removed from the test site, if possible. If it is impossible to remove the interference source, it is recommended to use 2 to 4 accumulations (see "Change of number of accumulations").

Any thickness measurement to be carried out with PE1437 is performed relative to the known thickness in a certain point of the test object. Therefore, prior to the thickness measurements, it is necessary to calibrate the Device for this test object. To calibrate, place the sensor on the test object at the point with known parameters and calibrate the Device using the "Calibrate" menu.

WARNING!

During calibration, hold the sensor motionless on the test object!

After calibration, you can measure the thicknesses. To measure the thickness, install the Device on the test object, press single thickness measurement button on the Device keyboard



The Device will measure the thickness, and the measured value will be displayed on the Device screen.



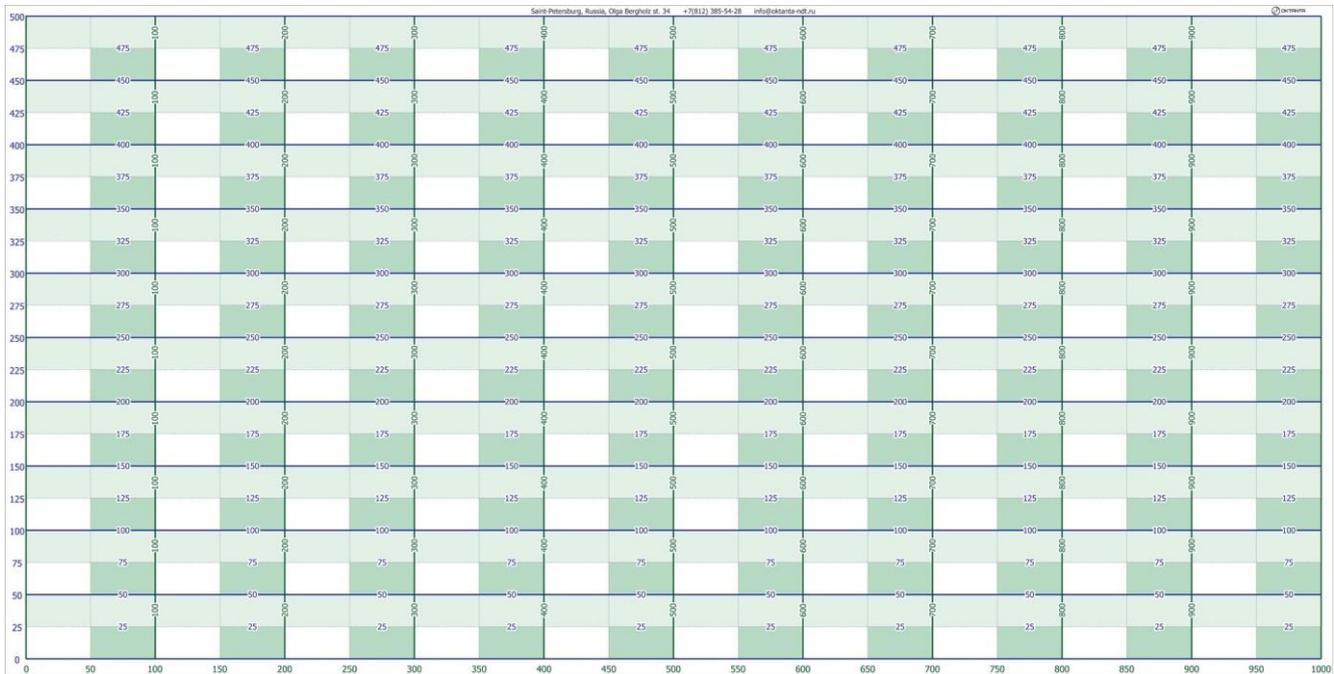
You can start the continuous measuring mode using the button. In this mode, the Device performs thickness measurements periodically; it updates the readings on the Device screen each time after measuring. To deactivate the continuous measuring mode, press the button again.

C-scan filling mode

When you need not only to measure the thickness in some points, but to measure a certain area completely, then you shall use the scan mode.

