OKOndt GROUP

Eddy current flaw detector

Eddycon C

NDT Supply.com, Inc.
7952 Nieman Road
Lenexa, KS 66214-1560 USA

Phone: 913-685-0675, Fax: 913-685-1125
e-mail: sales@ndtsupply.com, www.ndtsupply.com

NDT SUPPLY.COM

Operating manual

EC.14327992.03.13 OM

Produced by LLC "ULTRACON-SERVICE"

TABLE OF CONTENTS

P.

INTRODUCTION

User manual of «Eddycon C» portable eddy current flaw detector (hereinafter referred to as "Flaw detector"), is intended for the study of operation principles of the flaw detector and its operating instructions, and includes the information on application, specifications, operating principle and structure, operating instruction, and also other information allowing a full-scale implementation of flaw detector technical capabilities.

The following graphic symbols and designations of controls, plug-type connections and indicators are used in the flaw detector.

<u>Front panel of the «Eddycon C»</u>:

Figure 1 – «Eddycon C» eddy current flaw detector. Front panel

Automatic flaw alarm by the first and second frequencies, respectively, and by the mix of the 1st and 2nd frequencies, as well as overloading alarm square. If ALARM triggers during testing, the signal amplitude and phase are automatically measured and the signal is evaluated by the calibration curve.

NULL F1 | DISP MODE F2 | ERASE F3 - Function keys.

Respectively:

"F1 NULL" – Balancing, "F2 DISP MODE" – different types of full-screen mode, "F3 ERASE" – erase and centering – in "TEST" menu;

"F1 Load", "F2 Create/ Save","F3 Delete"– in "RESULTS"/"SETTINGS" submenu;

"F1 An" (An - amplitude noise) – in "VIEW" menu;
"F1 Add", "F2 Del", "F3 STD"– in "CALIBRATION" menu.

1 AUTO LIFT _-#	- automatically puts a displayed signal from lift-off (or from any interference) in horizontal position; - in the mode of name editing – selects a digit/letter
2 STEP ABC	- changes the parameter variation step; - in the mode of name editing – selects a digit/letter
3 INC DEF	- increases the selected parameter; - in the mode of name editing – selects a digit/letter
4 SWITCH FREQ GHI	- changes the frequency; - in the mode of name editing – selects a digit/letter
5 ↑ JKL	- moves up through the menu; - in the mode of name editing – selects a digit/letter
6 DEC MNO	- decreases the selected parameter; - in the mode of name editing – selects a digit/letter
7 FREEZE ✕ PQRS	- cancels the selection; - in the mode of name editing – selects a digit/letter; - pressing the key results in displaying the firmware version in"SETTINGS" menu
8 ↓ TUV	- moves down through the menu; - in the mode of name editing – selects a digit/letter
9 SAVE DFLT ✓ WXYZ	- confirms the selection; - in the mode of name editing – selects a digit/letter; - pressing the key in "TEST" menu results in saving of current setup as a default one (if the current item is above the ALARM item)
TEST	- quick access to "TEST" menu

	- quick access to "SETTINGS" menu
	- quick access to "VIEW" menu
	- quick access to "ARCHIVE" menu; - confirms the saving of the entered name of the file or folder while operating in "ARCHIVE" menu
	- quick access to "CALIBRATION" menu
	- automatically sets the parameters of single coil (parametric) ECP with switched on Single input; - sets the number of rounds while operating with eddy current rotary scanner
	- switches On/Off the instrument

Rear panel of the flaw detector:

1 – Ethernet port for connecting a communication cable to PC;
2 – USB port for updating the flaw detector software and recording the testing results on the external Flash-Card

Figure 2 – «Eddycon C» eddy current flaw detector. Rear panel

Table 1 – **Description of connector for the instrument connection to the PC Ethernet port**

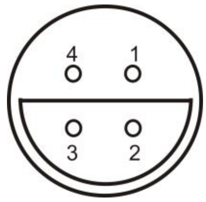
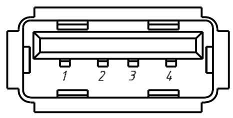
Contact	Description	Ethernet
1	Data of transmitter «+»	
2	Data of transmitter «–»	
3	Data of receiver «+»	
4	Data of receiver «–»	ERA.0S.304.CLL (front view)

Table 2 – **Description of connector for the instrument connection to the PC USB port**

Contact	Signal	USB type A (front view)
1	+5 V	
2	Data –	
3	Data +	
4	Common	

<u>Left side panel of the flaw detector</u>:

1 - LEMO jack for headphones with microphone connection;
2 - Charger connector;
3 - Switching On/Off the instrument.

Figure 3 – «Eddycon C» eddy current flaw detector. Left side panel

Table 3 – Description of LEMO jack for headphones with microphone connection

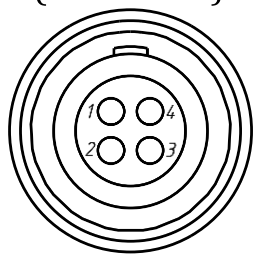
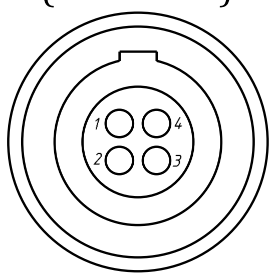
<table>
<tr><th>Cont.</th><th>Signal</th><td rowspan="5">EGG.0B.304.CLL
(front view)
</td></tr>
<tr><td>1</td><td>Input signal from the microphone</td></tr>
<tr><td>2</td><td>Right audio output</td></tr>
<tr><td>3</td><td>Common</td></tr>
<tr><td>4</td><td>Left audio output</td></tr>
</table>

Table 4 – Description of charger connector

<table>
<tr><th>Cont.</th><th>Signal</th><td rowspan="5">EGG.1B.304.CLL
(front view)
</td></tr>
<tr><td>1</td><td>Charging device –</td></tr>
<tr><td>2</td><td>Not used</td></tr>
<tr><td>3</td><td>Charging device +</td></tr>
<tr><td>4</td><td>Sync signal output</td></tr>
</table>

Right side panel of the flaw detector:

1 - Single (parametric) eddy current probe (ECP) connector;
2 - Connector for eddy current probe (ECP) and eddy current rotary scanner;
3 - Encoder (Enc) connector

Figure 4 – Eddycon C eddy current flaw detector. Right side panel

Table 5 – Description of single (parametric) eddy current probe (ECP) connector

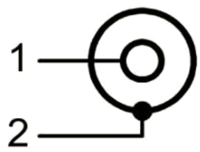
Cont.	Signal	Lemo ERA.00.250CLL
1	Parametric ECP	
2	Common for parametric ECP	

Table 6 – Description of encoder (Enc) connector

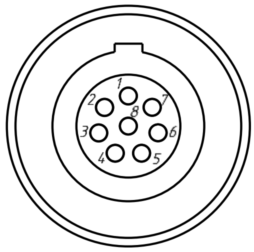
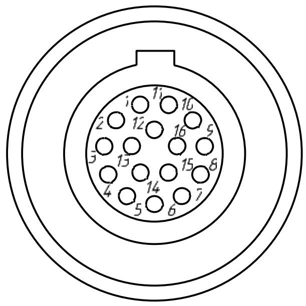
Cont.	Signal	
1	Positive signal input "A"	Lemo EGG.1B.308CLL (front view) 
2	Power "+5V"	
3	Negative signal input "Z"	
4	Positive signal input "Z"	
5	Negative signal input "B"	
6	Positive signal input "B"	
7	Negative signal input "A"	
8	Common	

Table 7 – Description of connector for eddy current probe (ECP) and eddy current rotary scanner

Cont.	Description	
1	Common	 EGG.2B.316.CLL (front view)
2	Positive amplifier input	
3	Bridge generator output	
4	Generator signal output	
5	Single-wire interface	
6	Signal input to control the rotation speed of the rotary scanner (four pulses per revolution) Common	
7	Rotary scanner power	
8	Common of rotary scanner	
9	Signal input to control the rotation speed of the rotary scanner (one pulse per revolution)	
10	Bridge generator output	
11	Negative amplifier input	
12	External balancing input	
13	External cleaning input	
14	Alarm output	
15	Power «+12V »	
16	Not connected	

1 PURPOSE

1.1 The flaw detector is intended for manual and mechanized testing by eddy current method for the presence of surface and subsurface defects, such as material discontinuity (cracks, laps, cissings, fine cracks etc.), for conductivity and thickness measuring.

1.2 The flaw detector can be applied for the testing of products during their manufacture and operation by NDT services and laboratories of enterprises that provide the products quality control.

1.3 The parameters of testing objects, which limit the flaw detector application area, are specified in regulatory documents for a specific type of testing products and materials.

1.4 The flaw detector provides the possibility of connecting and operating ECP of the following types:

- differential ECP;
- differential ECP, connected by the bridge circuit;
- differential transformer ECP with center-point earth;
- differential transformer ECP;
- single (parametric) ECP;
- single transformer ECP.

1.5 Operating and ambient temperature range is from minus 20 °C to plus 45 °C.

1.6 The level of the flaw detector protection from solid bodies and water penetration is IP 64.

1.7 The flaw detector is intended for operation in industrial enterprises environment and refers to A level equipment, 1 group equipment according to CISPR 11.

2 MAIN SPECIFICATIONS

2.1 Range of operating frequencies adjustment – from 10 Hz to 16 MHz.

2.2 Setup of the max. sampling frequency/digitizing rate – 10 kHz/10000 samples per second (max).

2.3 Setup of the range of adjustment of ECP excitation signal voltage (double amplitude) – from 0.5 to 6.0 V.

2.4 Preamplifier adjustment – from minus 6 to plus 40 dB with a step of 0,1; 1; 10 dB.

2.5 Gain adjustment – from 0 to 30 dB with a step of 0,1, 1 and 10 dB.

2.6 When displaying the signal in a complex plane it is possible to have the following variants: a) the complex plane center is situated in the center of display area; b) the complex plane center is situated in the left upper corner; c) the complex plane center is situated in the right upper corner; d) the complex plane center is situated in the left bottom corner; e) the complex plane center is situated in the right bottom corner; f) all frequencies and mixtures are displayed on the same page (when operating in dual-frequency mode); g) manual adjustment of the positioning of the center of the complex plane.

2.7 There is automatic LED and sound flaw alarm (ALARM) in the flaw detector.

2.8 In processing of the testing results the flaw detector provides the following options:

- changing of ECP signal phase (the range of signal turn – from 0° to 360° with a step of 0.1°; 1°; 10°);
- filtering of ECP signal (there are 5 types of filters: Averaging, Differential, Low-pass, High-pass, Bandpass);
- formation of a mix of two frequencies (for combining an operator can select one of 4 algorithms: summation, subtraction, summation with horizontal inversion, summation with vertical inversion).

2.9 Time of continuous operation of the flaw detector from fully charged storage battery – no less than 8 hours.

2.10 Average mean time between failures – no less than 40000 hours.

2.11 Defined no-failure operating time – 4000 hours.

2.12 Total average service life – 10 years. The criterion of marginal state of the flaw detector is economical inexpediency of restoration of its performance by repair.

2.13 The flaw detector is powered from the in-built storage battery with rated voltage of 12 V.

2.14 Weight of the flaw detector with a storage battery (without ECP set, cables and casing) – no more than 0.9 kg.

2.15 Overall dimensions of the flaw detector – no more than 230 mm × 135 mm × 98 mm.

3 DESIGN OF THE FLAW DETECTOR

3.1 Instrument appearance

Instrument appearance is shown in Figure 5.