For this mode, you shall apply a special grid on the test object to perform measurements in the grid nodes. We produce the special self-adhesive grid which can be attached to the test object. The example of such grid is shown in Figure below:

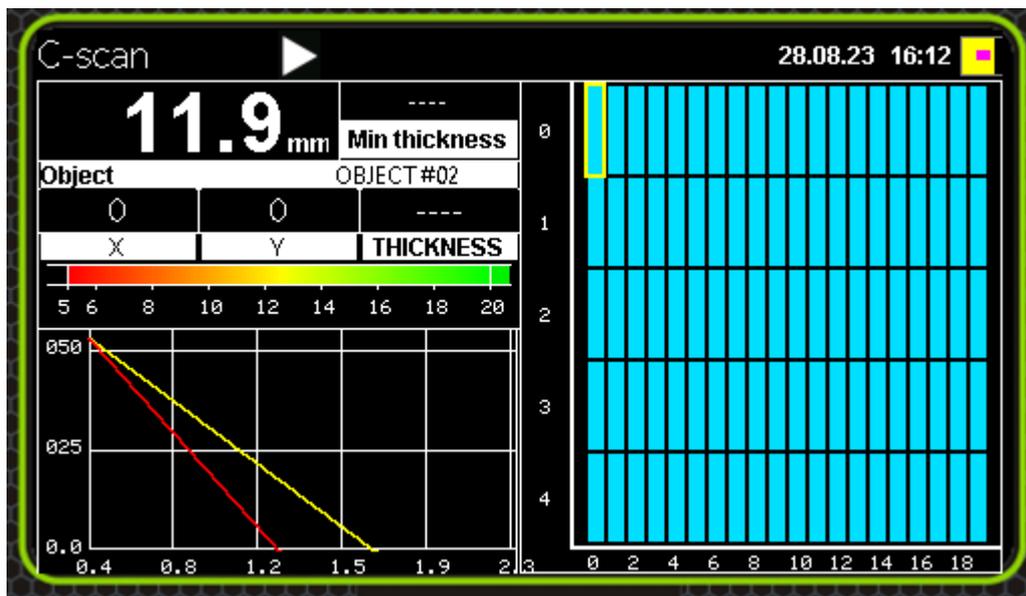
Example of self-adhesive grid produced by Oktanta



You can manually draw the grid on the test object using a ruler and a marker, however, we do not recommend this method as it requires a lot of time.

Select the C-scan window in the Device menu (see Section “C-scan window”). In this window, select menu item “Start measurements”. Enter all necessary data such as the type and name of the test object, number of points on C-scan, nominal thickness and minimum permissible thickness of the test object; then select “Start measurements”.

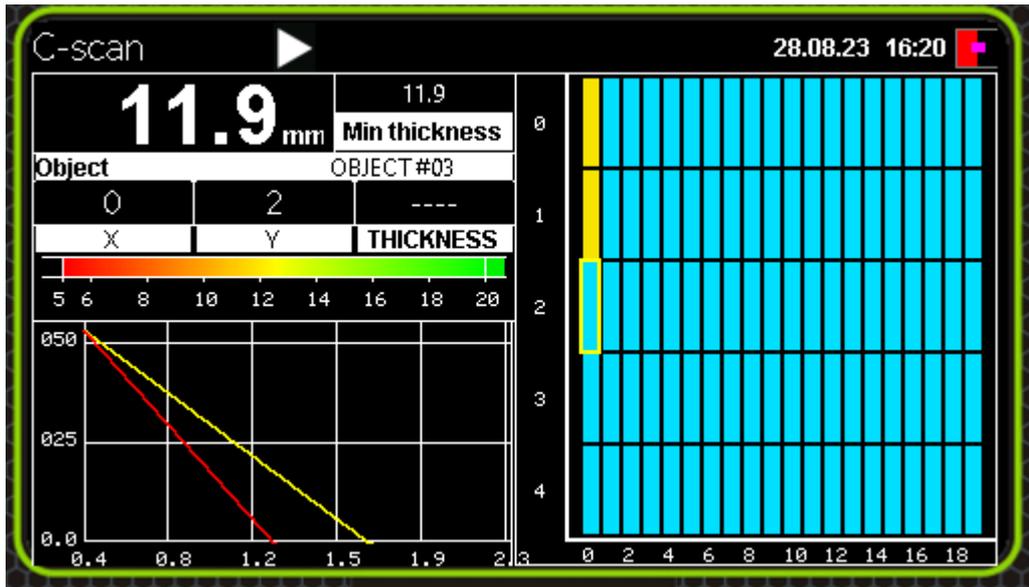
Then, the C-scan window will be as shown in the Figure below:



C-scan filling mode

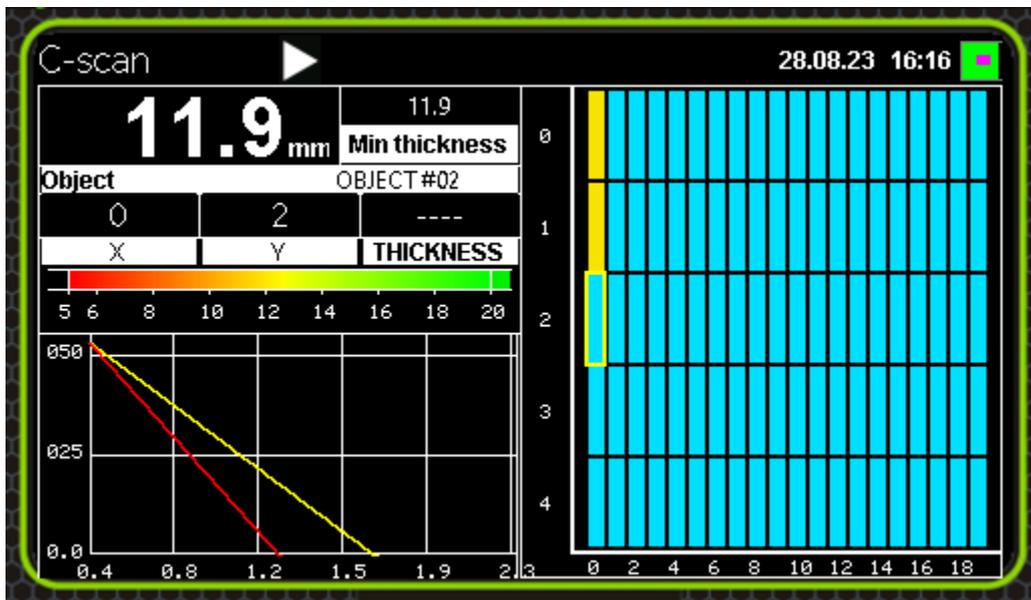
The cursor on the C-scan will be in the position with coordinate (0.0). Install the sensor on the test object into the grid node corresponding to coordinate 0.0

and press the  button on the Device. Then, the Device will perform measurements, fill one of the C-scan cells with a color according to the measured thickness and move the cursor to the next cell.



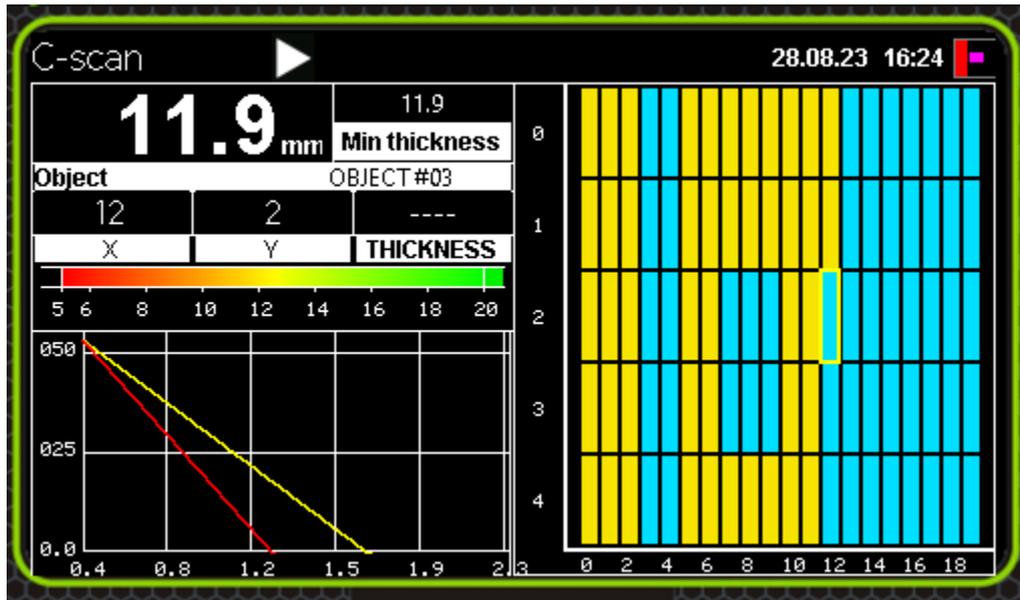
C-scan filling procedure

Then, move the sensor to the appropriate next node and re-press the button. Then, the following measurement will appear on the C-scan:



C-scan filling procedure

As a result, the whole C-scan will be filled step-by-step.

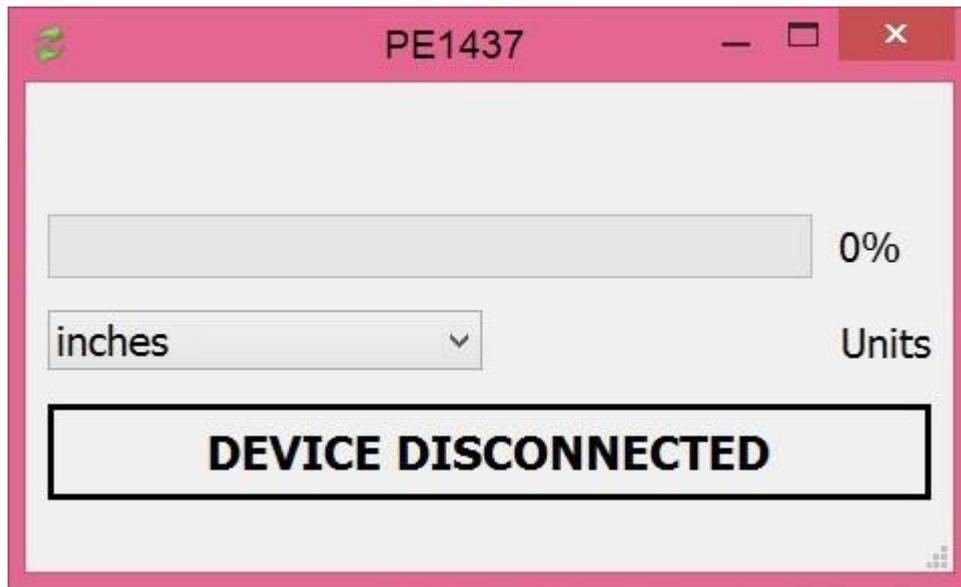


C-scan filling procedure

The black cells on the C-scan mean that there are thicknesses less than the minimum permissible one. After saving the C-scan can be opened on the Device or read it using the software on the PC.

Data transfer to PC

All saved archives with C-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 PE1437_Downloader application. The application window is shown in the Figure below:



PE1437_Downloader application

To download the files, connect the Device to the PC with the installed PE1437_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

Recommended precaution measures:

1. Be careful when moving the sensor near knives, forks, needles, and other sharp metal objects. Such objects can be magnetized to the sensor casing and injure the user.
2. The Device sensor generates the pulsed magnetic field. This field can damage the magnetic strip of plastic cards, as well as the magnetic hard disk drive. Do not place the Device sensor near such objects.