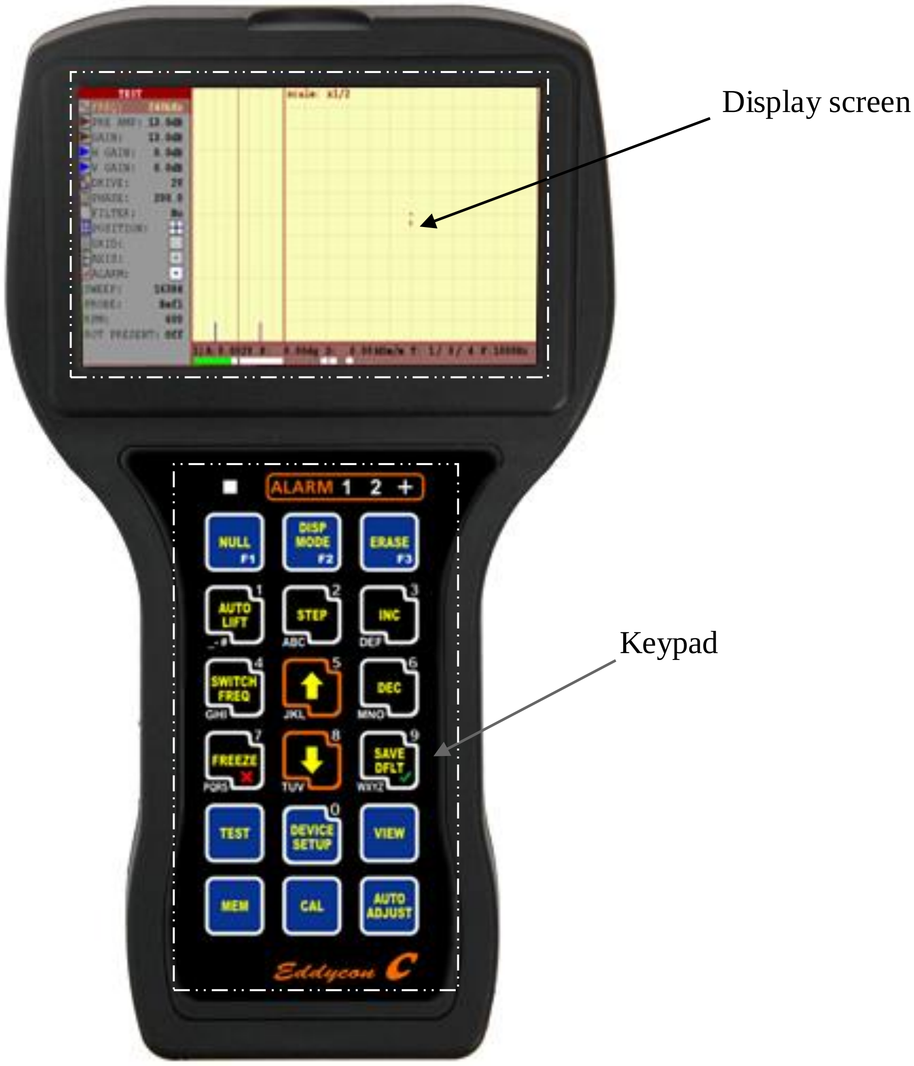


Figure 5 – «Eddycon C» eddy current flaw detector

3.2 Structural scheme

Structural scheme of the flaw detector

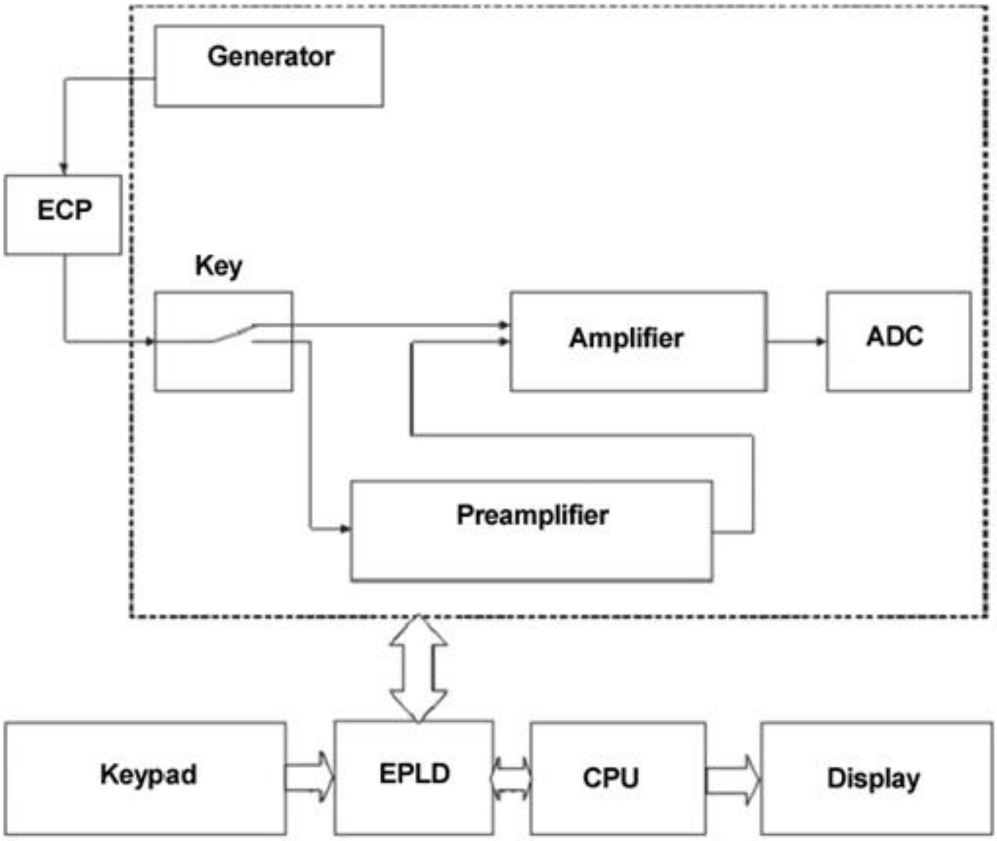


Figure 6 – Structural scheme of the flaw detector

Structurally, the flaw detector consists of:

a) casing and cover plate with the membrane keypad, indicators of ALARM and overloading, Mini-USB port for connection to PC, USB port for external flash-card connection, charger connector, headphones and microphone;

b) connector, ECP connector;

c) TFT display;

d) processor and memory boards;

e) analog board;

f) battery.

3.3 Appearance of the flaw detector screen

Appearance of the flaw detector screen is shown in Figure 7.

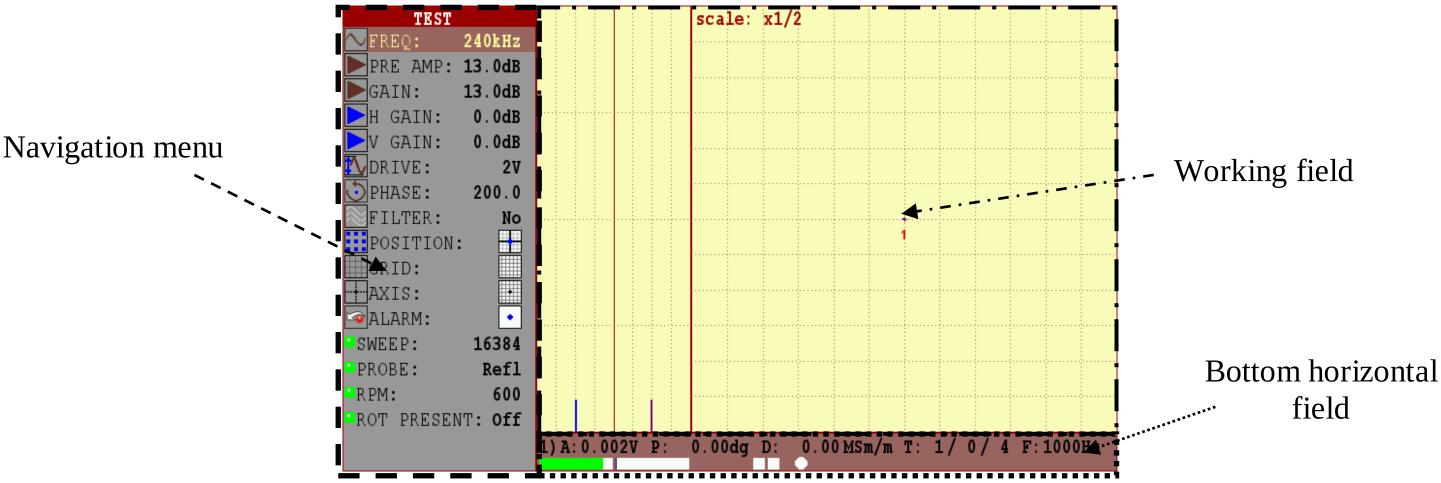


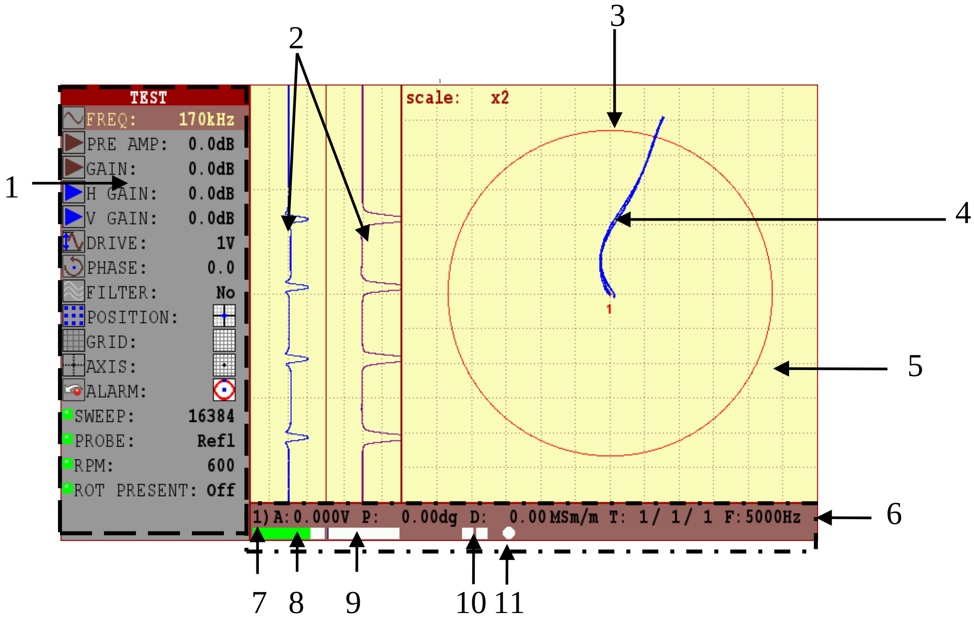
Figure 7 – Display appearance after switching On the flaw detector

Working filed in the testing mode is divided in 3 areas of signal reflection and display area title:

- Working field (display areas – complex plane, time charts);
- Bottom horizontal field (data line);
- Navigation menu:
  - FREQ – test frequency;
  - PRE AMP – preamplifier gain;
  - GAIN – main gain;
  - H GAIN – horizontal gain;
  - V GAIN – vertical gain;
  - DRIVE – probe drive level;
  - PHASE – phase adjustment;
  - FILTER – filter type;
  - POSITION – spot position;
  - GRID – grid;
  - AXIS – axis;
  - ALARM – short cut to ALARM Setting;
  - SWEEP – number of points in a screen scan;
  - PROBE – type of connector;

- RPM – rounds per minute for the eddy current rotary scanner;
- ROT PRESENT– type of connected rotary eddy current scanner.

The flaw detector displays two time charts of time dependence of signal and eddy current signal which is displayed in a complex plane for the selected frequency.



1 - Navigation menu; 2 - Time charts; 3 - ALARM frame; 4 - Eddy current signal; 5 - Signal display area; 6 - Parameters of the measured signal (A – amplitude in “Volts”, P – phase in “degrees”, D – equivalent depth of flaw in “mm” or conductivity in “MSm/m”), T - current value of a receive circuit parameters (“…/” – load of the input circuit before the balancing; “…/” non-balance of the input circuit; “…” – the current value of the input circuit expressed in % from the maximum possible), F- sampling frequency; 7 - Frequency number; 8 - Battery life indicator; 9 - Temporary memory indicator of the flaw detector; 10 - Digital overload indicators for receiving circuit; 11 - digital trigger indicators of ALARM levels for the first, second and mix of frequencies respectively (from left to right)

Figure 8 – The flaw detector interface

Note – *Parameter "T: .../.../..." shows:*

1) *The value of a signal amplitude at the input of the receiving circuit expressed in % from the maximum possible,*
2) *Input circuit is not balanced, after performing the balancing in %;*
3) *Current value of the load of the input circuit expressed in % from the maximum possible.*

The most suitable option is one in which the two parameters do not exceed, or exceed but not significantly the 50 %. Operation in mode, in which one of the parameters exceeded the threshold of 90 % is unacceptable and requires the adjustment of flaw detector parameters.

Lightning of a left overload indicator (pos. 10, Figure 8) **-** indicates that unacceptably large amplitude signal came to the input of the receiving circuit.

The flaw detector electronic unit displays the signal in complex plane that allows to foil defects by waveform analysis (Figure 9):

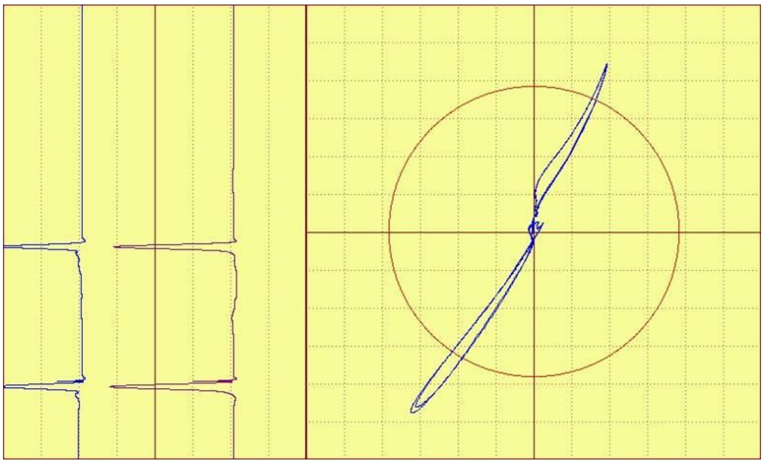


Figure 9 – Display of signal in the complex plane (XY)

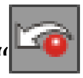
Figure 10 – Mix of two frequencies (MIX)

The flaw detector has the mechanism of automatic flaw alarm (ALARM). It is provided for the creation of up to 4 "frames" (threshold levels) of alarm for each frequency and mix (examples of threshold levels see Figures 14, 15, 16, 17). These frames together with the signal form an event (for example, the threshold level exceeding by the signal). An operator is able to adjust the reaction to an event. Reaction to an event can be the following:

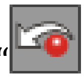
- LEDs illuminating on the instrument panel;
- or LEDs illuminating and sound alarm.

"ALARM" menu setup

This menu allows setting of ALARM (automatic flaw alarm). There is a possibility to setup ALARM for each frequency and mix. ALARM itself is the response of flaw detector to the event occurring at crossing or non-crossing of alarm frame (threshold level) by a signal. All in all one alarm frame can be activated for each frequency.

Frame setup is carried out in special item of ALARM settings – " ALARM" from "TEST" menu. To change the type of the alarm frame operator should press 

or 

key on " ALARM" position (if the icon  is displayed, the frames are switched off). To enter in alarm frame setup operator should press 

key.

 **Note.** *An operator is offered to set up the frame according to the frequency, he plans to work with.*

Automatic measurement of the signal amplitude and phase provides a possibility to evaluate the defect size in analyzing the data. The measured values of the voltage phase or amplitude are required for estimating the defect size in conformity with the selected calibration curve. Such curve compares the parameters of signal amplitude or phase with the defect parameters in millimeters or percent from the wall thickness. The flaw detector interface allows calibration curves plotting both by the phase and amplitude.

The flaw detector connectors for the eddy current probes connection (see Figure 4) provide the possibility of ECP connection of various constructions (see Figure 11):

- differential ECP, connection by the bridge circuit;
- single transformer ECP;
- differential ECP, connection by the bridge circuit;
- differential transformer ECP with center-point ground;
- single (parametric) ECP;
- differential transformer ECP.

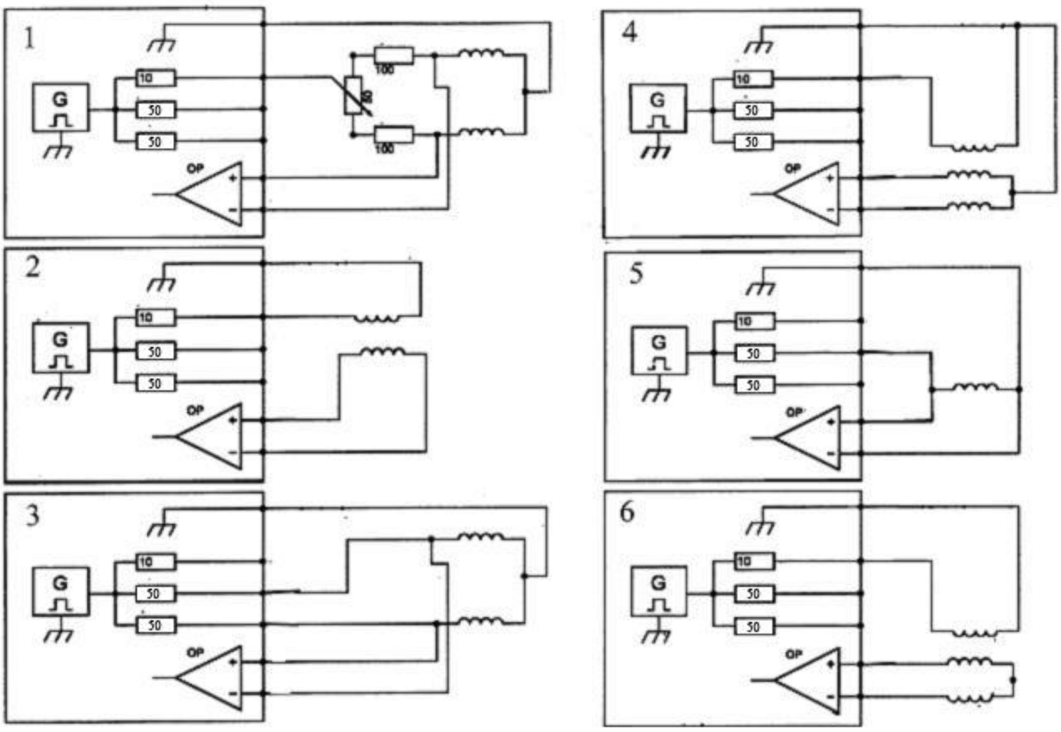


Figure 11 – Circuits of PROBE connection

3.4 Menu structure

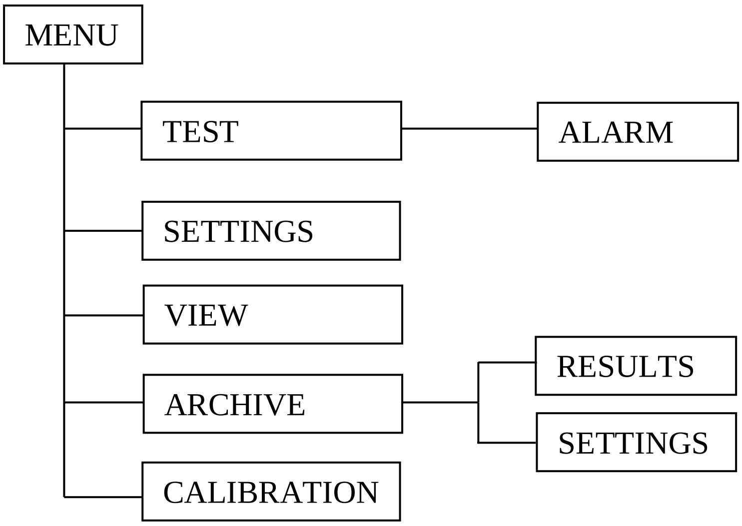
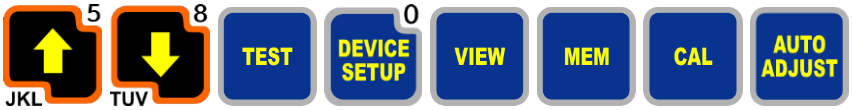


Figure 12 – Menu structure

Navigation of the menu map described below is performed with the help of the following keys:



The instrument menu is divided in five inserts: "TEST", "SETTINGS", "VIEW", "ARCHIVE", "CALIBRATION", the first and the fourth ones are also divided in submenus.

3.5 "TEST" menu

"Test" menu is displayed immediately after switching On the instrument (see Figure 13) and contains main settings an operator will need to set during operation.

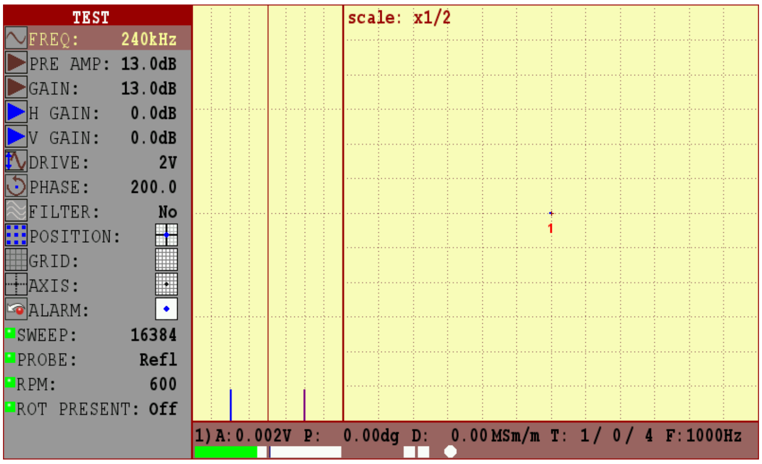


Figure 13 – "TEST" menu

In this menu, an operator can set (change) the settings of the selected frequency, the values of operating frequency, gain and preamplifier, generator voltage, initial phase of signal, filter type and its parameter, input type, general scale and independently to axles, position of complex plane center as well as set up ALARM and general flaw detector parameters.

Moving through the vertical menu of the electronic unit parameters is carried out by  keys. In order to change the value of any parameter one should use  keys. A step of parameter variations can be changed by multiple pressing of  key.

Quick selection to "TEST", "SETTINGS", "VIEW", "ARCHIVE", "CALIBRATION" inserts is carried out by pressing TEST, DEVICE SETUP, VIEW, MEM, CAL keys.

"Hot keys" which are operated by "F1", "F2", "F3" function keys are situated on the keypad of the flaw detector:

- F1 (Balancing)[1] – to balance the signal, place it in the screen center and clear the flaw detector screen;
- F2 (Full-screen mode) – the complex plane and time chart is maximized to fill the entire screen.
- F3 (Centering) – to place the signal in the screen center and clear the flaw detector screen;

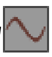
"Balancing" – it is hardware compensation of input signal. It is carried out by summation of input signal with reference signal of the same amplitude but opposite in phase. Current procedure is conducted after preamplifier according to radio signal (before signal detecting). Balancing algorithm is iterative and takes some time. The procedure is necessary for ECP non-balance voltage compensation. After the balancing of flaw detector the centering is carried out automatically.

"Centering" – it is a displacement of present (complex) signal in user selected position on the screen of the flaw detector. The algorithm is fully performed by processor module. Current procedure is carried out according to digital detecting signal and necessary for signal displacement elimination caused by amplifier and digital filters.

Balancing should be applied in case if:

- ECP type was changed;
- One of following parameters was changed: ECP frequency, gain coefficient, preamplification coefficient, ECP excitation voltage;
- Testing object was changed.

Centering should be used if the operator needs to set the signal in the complex plane centre.

1 " F, Hz"- operating frequency of probe[2]; varied in the range from 10 Hz to 16 MHz with a step of 1, 10, 100, 1000, 10000, 100000, 1000000, 10000000 Hz.

[1]Balancing of the flaw detector is required after the ECP operating frequency was set or changed. Also, the balancing should be carried out after the ECP replacement. If the flaw detector was once balanced and its operating frequencies were not changed, it is possible to carry out centering.

Here you adjust the test frequency of the probe that is connected to the instrument. The frequency depends on the probe you use and the application at hand. You can select the frequency between 10 Hz and 16 MHz.

2 " PRE AMP" - preamplifier for amplifying the probe voltage; varied in the range from -6 to 40 dB with a step of 0,1, 1, 10 dB.

To adapt the eddy current probe that is to be used, you can adjust the preamplification in 0.1; 1; 6; 10 dB steps between 0dB and 40dB. Please avoid a preamplification overload because it may tamper with the results of the measurement. The overload is indicated by the amber light of the ALARM-LED.

3 " GAIN" - gain for amplifying the probe voltage; varied in the range from 0 to 30 dB with a step of 0,1; 1; 10 dB.

Here you adjust the signal amplitude for the best possible display of the eddy current signal by moving the probe across a reference defect while slowly increasing the gain. You can adjust the gain between 0 dB and 30 dB. The display shows the overall gain simultaneously for X and Y- coordinates.

4 " H GAIN" – horizontal gain for amplifying the probe voltage; varied in the range from 0 to 30 dB with a step of 0,1; 1; 10 dB.

5 " V GAIN dB" – vertical gain for amplifying the probe voltage; varied in the range from 0 to 30 dB with a step of 0,1; 1; 10 dB. This item is often used to set up single coil probe for visual increase of angle between lift-off signal and signal from defect.

6 " DRIVE" - ECP excitation voltage[3]; it is possible to set specified values of 0.5; 1; 2; 4; 6 V (double amplitude value). The maximum voltage for single coil probe is 2V. The maximum voltage for other types of probes is limited by 6V. High voltage is used for subsurface defects detection.

7 " PHASE" - signal phase change (signal turn) – from 0 to 360˚ with a step of 0.1˚, 1˚, 10˚.

8 " FILTER" - Filter type: Averaging, Differential, Low-pass, High-pass, Bandpass;

Filters setup is carried out for the channel Frequency 1 and Frequency 2.

---

[2] Operating frequency of probe is selected from the rage of frequencies indicated in the registration certificate for the given ECP.

[3] ECP exciting voltage is selected from the range indicated in the registration certificate for the given ECP.

Averaging Filter

Switching on of the averaging filter "AVRG" sets a number of points N to be averaged from 2 to 127 points with a step of 1, 10, 100 points. Can be used when working with high gains and scales to reduce noise signal by smoothing it.

Differential Filter

Switching on of a differential filter “Diff” activates its settings, where L – filter depth, set in the range from 2 to 127 units with a step of 1, 10, 100.

Low-Pass Filter

Switching on of a low-pass filter activates the field for setting up the frequency LF from 1 to 5000 Hz with a step of 1, 10, 100, 1000 Hz. The frequencies from 0 Hz to the set value of Hz are allowed.

The low-pass filter is used to reduce the noise respectively high-frequency non-essential signal components by displaying only those signals whose alternating frequency is lower (i. e. slower) than the frequency of the selected low-pass filter. Since electronic noise is usually caused by high-frequency signals, the noise on the screen is lower, if the frequency of the low-pass filter is set low, too.

The low-pass filter is used for static applications (usually with hand-held probes).

It is important that the low-pass filter is not too low, because defect signals are not displayed anymore, if you move the probe across the crack at a speed that is too high with regards to the filter frequency. If for example you move the probe very slowly across the crack, then the dot slowly tracks the full defect signal at a low-pass frequency of 10 Hz. If, one the other hand, you move the probe across the crack more quickly at the same low-pass frequency, you will see only a small amplitude on the screen. This happens because the frequency of the signals is now too high for the low-pass filter frequency you selected.

If, however, you increase the low-pass filter frequency, the full amplitude of the defect signal is displayed, i. e. the higher the test speed the higher the frequency of the low-pass filter to be selected. Since differential probes generate a dual signal that changes more quickly than that of an absolute probe at the same speed, you should select a higher low-pass frequency for differential probes than for absolute probes. Thus the minimum low-pass frequency to be selected for a particular application depends on the test speed and the coil system of the probe you use.

The easiest way to determine the minimum low-pass frequency is probably by trial and error.

High-Pass Filter

Switching on of a high-pass filter activates the field for setting up the frequency HF from 1 to 5000 Hz with a step of 1, 10, 100, 1000 Hz. The frequencies from the set value of Hz to $F_{SAMPLING}$ /2 Hz (where $F_{SAMPLING}$ – sampling frequency) are allowed.

If you use a high-pass filter, the signal dot always returns to the selected compensation point, if the probe is not moved relative to the surface of the test specimen. This can be likened to an „automatic reset". Thus, if you move the probe across materials with varying electric conductivity, the signal dot briefly moves to a position on the screen that varies depending on the material; the dot then returns to the selected compensation point.

The filters are intended to improve the signal/noise ratio and/or supress undesired signals so that the signal evaluation and test sensitivity are optimized. The noise can be „electronic“(caused by the instrument or the probe), or it can be caused by other factors such as scanning rough surfaces. You can easily identify electronic noise by the so-called „fuzzy“ signal image instead of a steady dot. This happens frequently, if you carry out inspections with low frequencies or high gain. The filter frequency does not depend on the alternating frequency of the current that flows through the coils, but on how frequently the test signals change. If for example you move a probe across a crack, the frequency depends on how fast you do so. The high-pass filter is designed so that only those signals whose frequency is greater than that of the high-pass filter are depicted by deflecting the signal dot. If the high-pass filter is active the signal dot on the screen remains on the compensation point.

Bandpass

Switching on of a bandpass filter activates its settings:

Carrier frequency F is set from 1 to 5000 Hz with a step of 1, 10, 100, 1000 Hz;

$F \le \frac{F_{SAMPLING}}{2}$, where $F_{SAMPLING}$ – frequency is set in "SETTINGS" (sampling frequency);

WF bandpass is set from 1 to 5000 Hz with a step of 1, 10, 100, 1000 Hz.

You can use the bandpass-function to adjust both the high pass and the low pass. This is very helpful when you want to quickly determine the frequency band for the best possible defect display - especially for rotor applications or inspections of rotating parts.

Note. Only one filter can be set in the frequency selected by an operator. Activation of other filter makes the earlier selected filter inactive within the set frequency.

9 "" - selection of the position of complex plane center. Can be set in the following positions: - complex plane center, - in the right center of the screen, - in the right upper corner, - in the upper center of the screen, - in the left upper corner, - in the left center of the screen, - in the left bottom corner, - in the bottom center of the screen, - in the right bottom corner, - per-channel display when operating in double frequency mode.

10 " Grid"– variants of marking for the complex plane: ""– square, "" – radial, "" – Off.

11 " Axis"– activates coordinate axes.

12 " ALARM" – activation and setting of frames (threshold levels). Types of frames: - frames are switched off, - circle frame type, - threshold frame type, - sector frame type, - cutoff frame type.

13 "SWEEP" – number of samplings displayed on time charts (see Figure 8, pos. 4) - 256; 512; 1024; 2048; 4096; 8192; 16384, 32768 measurements.

14 "PROBE" – Connector type: "Refl", "Bridge", "Single".

15 "RPM" – rounds per minute for the eddy current rotary scanner. Selected from the standard range: 600, 840, 1020, 1200, 1500, 1800, 2100, 2400, 2700, 3000.

16 "ROT" – type of connected rotary eddy current scanner SVR-03 or MINI MITE.

17 "Mix type" – is selected for the frequencies mixing (setting is available in double frequency mode), where:

"+" – summation, "–" – subtraction, "~X+" - summation with inversion in X-direction, "~Y+" - summation with inversion in Y-direction.

If the mix type is "+", then:

$XCi=X1i*M1+X2i*M2;$

$YCi=Y1i*M1+Y2i*M2.$

If the mix type is "-», then:

$XCi=X1i*M1-X2i*M2;$

$YCi=Y1i*M1-Y2i*M2.$

If the mix type is «~Y+», then:

$XCi=X1i*M1-X2i*M2;$

$YCi=Y1i*M1+Y2i*M2.$

If the mix type is «~X+», then:

$XCi=X1i*M1+X2i*M2;$

$YCi=Y1i*M1-Y2i*M2.$

Where XCi, X1i, X2i – horizontal components of the mix of the 1st and 2nd frequencies, respectively;
YCi, Y1i, Y2i – vertical components of the mix of the 1st and 2nd frequencies, respectively;
M1, M2 – scales of the 1st and 2nd frequencies, respectively.

Threshold levels setup

- **Setup of "Circle" type frame**

To set up circle type frame, operator should select "Type: " in special item of settings ALARM– (see Figure 14).