3. Do not place the sensor near working electronic devices and tools. The pulsed field generated by the sensor can interfere with electronics operation.
4. If the sensor cable is damaged, replace the sensor with a new one.

WARNING!

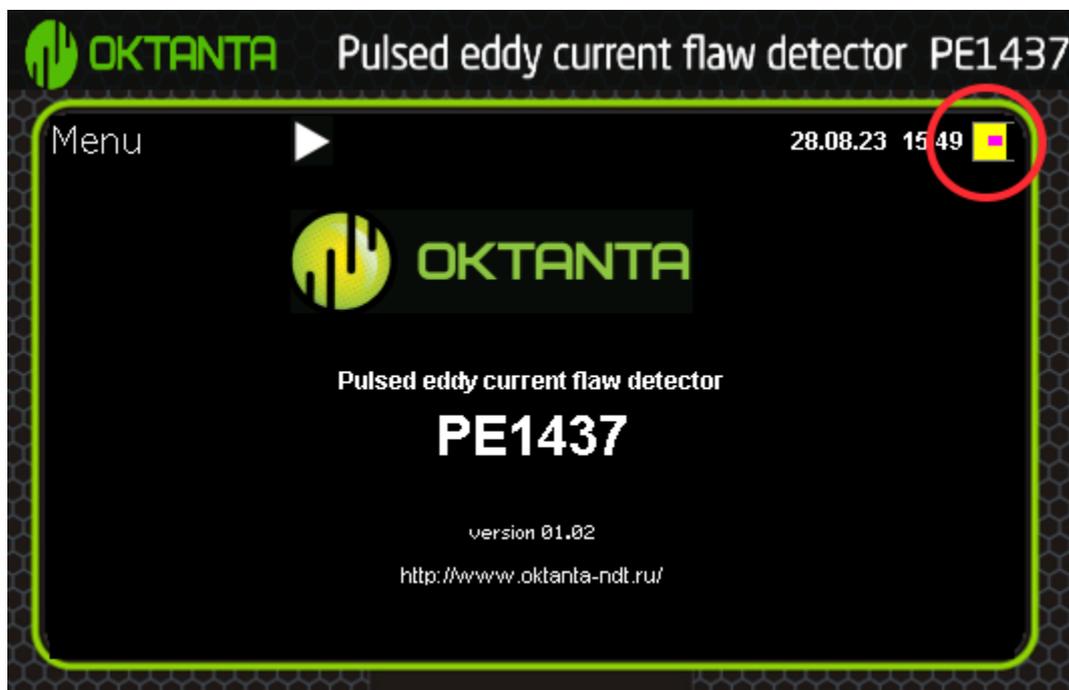
Using the sensor with the damaged sensor or cable may cause severe sparking which may result in fire.

WARNING!

Using the sensor with the damaged sensor or cable may lead to electric shock!

Battery Charge

Below you can see how the battery charge 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.

MAINTENANCE

Transducer Replacement

When the plastic coating of the transducer is worn to the exposed wire contacts or damaged insulation of the sensor cable, replace the sensor.

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.

The Device battery will discharge during long-term storage. Long-term discharge state of the battery can reduce its capacity. So we recommend to perform regular check (at least once per year) of the Device charge level and, if necessary, to recharge the battery.

SCOPE OF SUPPLY

The standard scope of supply of the Device includes:

Flaw detector PE1437	1 pc.
Sensor PEC143702	1 pc.
Recharger	1 pc.
Operation Manual	1 pc.
Transportation case	1 pc.
Protective cover with shoulder strap to carry the Device	1 pc.

MANUFACTURER WARRANTY

The warranty period for the Device is 2 years 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 equipment is used for purposes other than those specified in this 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	<u>PEC Flaw Detector</u> <u>PE1437</u>
Serial Number	_____
Warranty Period	_____
Manufacturer	Oktanta Mayakovsky Street, 22-34, Saint Petersburg +7(812)385-54-28 info@oktanta-ntd.ru Signature, stamp

INFORMATION ABOUT REPAIR

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