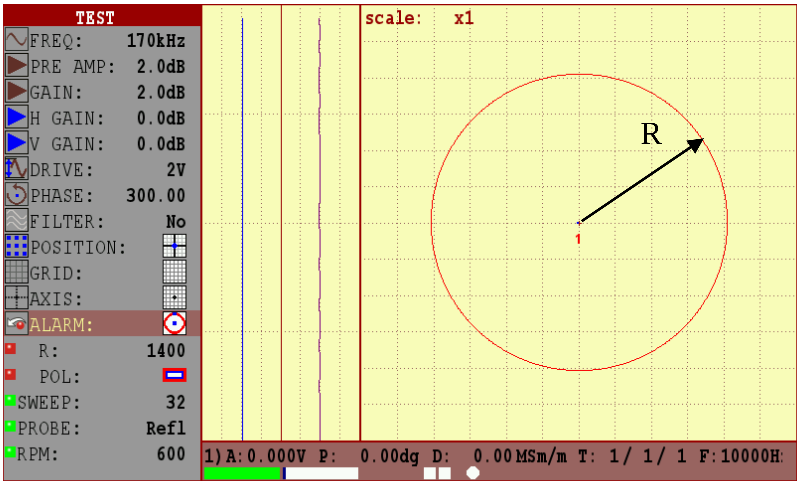


Figure 14 – Setup of "Type: " of threshold level

"R:" parameter variation allows change the inner radius of threshold level. Height parameter variation is carried out in the range from 0 to 32768 with a step of 1, 10, 100, 1000, 10000 (see Figure 14).

- **Setup of "Threshold" type frame**

To set up threshold type frame, operator should select "Type: " in special item of settings ALARM– (see Figure 15).

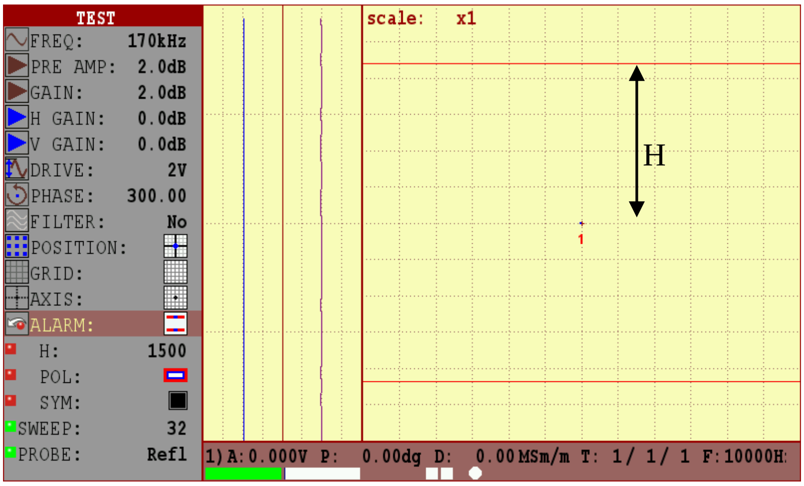


Figure 15 – Setup of "Type: " of threshold level

"H:" parameter variation allows change the height of the threshold level. Parameter variation is carried out in the range from 0 to 32768 with a step of 1, 10, 100, 1000, 10000 (see Figure 15).

- **<u>Setup of "Sector" type frame</u>**

To set up sector type frame, operator should select "Type: " in special item of settings ALARM– (see Figure 16).

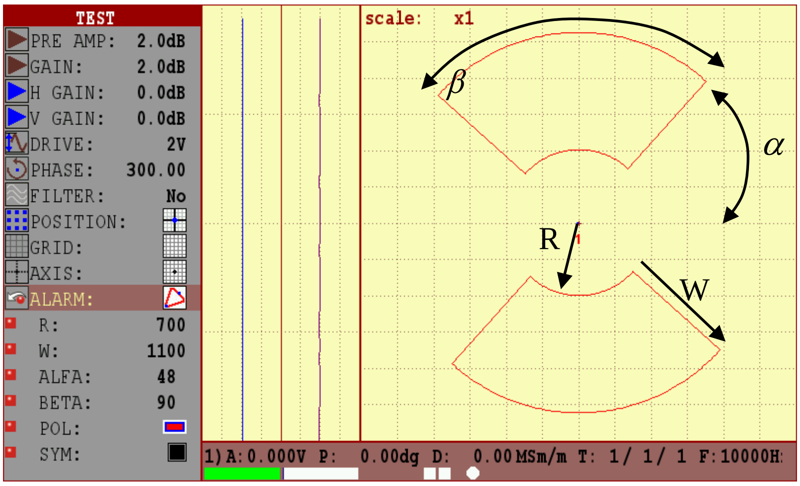


Figure 16 – Setup of "Type: " of threshold level

"R:" parameter variation allows change the inner radius of threshold level. Height parameter variation is carried out in the range from 0 to 32768 with a step of 1, 10, 100, 1000, 10000 (see Figure 16).

"W:" parameter variation allows change the width of threshold level. Radius parameter variation is carried out in the range from 0 to 32768 with a step of 1, 10, 100, 1000, 10000 (see Figure 16).

" α :" parameter variation allows change turning angle of threshold level relative to the complex plane center. Turn angle variation is carried out in the range from 0˚ to 359˚ with a step of 1˚, 10˚, 100˚ (see Figure 16).

" β :" parameter variation allows change turning angle of threshold level. Turn angle variation is carried out in the range from 0˚ to 180˚ with a step of 1˚, 10˚, 100˚(see Figure 16).

Select the frame polarity "Pol:", which makes the alarm trigger:

– the signal gets beyond the limits of the threshold level;

– the signal is within the limits of the threshold level.

If the symmetrical displaying of threshold level on the position “Symm:” with ,  keys is required, this parameter can be activated.

- **<u>Setup of "Trapezium" type frame</u>**

To set up trapezium type frame, operator should select "Type: " in special item of settings ALARM– (see Figure 17).

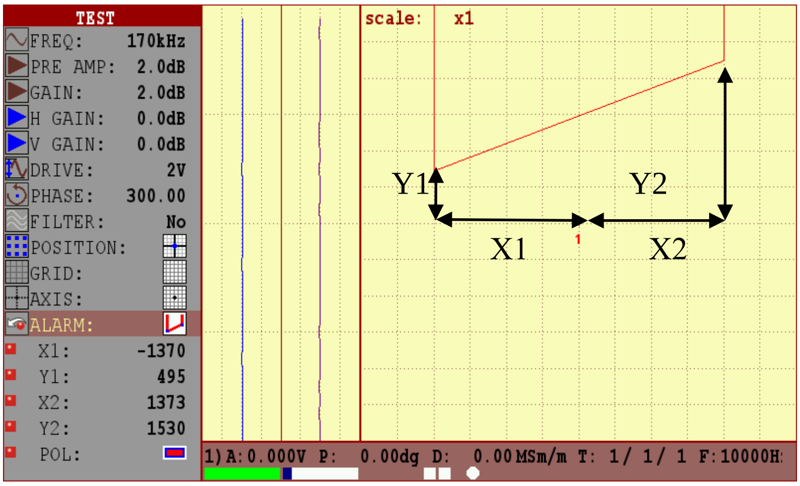


Figure 17 – Threshold level setup "Type: "

"X1:" parameter variation allows changing the angle position of threshold level in X1-direction. X1 parameter variation is carried out in the range from - 32768 to 0 with a step of 1, 10, 100, 1000, 10000 (see Figure 17).

"X2:" parameter variation allows changing the angle position of threshold level in X2-direction. X2 parameter variation is carried out in the range from 0 to 32768 with a step of 1, 10, 100, 1000, 10000 (see Figure 17).

"Y1:" parameter variation allows changing the angle position of threshold level in Y1-direction. Y1 parameter variation is carried out in the range from - 32768 to 32768 with a step of 1, 10, 100, 1000, 10000 (see Figure 17).

"Y2:" parameter variation allows changing the angle position of threshold level in Y2-direction. Y2 parameter variation is carried out in the range from 32768 to

- 32768 with a step of 1, 10, 100, 1000, 10000 (see Figure 17).

Select the frame polarity "Pol:" which makes the alarm trigger:

– the signal gets beyond the limits of the threshold level;

– the signal is within the limits of the threshold level.

3.6 GUIDELINES FOR OVERLOAD PROCESSING

1 For the Input – "Refl", "Bridge":

1.1 Reduce the probe drive;

1.2 Perform the probe balance by pressing **NULL F1** *key.*

2 For the Input – "Single":

2.1 Choose the capacitor by pressing **AUTO ADJUST** *key;*

2.2 Perform the probe balance by pressing **NULL F1** *key;*

2.3 If the recommendations specified in paras 2.1-2.2 didn`t resolve the overload, then it is necessary to reduce the probe drive and repeat paras 2.1-2.2.

Lightning of the right overload indicator *(pos. 10, Figure 8) – indicates the general overload of the input of the receiving circuit. General overload may include: overload by the input of the receiving circuit (exceeding the maximum allowed signal amplitude at input of the receiving circuit**),** ADC overload (exceeding the maximum allowed signal amplitude at ADC input).*

3 For the input – "Refl", "Bridge" and "Single":

3.1 If the left indicator lights, then repeat the steps described for overload processing for the left indicator (see above);

3.2 *If the right indicator lights only, then it is required alternately reduce the " PRE AMP" and " GAIN". After each gain change it is required to press* **NULL F1** *key.*

3.7 "CONDUCTIVITY" mode

Basics of Conductivity

The SI derived unit for conductivity is the Siemen per meter, but conductivity values are often reported as % IACS. IACS is an acronym for International Annealed Copper Standard, which is the material used to make traditional copper electrical wire. The conductivity of the annealed copper is 5.8 x 107S/m and copper is defined to be 100% IACS at 20°C. All other conductivity values are related back to this conductivity of annealed copper.

Conductivities of metals at ambient temperature are typically in the range of 1 to 60 MegaSiemens per meter.

The Eddycon C measures the conductivity of non-magnetic metals and alloys in the range 0.8 to 110.0 % IACS. It uses the Eddy Current technique for measuring the conductivity of materials in % IACS, or MSiemens/meter.

It is important to understand that eddy current measurement is essentially a ‘skin’ effect.

The eddy current field intensity is greatest at the surface and decreases exponentially with depth. The depth at which the field strength reduces to 1/e (37 %) of its surface value is referred to as the ‘standard depth of penetration’. This depends primarily on the operating frequency and the conductivity of the metal.

It is generally considered that materials of thickness greater than 3 standard depths of penetration can be measured without any correction factors being required. For example at 60 kHz this figure (the “effective depth of penetration”) is around 0.05” (1.25 mm) in Aluminium Alloys (conductivity approximately 35% IACS) and 0.32” (8 mm) in Titanium alloy, (conductivity approximately 1% IACS). At 500 kHz the corresponding values are 0.02” (0.5 mm) and 0.11” (2.8 mm).

Care must also be taken when measuring non-homogeneous materials, for example materials which have been surface heat-treated, clad or plated, or where the surface is rough or corroded. Measurements at different frequencies will give different results due to the different distribution of energy within layers of different conductivity. Care must be taken to always measure such materials at the same frequency (usually 60 kHz).

Setting up the device for measuring the conductivity and the thickness of non-conductive coatings

To use the Eddycon C for Conductivity measurement requires the following:

- Eddycon C flaw detector;
- Standard 60 kHz Probe (CP-13) and Cable (Conductivity).
- Conductivity standards of known value.

To connect the flaw detector with Cable and the eddy current probe CP-13 for measuring the electrical conductivity.

To press the  button for entering the instrument menu «SETTINGS» and to choose «Test mode» - «CONDUCTIVITY».

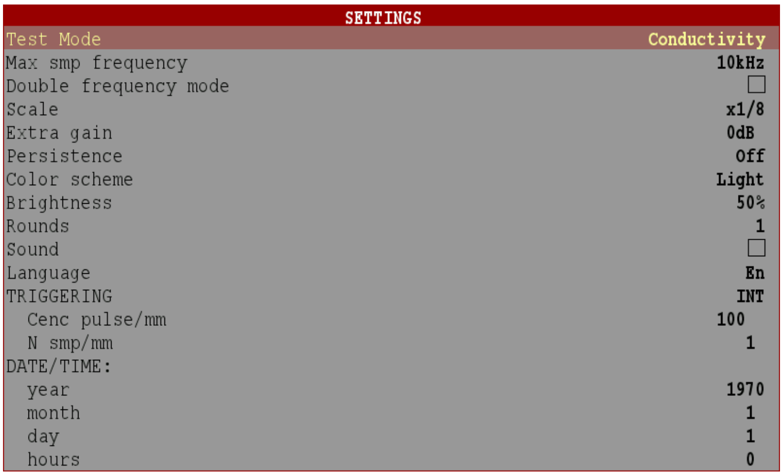


Figure 18 – «CONDUCTIVITY» Test Mode

To press  to enter the «TEST» menu.

In the menu «TEST» under the position «Current set», to choose by ,  buttons the appropriate setting for the measurement at a specified frequency and to press the  button to activate the settings.

«CP13 – 60 kHz»;

«CP13 – 480 kHz».

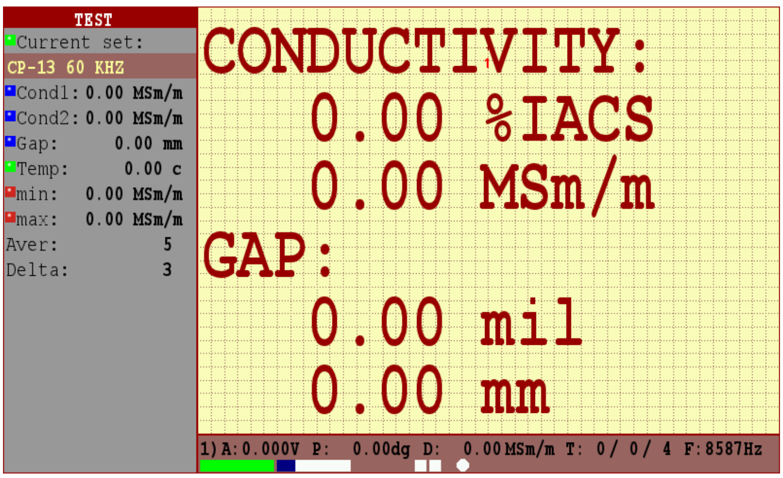


Figure 19 – Choosing and activating settings «CP13 – 60 KHZ»

After settings activation make calibration at standard samples.

To determine the material by its conductivity the setting up samples should generate the range of the conductivity, wherein the first sample value is lower and the second sample value is higher than the conductivity of the material being measured.

Conductivity measurement tolerances are:

- ±0.5 % IACS [±0.3 MS/m] for the conductivity range from 0.9 % to 62 % IACS [0.5 до 36 MS/m];
- ±1.0 % IACS [±0.6 MS/m] for the conductivity range from 62 % to 110 %.

  Tolerances for coating thickness measurement:
- ±1 mil [±0.0254 мм] for the thickness range 0-20 mil [0-0,508 mm].


Note – The narrower the range is, formed by the setting up samples, the more accurate is the measurement.

Before beginning the calibration at the positions of Cond 1 (the lower conductivity value) and Cond 2 (higher conductivity value) there must be set the values of the conductivity of the samples, which will be calibrated, using the 

, 

buttons.

To set up the coatings thickness measurement there must be used the 20 mil [0.5 mm] film thickness. Gap value is 20 mil [0.5 mm] to be set.

For beginning the calibration - to press the 

button and to follow the instructions displayed on the screen of the flaw detector.

Hold the eddy current probe in the air at a considerable distance from metal objects and press 

.

Set the eddy current probe on the sample with Cond 1 conductivity and press 

.

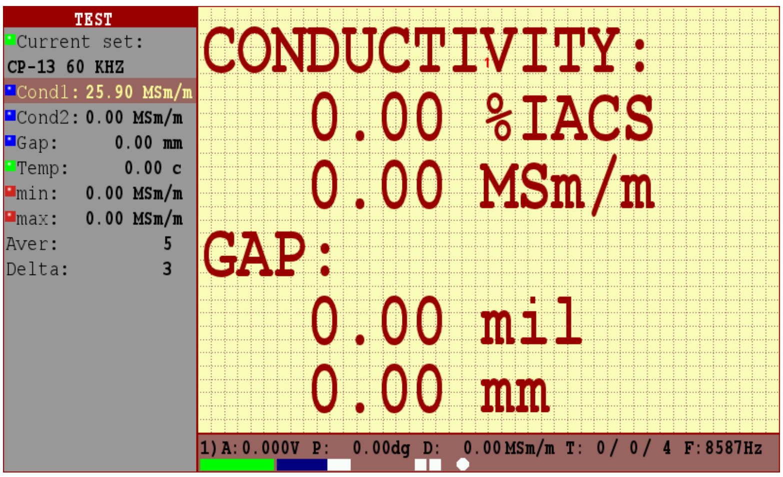


Figure 20 – Entering the conductivity value for the sample Cond 1

Set the eddy current probe on the sample with Cond 2 conductivity and press .

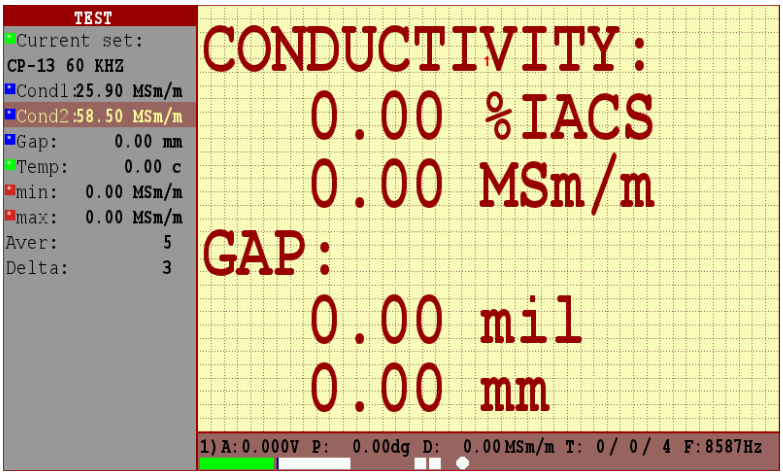


Figure 21 – Entering the conductivity value for the sample Cond 2

To put on the sample with Cond 1 conductivity the gap element (20 mil [0,5 mm]), set the eddy current probe on the sample and press .

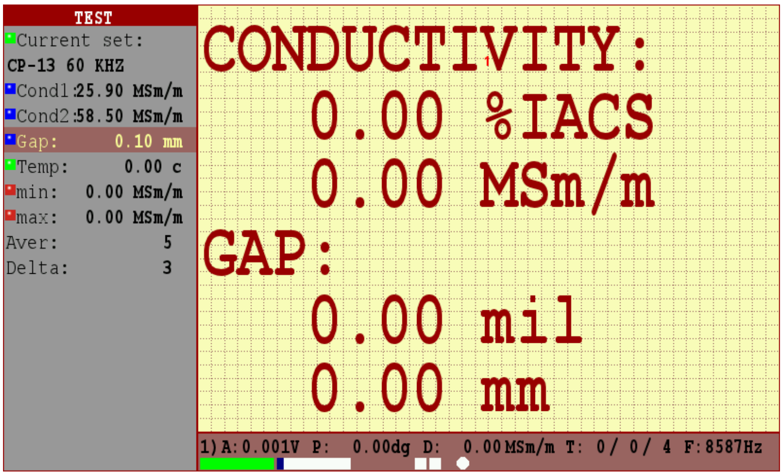


Figure 22 – Entering the gap value for setting on the Cond 1 sample

<u>Measuring Conductivity and Coating Thickness with the Eddycon C</u>

Guidelines for successful operation:

– For accurate measurement of conductivity the surface coating thickness should be 0.5 mm (0.020 inches).
– The surface to be measured should be flat, or of the same curvature as the calibration standards. Where curved surfaces must be measured, additional error may be introduced.

– Measurement close to edges and on thin materials may give erroneous results.
– Check on a known consistent material to establish the influence of these effects.
– The coating thickness measurement function does not require further calibration, it should be accurate to better than 10 % of the displayed value on base materials having a conductivity between approximately 1 % and 100 % IACS.

3.8 "GENERAL SETTINGS" menu

When selecting "General settings" menu, the flaw detector displays the window with margins for the flaw detector settings correction.

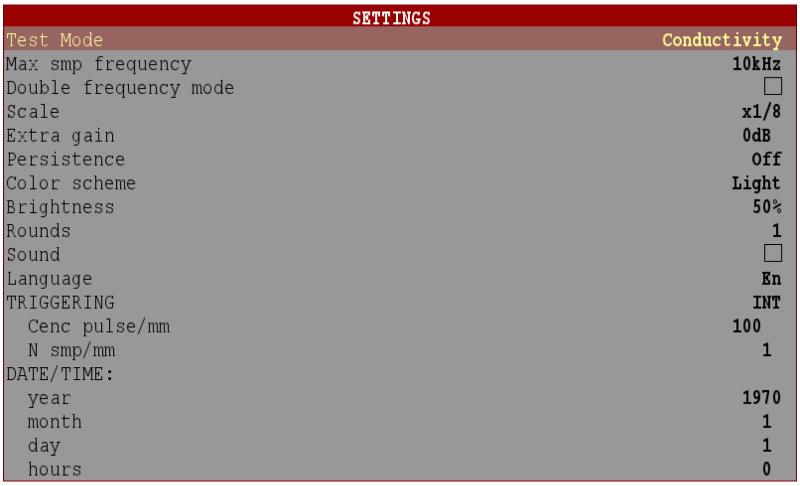


Figure 23 - "GENERAL SETTINGS" menu

Operator sets the following values in the corresponding menu lines:

– "Test mode" – test mode. Can be "Conductivity", "Expert" and "Simple". "Conductivity" mode is intended for conductivity and thickness measuring. In "Simple" mode a part of operating settings is not displayed.

– "Max smp frequency" – measurement frequency for the "TEST" mode. Samplings frequency in Hz (sampling frequency of ECP per 1 second) from 1 kHz to 10 kHz. If the value of the selected frequency from a fixed number of measurements set at a given operating frequency of ECP is not supported, then the instrument will automatically determine the maximum possible frequency of measurement.

– "Double frequency mode" – activated when there is a possibility to remove the interfering factor by means of frequencies mixing.

– "Persistence" – time value, on the expiry of which all data on the flaw detector screen is deleted (at the switched on "Persistence"), from (0,1 s 0,5 s, 1 s, 2 s, 3 s, 4 s);

– "Color scheme" – 1. "Light" - for operation with faint outer lighting; 2. "Dark" - for operation with intense outer lighting; 3) "Standard" – standard scheme.

– "Brightness" – display brightness in % - from 10 to 100 with a step of 10%;

– "Rounds"– the number of full turns of rotating ECP displayed in time chats.

– "Sound" – sound alarm if the ALARM triggers.

– "Language" - language selection.

– "TRIGGERING":

1) Internal – synchronization from inner generator;
2) Enc – synchronization from encoder;

Cenc (pulses/mm)[4] – number of pulses per 1 mm generated by encoder – from 10 to 10000 pulses/mm with a step of 1; 10; 100; 1000 pulses/mm;

– N meas/mm – number of measurements per 1 mm.

– "Input" – active connector for ECP:

1) Single (for single coil ECP),
2) Refl (for other ECP);

– "Date" – selection of current date (year, month, date);

– "Time" – selection of current time (hours, minutes, seconds)

3.9 VIEW

When entering "VIEW" menu, an operator is offered to view and analyze current testing results as well as the saved results.

In order to view the current testing results, it is necessary to press 

key.

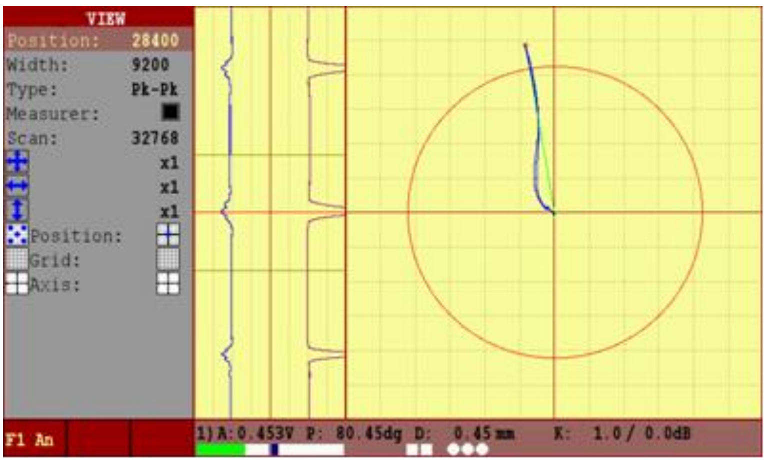


Figure 24 – "VIEW" menu

[4] C_{enc}value (pulses/mm) is indicated in the registration certificate for the scanning device where an encoder (Enc) is used.

Note. To view previously saved testing results, it is necessary to press MEM key, choose the "RESULTS" submenu and press SAVE DFLT key. Then, move the cursor to the certain result and press NULL F1 key – "F1 Load". Then, an automatic enter in "VIEW" is carried out.

Position "Position" – moves the measurement cursor in the time chart.

Position "Width" – sets the width of the measuring cursor.

Position "Type" – the type of cursor measurement. Four types of measurement are available.

◦ Pk-Pk – the measurements are made between two points situated at the max. distance from each other in cursor width.

◦ Cnt-Pk - the measurements are made between the cursor center and the point situated at the max. distance from the center in cursor width.

◦ Cnt-K - the measurements are made between the center and the cross point of cursor center signal.

◦ Vrt-M – vertical maximum - the measurements are made between two points situated at the max. distance from each other in the cursor width in vertical projection.

Position "Measurer" – is intended for meter signal parameters displaying in complex plane.

Position "Scan" – is for changing the number of points in a strip chart. When moving the cursor in the strip chart, the complex plane display is updated with the signal, which is located within the cursor width. The values of amplitude in volts, phase in degrees and defect depth in millimeters or percent are displayed in the information line.

Note. The flaw detector has a feature, which allows the quick signal/noise ratio measurement. In order to measure the ratio, first place the measuring cursor on defect free-area in the strip chart and press NULL F1 – defect free area "F1 An" key, then move the center of measuring cursor to the signal peak from a defect. The result appears in the right bottom corner of the flaw detector electronic unit at the "K= ..." position, the measured signal/noise ratio will be displayed.

In the view menu it is possible to estimate the saved or just taken data; carry out the assessment of detected defects depth. By changing the position of measuring cursor, change the cursor width in such way that the signal from defect stays within the cursor width. In this case, the amplitude "A: ", phase "P: " and estimated defect size in millimeters or percent "D: " will be displayed in the flaw detector bottom information bar; the path data in mm will be displayed in the top panel during the testing with ENC (see Figure 19). By moving the cursor to the next signal from defect, the data corresponding to the marked defect will be displayed on the screen.

The depth of the defect will be displayed only if the correct calibration curve is created!

3.10 "ARCHIVE" menu

In order to load/save testing results or device settings, it is necessary to press 

- key, choose submenu "RESULTS" or "SETTINGS" and press 

key. The flaw detector is capable of storing of more than 1000 settings and up to 1000 testing results (depending on the defectogram size) in the memory.

Figure 25 – "RESULTS" menu

3.11 "RESULTS" menu

The given menu allows storing and loading of the testing results.

In selecting "Results" menu the flaw detector displays the window with a list of results (Figure 21). The list of results contains catalogs (folders) and files. The catalogs are displayed in the top part of the list (and are marked with the folders icon), the files – in the bottom part and are numbered. The catalogs, in their turn, can comprise subdirectories and files.

A new catalog is created by placing the cursor on the line with colon or on the existing catalog and pressing 

key ("F2 Create"). The existing catalog is deleted by pressing 

key ("F3 Delete").

Having placed the cursor on an empty string or on the existing file, function keys change their function for the operation with files of results or settings.

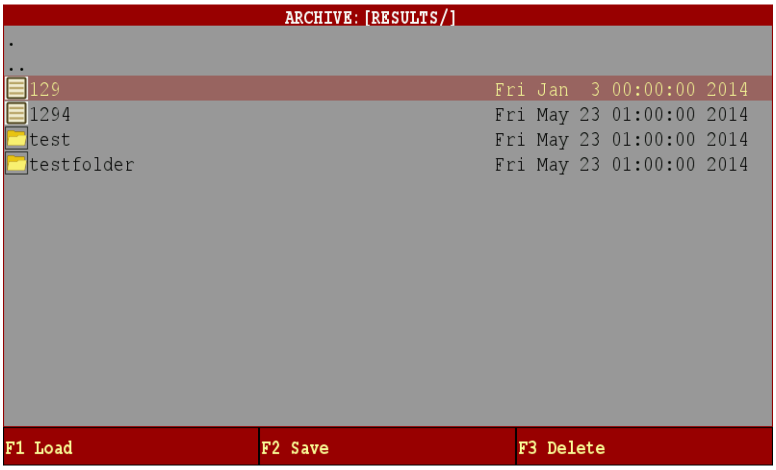


Figure 26 – "RESULTS" menu. List of catalogues and files

 **Note.** To prevent an accidental deleting of catalogues with useful information, the flaw detector has a protection, which allows only empty catalogues deleting. In order to delete the catalogues, firstly you need delete its contents.

With the help of function keys , ,  – "F1 Load", "F2 Save", "F3 Delete" (see Figure 27) – an operator can load the selected result (settings and data are automatically loaded), save the current result and delete the selected result.

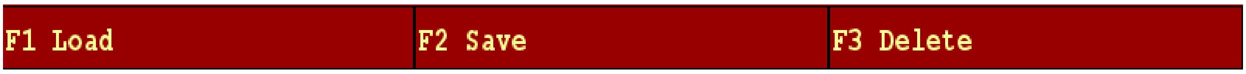


Figure 27 - Operations with the testing results

When loading the saved testing results, the setups which were used while the testing are set in the instrument and the automatic transition (move) to "VIEW" menu is carried out.

When saving the results (and anywhere where it is necessary to enter the text information), ", , " function keys delete the previous character – "backspc", move left – “move” and cancel the information input – "cancel".

3.12 "SETTINGS" menu

When selecting "Settings" menu the flaw detector displays the window with a list of settings (see Figure 28). The given menu allows the testing results saving and loading.

After the setups file loading, automatic enter in "Testing" menu is carried out.

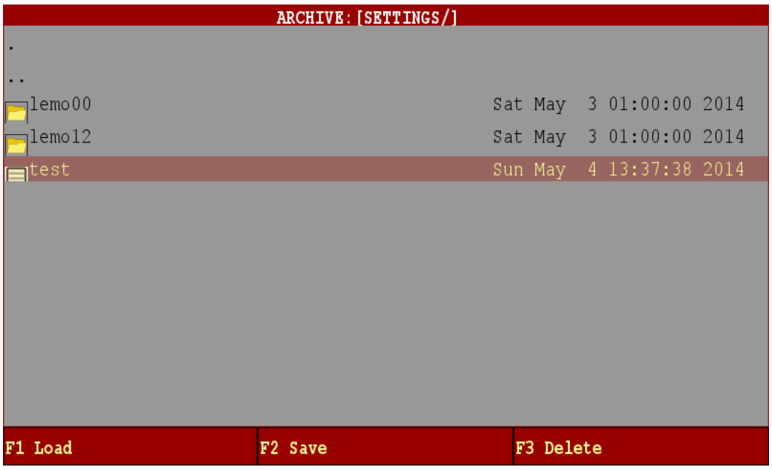


Figure 28 – "SETTINGS" menu

3.13 Set up of "CALIBRATION" menu

The calibration curve plotting will be illustrated using the calibration block 2353.08. To plot the calibration curve, it is essential to set up all parameters of the flaw detector for operation with a specific probe (i.e. select the ECP operating frequency from the range indicated in the registration certificate, the required ECP exciting voltage, gain, scale) and take the calibration block 2353.08 (Ra 1.25).

In the "TEST" menu place the ECP on the flaw-free section before an artificial flaw with the depth of 0.1 mm[5] and press 

key (balancing). Pass all defects, having chosen such scanning speed to have all signals from defects of regular shape (i.e. max symmetric relative to the peak signal on time charts, see Figure 29).

The signals from the defect are not bound to stay only within the limits of one screen scan.

[5] When operating with MDF probes, the mark on ECP case must coincide with the direction of scanning trajectory.

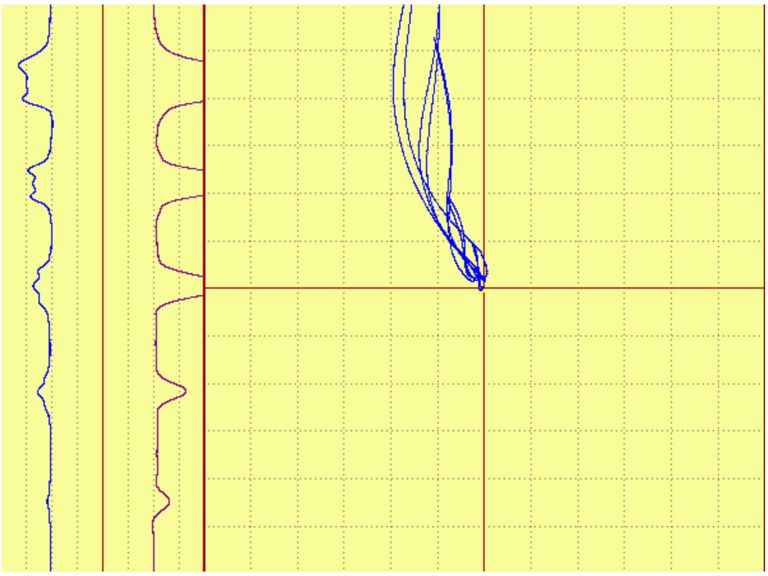
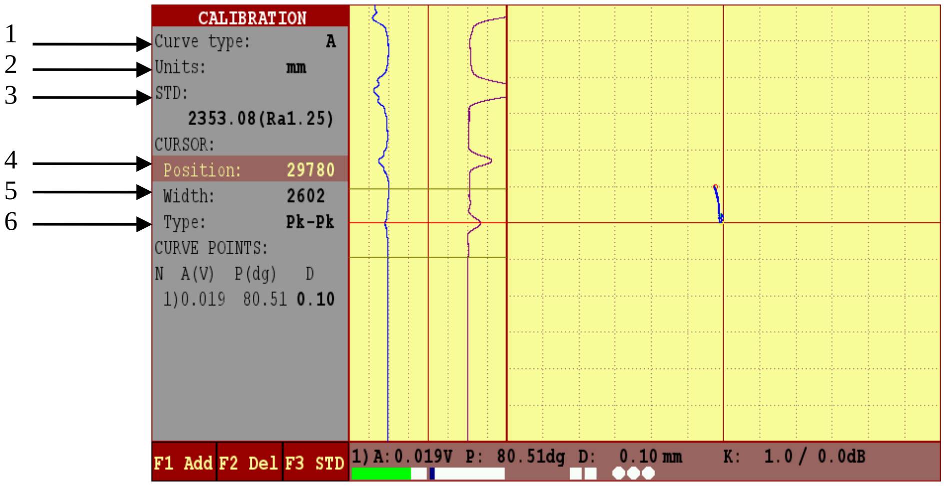


Figure 29 – Appearance of defectogram for the calibration curve plotting

After the acquisition of defectogram, press 

key, for the quick transition to "CALIBRATION" menu.



1 - Set a curve for evaluation of the defect depth (Amplitude, Phase);
2 - Select the units of defect measurement (mm, %);
3 - Calibration block selection;
4 - Position of the measuring cursor on the time chart;
5 - Width of the measuring cursor on the time chart;
6 - The type of the measuring cursor, see item 3.7

Figure 30 – "CALIBRATION" menu

Note. After plotting the calibration curve, there is no point in changing the units of defects measurements.

Before plotting the calibration curve it is necessary by the , keys, to move to the "CURVE POINTS:" item position "1)" and by the F2 key, delete all points of previous calibration curve (see Figure 30).

Select the type of measurement in the cursor "Type" – Pk-Pk. Move to the "Position:" menu item and by the , and keys, position the central line of the cursor on the peak of signal from the min. defect. Move to the “Width:” menu item and increase the cursor width to such an extent that only one friendly signal could get there, i.e. the signal from the defect (see Figure 3). Having placed the cursor on a defect, press the key, – "F1 ADD" (add the calibration curve point).

With the help of , keys, move to the "CURVE POINTS" – 1) and by , and keys, set the depth of the first defect of the calibration curve, i.e.0.1 mm (see Figure 31). Then it is essential to perform similar operations for all other defects by setting corresponding depth.

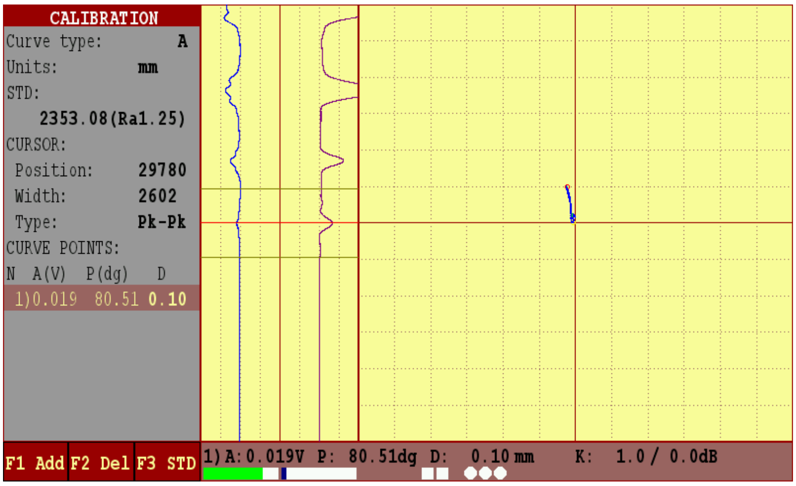


Figure 31 – Plotting of the calibration curve

Each newly added point of the calibration curve is assigned with a number (1), 2), 3) and so on). The max number of the calibration curve points – 16.

Note. If calibration is carried out on any of the listed calibration blocks in pos. 3, Figure 30, then an operator can easily select an appropriate type of the calibration block before adding of the calibration curve points. Then add in order, starting with a minimum, all signals from defects of a given STD, see an item 3 and press key, -"F3 STD" and the flaw detector will automatically assign the wanted depth to the defects.

3.14 Communication with PC

The flaw detector in a set with "Eddycon C" software ensures communication mode with a PC for the information input to the PC from the flaw detector memory (testing results, operating setups) and the possibility to print out this information and to form a report.

3.14.1 Running the program

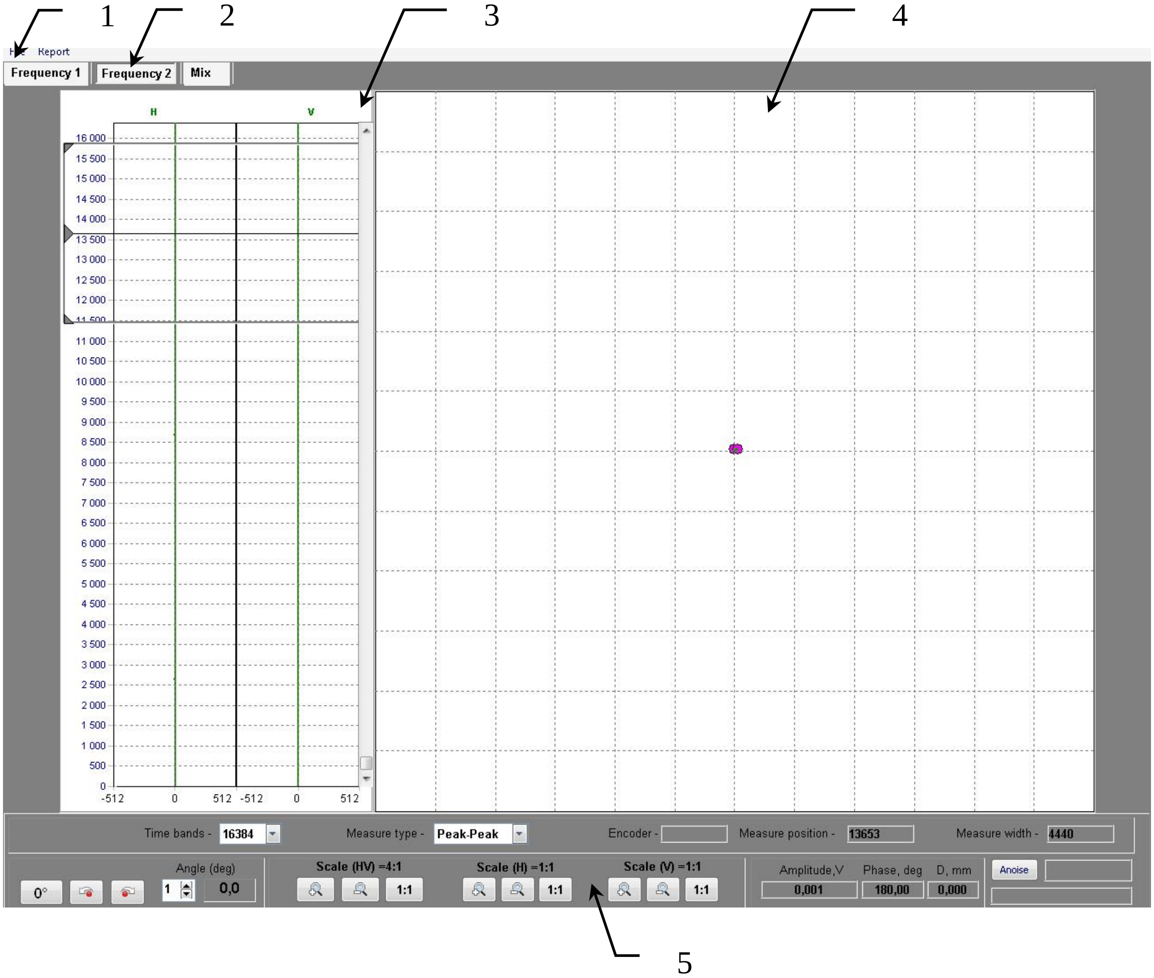
To run the program it is required:

- to copy the files to the PC hard disk drive from the disk, that is included to the flaw detector delivery set;

- run the file "Eddycon _C.exe"  .

3.14.2 Program description

The operating window of "Eddycon C" program includes the following areas (Figure 32):



1 - main menu; 2 - tab panel; 3 - time diagrams area; 4 – signal display area (active area); 5 – bottom status bar

Figure 32 – Active window of Eddycon C program

3.14.2.1 Main menu

Main menu bar includes the following menu items:

- File;
- Report.

"**File**" menu item includes the subitems:

Figure 33

When selecting "Open" subitem, there appears a window for selection the path to the saved testing results (by default the "RESULTS" folder is proposed, saved on the hard disk drive of PC in the program directory of «Eddycon C»).

This file can be located in the flaw detector memory or also be stored on hard disk drive of PC (if previously copied to the hard disk drive (3.14.3.2)). Double-click of the mouse left button opens the file.

"Loading" subitem allows to view the files of all testing results saved in the flaw detector memory and to copy them to the hard disk drive of PC (3.14.3.2).

When selecting "Device settings" subitem, there appears a window with the flaw detector settings of the carried out testing (Figure 34).

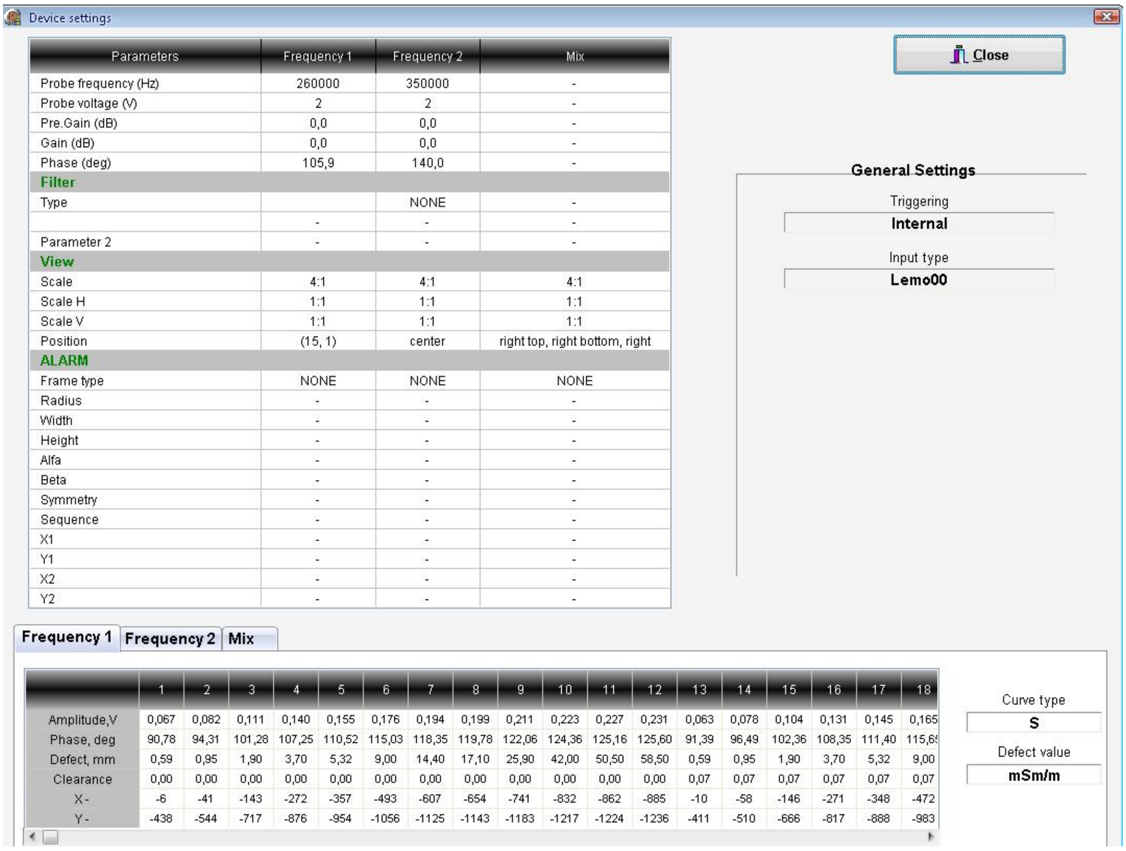


Figure 34 –**"Flaw detector settings" window**

When selecting **"Language"** subitem, there appears a window for selecting the language of program interface.

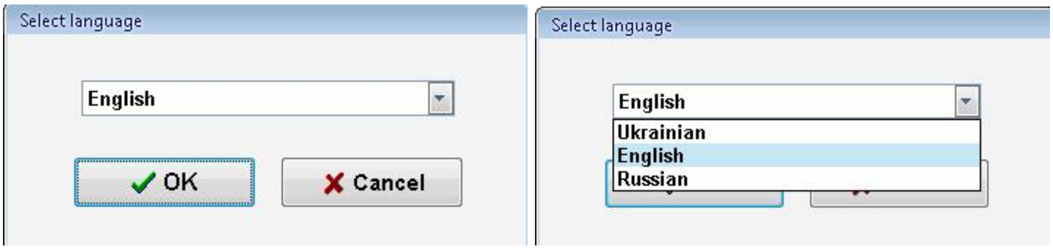


Figure 35 – **"Selecting the interface language" window**

 ***Note*** – *Reload the program to change the interface language.*

Select **"Exit"** subitem to finish the "Eddycon C" program.

When selecting **"Report"** item of the main menu, there appears a window for filling in the report form of the testing carried out (Figure 36).

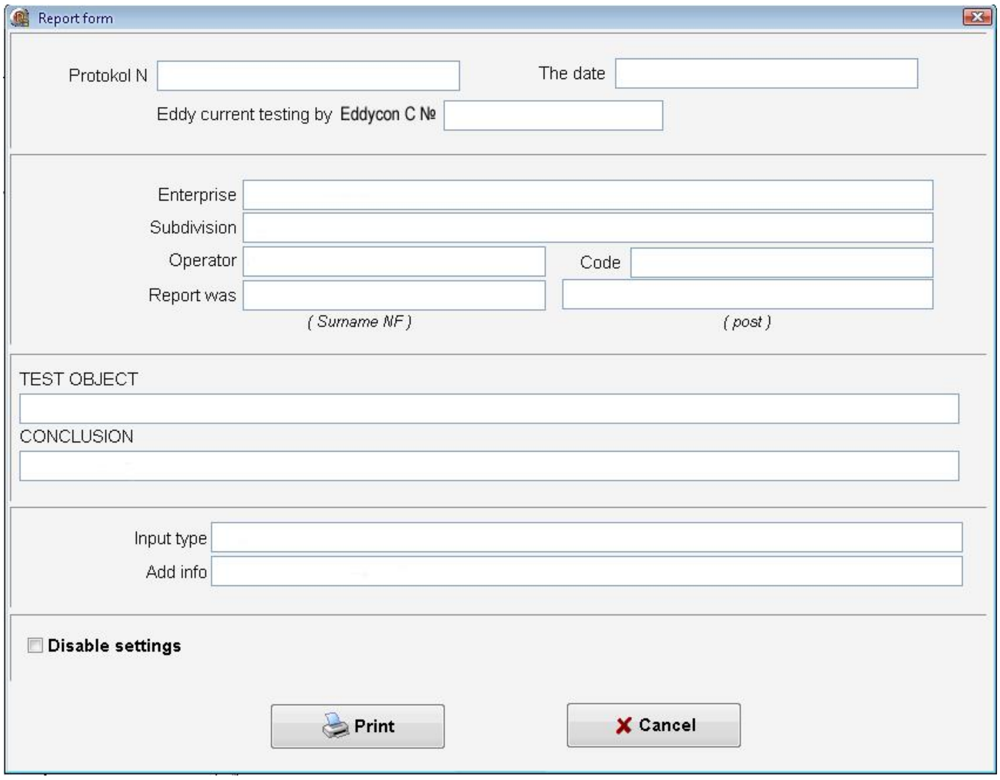
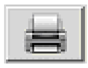


Figure 36 – Report form of a testing carried out

After pressing 

button, there appears a window to preview the testing protocol. There is an option to select between: weather to print out the setting parameters of the flaw detector or not.

To abstain from printing out the flaw detector settings, put a tick in front of **"Disable setting".**

To print-out the testing protocol, press **"Print"**  button in the upper part of a testing protocol window.

To save the testing protocol in a «*.pdf» format, press  button.

To exit the review mode of a testing protocol it is required to press 

button.

3.14.2.2 Tab panel

Tab panel includes three tabs. Each tab corresponds to the selected frequency or to the mix of frequencies (MIX): Frequency 1, Frequency 2, MIX.

 ***Note*** *- Frequency 2 and MIX are available for viewing only if the testing is carried out in a two-frequency mode.*

3.14.2.3 Time diagram area

Two diagrams of signal to time dependence are displayed in time diagram area (item 3, Figure 32).

3.14.2.4 Signal display area (active area)

In the display area of eddy current signals is displayed the eddy current signal, which is represented by an image in the complex plane for the frequency selected (item 4, Figure 32). In the active area are displayed the signals that come into the area covered by the measuring cursor.

3.14.2.5 Bottom status bar

Figure 37

"Duration of time sweeps" - sets the number of measurements to be displayed on time sweeps. Duration of time sweep is measured in a range from 256 to 32768.

"Type of measurement" – allows to select the required type of cursor measurement from the following list:

- ***Peak-Peak*** (the measurement is made between two points situated at the max. distance from each other in cursor width);
- ***Vrt-M*** (vertical maximum - the measurement is made between two points situated at the max. distance from each other in cursor width in vertical projection);
- ***Cnt-Pk*** (center peak - the measurements is made between the cursor center and the point situated at the max. distance from the center in cursor width);
- ***Cnt-K*** (center cursor - the measurements is made between the center and the cross point of cursor center signal);

ENC *(encoder)* – displays the reference number by encoder when synchronizing from ENC.

Cursor position – displays the current vertical position of a measuring cursor in readings.

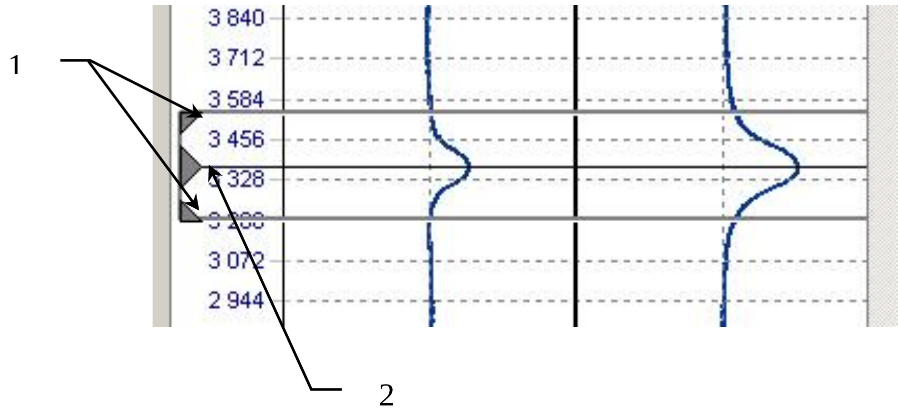


Figure 38

To change the cursor position it is required to place the "mouse" cursor onto the center of a measuring cursor (item 2, Figure 38), and when there is a ✥ cursor, move the measuring cursor to the required position by holding the left mouse button down.

- ***Cursor width*** – displays a set width of a measuring cursor (in readings).

To change the width of a measuring cursor, place the "mouse" cursor to the extreme position of the measuring cursor (item 1, Figure 38), and, when there is a ↕ cursor, set the required width of a measuring cursor by holding the left mouse button down.

"Signal angle" – allows to change the signal phase:

- selects the step for signal phase change (from 0 to 90°);

- changing the signal phase with counterclockwise rotation considering the selected step;

- changing the signal phase with clockwise rotation considering the selected step;

0° - restoring the initial signal phase.

Scale (HV) - simultaneous horizontal and vertical scaling of a signal image:

- scaling-up the signal image;

- scaling down the signal image;

1:1 - restoring the initial *horizontal to vertical ratio*.

Scale (H) – allows to adjust the horizontal scaling of a signal image:

- scaling-up the signal image horizontally;

- scaling down the signal image horizontally;

1:1 - restoring the initial scale horizontally.

Scale (V) - allows to adjust a vertical scaling of a signal image:

 - scaling-up the signal image vertically;
 - scaling down the signal image vertically;


- restoring the initial scale vertically.

Signal parameters located in a measuring cursor are displayed in information area of a bottom status bar:

- Amplitude (V);
- Phase (deg.);
- D (mm) - conditional defect depth;
- An (dB) - noise amplitude;
- S/N – measured value of signal to noise ratio.

 ***Note*** *– In order to measure the **S/N** ratio, place the measuring cursor on defect free-area and press "An" key, then move the measuring cursor to the signal peak from the defect. The measured signal/noise ratio will be displayed in the amplitude area.*

3.14.3 Working with the program

3.14.3.1 Connecting the flaw detector to PC

Connect the flaw detector to PC using the USB connecting cable that is included to the flaw detector delivery set.

Switch on the flaw detector by pressing the power On/Off  button and hold it pressed until a short beep sound is emitted.

Wait until the flaw detector is recognized on PC as a removable media (when the flaw detector is recognized as a removable media, it is displayed on PC screen).

3.14.3.2 Saving the testing results from the flaw detector memory to PC

To save the testing results from the flaw detector memory to PC, connect the flaw detector to PC using a USB cable (item 3.14.3.1). In the menu of «Eddycon C» program select the item **"Loading"**, and after, in the program window there are displayed the files of all the testing results stored in the flaw detector memory. Then, the program window asks to select the files that can be automatically copied to the selected location on the hard disk drive of PC.

3.14.3.3 Viewing results of testing

Download «Eddycon C» program to PC.

In "**File**" item of the main menu choose the sub-item "**Open**".

In the window that appears, choose the path to removable media – the flaw detector memory or the path where previously there was stored data on PC, move the cursor to the necessary file with the testing results and click "**Open**".

After opening the file in the time diagrams window and in the active area of the program there is displayed the stored defectogram and there is the possibility to view the testing results, measurements of the signal parameters, as well as to make the report protocol followed by its printing out.

Note *- Viewing a list of data on the testing results from the flaw detector memory does not store this data automatically in PC memory.*

3.14.3.4 Printing out results of testing

To print out the testing results it is required:

- Select "**Report**" item in the main menu.
- Fill in the report form (Figure 36).
- In the preview window of testing results click "**Print**" .

3.14.3.5 Disconnecting the flaw detector with PC

- Turn off the flaw detector by pressing the on/off button .
- Disconnect the USB cable.

4 LABELING AND SEALING

4.1 The flaw detector labeling complies with the manufacturer's set of documents and includes:

– manufacturer's name and trade mark;
– name and designation of the flaw detector;
– year and quarter of manufacture;
– serial number;
– designation of specifications (TU);
– pattern approval mark.

Labeling is performed in English.

4.2 Labeling is made on the flaw detector casing by polygraphic technique.

4.3 Pattern approval mark is made on the flaw detector electronic unit by at least two seals made on screws of casing cover.

5 COMPOSITION AND DELIVERY SET

5.1 The flaw detector comprises Basic delivery set consisting of the following components:

Table 8

Name and reference designation	Quantity
Electronic unit of Eddycon C eddy current flaw detector (Lemo 16)	1 pc.
Connecting cable Lemo16 – Lemo04 (electronic unit / ECP, Bridge) 1800 mm	3 pcs.
Eddy current probe WLD100K3×.35DA0	1 pc.
Eddy current probe WLD100K3×.43DA0	1 pc.
Eddy current probe WLD100K5A.5×2-.35DA0	1 pc.
Eddy current probe WLD100K5A.5×2-.43DA0	1 pc.
Eddy current probe WLD100K5A.5×2-.35DAT0	1 pc.
Eddy current probe WLD100K5A.5×2-.43DAT0	1 pc.
Charger Mascot Type 2542	1 pc.
Reference standart RS 2353/1-3N-Fe (with gaps 4×0.5 mm)	2 pcs.
Bag	1 pc.
Case	1 pc.
Tansport case	1 pc.
Operating manual for Eddycon C	1 copy
Quick start guide	1 copy
Operation manual for Mascot Type 2542	1 copy
Registration certificate for ECP	6 copy
Registration certificate for RS 2353/1-3N-Fe	2 copy
Calibration certificate for Eddycon C	1 copy

6 SAFETY MEASURES

6.1 In operation with the flaw detector, it is necessary to observe the safety measures while charging the storage battery unit of the flaw detector by means of automatic charger.

6.2 In operation with the flaw detector an operator should be governed by the safety standards in effect at the enterprise.

7 SETTING-UP PROCEDURES

7.1 The flaw detector is operated by one operator who has a corresponding level of qualification and has studied the present operation manual.

7.2 Before operating charge the battery of flaw detector (if required) governed by the passport of automatic charging device.

ATTENTION! WHEN CHARGING THE BATTERY, FLAW DETECTOR ELECTRONIC UNIT MUST BE SWITCHED OFF.

8 INSTRUCTIONS FOR USE

8.1 SINGLE COIL PROBE

8.1.1 Connect the ECP to the flaw detector using a connecting cable.

8.1.2 Select parameter "PROBE"– "Single" type (in the "TEST" menu).

8.1.3 Set the ECP frequency in a range specified in the registration certificate for the ECP.

8.1.4 Set the ECP drive not more than 2 V.

8.1.5 Press AUTO ADJUST key to select the capacitor.

8.1.6 Place the ECP to the flaw-free area of a calibration block.

8.1.7 Press NULL F1 key to balance the ECP.

8.1.8 Put a signal from a lift-off in the horizontal plane. For this, it is necessary to decline the ECP from the vertical axis at an angle of 15-45 °. While the vector end is deviated, press AUTO LIFT key. In case, if the first attempt to put the signal from the lift-off horizontally failed it is necessary to repeat the steps described above, or put the lift-off signal manually using the phase change (parameter). The signal from a defect should be appeared in the first or second quadrant of the complex plane.

8.1.9 Increasing the gain on preamplifier ▶ and amplifier ▶ you should maximize the signal amplitude, but at the same time monitor behind parameters of the input circuit.

8.1.10 After changing any parameter that affects the absolute value of the signal it is necessary to perform balancing by pressing NULL F1 key.

8.1.11 While testing aluminum alloys it is recommended to use the vertical gain "▶ V GAIN" for the visual spread of signals from the distortion and signals from a defect in a phase.

8.1.12 Select the required type of a threshold level.

8.1.13 Move the probe across the artificial defect at calibration block for several times and visually set up the ALARM relative to the signal from the defect. After the ALARM was properly set up, the light alarm while detecting the defect will be triggered on the flaw detector keypad (digital indicators on the display) and sound alarm (if it has not been turned off in "SETTINGS" menu).

8.2 REFLECTION, DIFFERENTIAL PROBE

8.2.1 Connect the ECP to the flaw detector using a connecting cable.

8.2.2 Select parameter "PROBE"– "Reflection" or "Bridge" type (in the "TEST" menu).

8.2.3 Set the ECP frequency in a range specified in the registration certificate for the ECP.

8.2.4 Set the ECP drive not more then recommended in a registration certificate for the ECP.

8.2.5 Place the ECP to the flaw-free area of a calibration block.

8.2.6 Press NULL F1 key to balance the ECP.

8.2.7 It is recommended, the signal from the defect to be placed in the first or second quadrant of the complex plane. To correct the ECP phase use parameter.

8.2.8 Increasing the gain on preamplifier ▶ and amplifier ▶ you should maximize the signal amplitude, but at the same monitor behind parameters of the input circuit.

8.2.9 After changing any parameter that affects the absolute value of a signal it is necessary to perform balancing by pressing NULL F1 key.

8.2.10 Select the required type of a threshold level.

8.2.11 Move the probe across the artificial defect at calibration block for several times and visually setting up the ALARM relative to the signal from the defect. After the ALARM was properly set up, the light alarm while detecting the defect will be triggered on the flaw detector keypad (digital indicators on the display) and sound alarm (if it has not been turned off in "SETTINGS" menu).

8.3 ROTATION PROBE

8.3.1 Connect the rotary scanner to the flaw detector using the connection cable.

8.3.2 Connect the ECP to the rotary scanner. Approximate marks on the case of the probe and scanner should coincide.

8.3.3 Without applying excessive force insert the ECP in the scanner. In case, when carrying out the connection you felt that the mating connectors have rested at each other, but the marks on the cases match, you must slightly decline the ECP from the vertical axis and insert the ECP until it stops. When the ECP is properly installed in the scanner, the rubber o-rings should not be seen.

8.3.4 Set the ECP frequency in a range specified in the registration certificate for the ECP.

8.3.5 Set the ECP drive not more than recommended in a registration certificate for the ECP.

8.3.6 At "ROT PRESENT" position, set up "On". In displayed menu choose the type of the rotary scanner and press SAVE DFLT 9 WXYZ key.

8.3.7 At "RPM" position, firstly set the min rounds – 600.

8.3.8 Press the switched on button on the case of the rotary scanner. The ECP should be in the air.

8.3.9 To set the scanner rounds properly, press AUTO ADJUST key and wait for the end of the procedure.

8.3.10 Press the switched on button of the rotary scanner.

8.3.11 Set the required rounds for the scanner.

8.3.12 Put the ECP into the hole of the calibration block.

8.3.13 Press the switched on button on the case of the rotary scanner.

8.3.14 Press NULL F1 key to balance the ECP.

8.3.15 It is recommended, the signal from the defect to be placed in the first or second quadrant of the complex plane. To correct the ECP phase use parameter.

8.3.16 Increasing the gain on preamplifier and amplifier maximize the signal amplitude, but at the same monitor behind parameters of the input circuit.

8.3.17 After changing any parameter that affects the absolute value of the signal it is necessary to perform balancing by pressing NULL F1 key.

8.3.18 Select the Bandpass filter and perform it`s setting. First of all, minimize the distortion signals from ECP in the hole by setting the "LB" parameter, and then proceed the "HB" setting. The filter is set by trial and error.

8.3.19 During the ECP rotation in a hole perform the ALARM setup. Visually set the ALARM relative to the signal from a defect. After the ALARM was properly set up, the light alarm will be triggered on the flaw detector keypad at detecting the defect (digital indicators on the display) and sound alarm (if it has not been turned off in "SETTINGS" menu).

9 MAINTENANCE

9.1 The flaw detector maintenance includes the maintenance inspection, operating repair and calibration.

9.2 Intervals between the maintenance inspections are set depending on the industrial conditions, but no less than once per month. Connecting cable fixation, condition of controls and indicators are checked during the maintenance inspection.

9.3 The maintenance inspection includes an external examination and is performed by attending personnel before starting the flaw detector electronic unit operation.

9.4 Replacement of the battery pack.

9.4.1 Unscrew two screws (item 1 Figure 39).

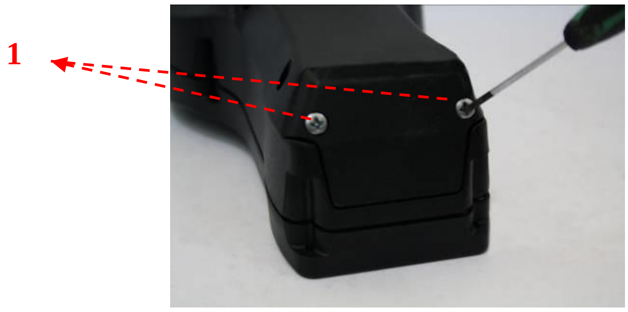


Figure 39

9.4.2 Open the contact terminal (item 1 Figure 40), pressing the clip (item 2 Figure 40).

Figure 40

9.4.3 Remove the battery pack (item 1 Figure 41).

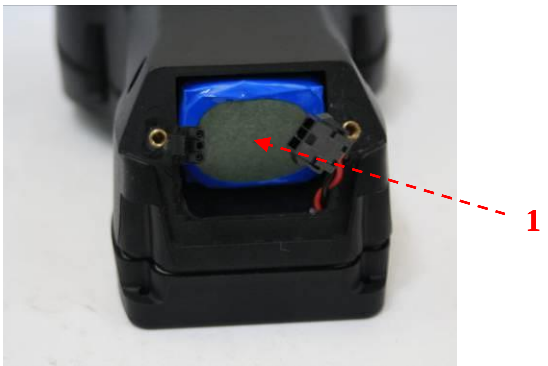


Figure 41

9.4.4 Battery pack mounting is carried out strictly in reverse order.

10 TYPICAL FAILURES AND TROUBLESHOOTING

10.1 The list of the most common and probable failures is given in Table 9.

Table 9 – Typical failures and troubleshooting

Failure	Probable cause	Remedy
When pressing "Power" key, the screen is not lightened	The storage battery is discharged	Charge the storage battery
When the instrument is switched On, the inscription "Storage battery needs charging" is displayed	The storage battery is discharged	Charge the storage battery

ATTENTION! THE FLAW DETECTOR MUST BE SWITCHED OFF WHEN NON-TYPICAL IMAGES APPEAR ON THE FLAW DETECTOR SCREEN AND SOFTWARE PROGRAMS BUZZ. IF REPEATED SWITCHING ON OF THE FLAW DETECTOR (NOT EARLIER THAN IN 3 MINUTES) DOES NOT LEAD TO THE RESETTING OF NORMAL OPERATION, THE FLAW DETECTOR SHOULD BE SENT TO THE MANUFACTURER FOR REPAIR OR IT IS NECESSARY TO ADDRESS THE SERVICE CENTER.

11 TRANSPORTATION AND STORAGE

11.1 Climatic conditions for the flaw detector transportation is at temperature range from minus 25 °C to plus 50 °C.

11.2 Transportation of the packed eddy current flaw detector may be shipped by any type of closed transport (except for the sea one) that protects the eddy current testing system from direct impact of precipitations, with a possibility of transshipping from one type of transport to the other. Air shipments are allowed only in the pressurized modules. Arrangement and fixation of boxes in transport vehicles should prevent them from displacement, shocks or impacts.

11.3 Storing the flaw detector in one room with acids, reagents, paints and other chemicals and materials, the vapors of which may have a harmful effect on the instrument is not permitted.

11.4 In storage, the flaw detector and ECP should not be affected by electromagnetic fields.

12 ACCEPTANCE CERTIFICATE

“Eddycon C” eddy current flaw detector with serial number №________ meets the requirements of specification EC.14327992.03.13 RE and is considered to be suitable for operation.

Person responsible for acceptance ______________ /_______________________/

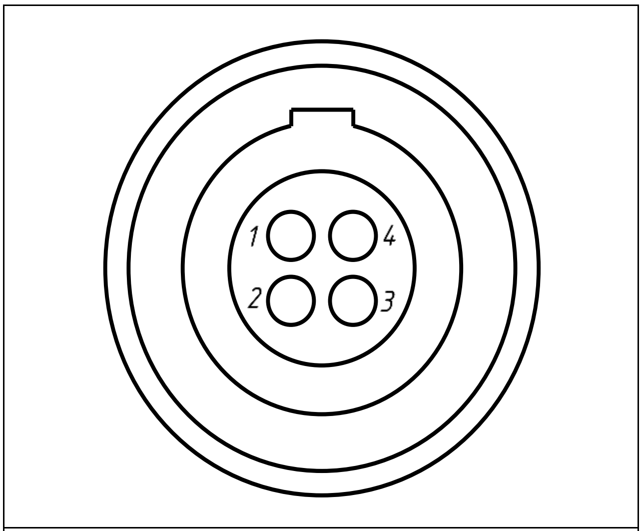
S.P. Date of manufacture _______________20___

APPENDIX A

REQUIREMENTS TO CHARGING DEVICE FOR PORTABLE EDDY CURRENT FLAW DETECTOR «EDDYCON C»

1 Special-purpose charging device for Li-Ion battery charging (3 elements) with rated voltage of 12 V and capacity of 4.5 A·hour.
2 Charge type – accelerated.
3 Charge rate – (2.3 ± 10 %) A.
4 After accelerated charging, the trickle charge mode is activated.
5 Electric supply of charging device: AC mains voltage from 100 to 240 V and frequency of (47 ÷ 63) Hz. Current consumption at full load up to 0.9 A.
6 Cable length of charging device – no more than 2.0 m.

Lemo EGG.1B.304.CLL



Front view

1	"–" Charging device
2	–
3	"+" Charging device –
4	Sync signal output

Figure A.1 – Soldering pattern of charging device output cable for the flaw detector connection

APPENDIX B

EDDY CURRENT PROBES FOR THE FLAW DETECTOR EDDYCON C

Table B.1

№	ECP type	Sizes of working surface, mm	Operating frequency, dimensions, кHz	Overall dimensions, mm	Detected flaws
1	**2**	**3**	**4**	**5**	**6**
1	SS1.5M05DA0	Ø5	500 - 2000	Ø 13 × 35	Surface defects in different conductive materials (e.g. aluminum alloys, ferromagnetic and austenitic steels.)
2	SS650K06DA0	Ø 6	500 - 1500	Ø 13 × 35	
3	SS400K07DA0	Ø 7	300 - 600	Ø 13 × 35	
4	SS300K08DA0	Ø 8	200 - 400	Ø 13 × 35	
5	SS340K09DA0*	Ø 9	250 - 400	Ø 13 × 35	Surface and subsurface cracks, pores, corrosive defects in aluminum alloys, ferromagnetic and austenitic steels and etc.
6	SS170K13DA0*	Ø 13	100 - 250	Ø 13 × 35	
7	SS50K15DA0	Ø 15	50 - 150	Ø 15 × 50	
8	SS10K33DA0	Ø 33	1 - 100	Ø 33 × 50	
9	SU450K3A6x8A0	Ø 6 × 8	900 × 1700	Ø 12.5 × 130	Surface cracks in rectangular grooves of products made of ferromagnetic and austenitic steels and etc.

Table B.1

1	2	3	4	5	6
10	SU450K05DA0	Ø 5	400 - 600	Ø 12.5 × 70	Surface cracks in aluminum alloys, ferromagnetic and austenitic steels and etc.
11	SU450K5A05DA0	Ø 5	400 - 600	Ø 12.5 ×135	
12	SU1.8M3.5DS01	Ø 3.5	1000 - 1900	Ø 9,6 × 55	Surface cracks in aluminum alloys, titanium alloys and etc.
13	SU1.8M3A3.5DS01	Ø 3.5	400 - 600	Ø 9.6 ×160	
14	SU450K05DA4	Ø 5	750 - 1100	Ø 15 × 170	Surface cracks, pores, corrosive damages in aluminum alloys, ferromagnetic and austenitic steels and etc.
15	SU300K08DA0	Ø 8	100 - 450	Ø 35 × 150	
16	SU350K6x0.5DA1	6 × 0.5	350 - 600	Ø 12 × 61	Testing for the presence of surface cracks in a metric thread with a step of 2 mm made on products of ferromagnetic material. Used with the SKV-MR-01 scanner.
17	SU350K6x0.5DA2	6 × 0.5	350 - 600	Ø 12 × 61	Testing for the presence of cracks in a metric thread with a step of 4 mm made on products of ferromagnetic material. Used with the SKV-MR-02 scanner.
18	SU350K6x0.5DA3	6 × 0.5	350 - 600	Ø 12 × 61	Testing for the presence of surface cracks in metric thread with a step of 6.35 mm made of ferromagnetic material. Used with the SKV-MR-03 scanner.

Table B.1

1	2	3	4	5	6
19	SU350K6x0.5DA4	6 × 0.5	350 - 600	Ø 12 × 61	Testing for the presence of surface cracks in a metric thread with a step of 1,5 mm made on products made of ferromagnetic material. Used with the SK-MR-04
20	SU350K6x0.5DA5	6 × 0.5	350 - 600	Ø 12 × 61	Testing for the presence of surface cracks in a metric thread with a step of 5,08 mm made on products of ferromagnetic material. Used with the SKV-MR-05 scanner.
21	RO1.7M5A9DFD0	Ø 9	1500 - 2500	Ø 9 × 55	Detection of surface defects in parts holes made of aluminum alloys, ferromagnetic and austenitic steels.
22	SU30K16DD0	Ø 16	30 - 200	Ø 50 × 55	Special-purpose probe for detection of surface cracks in fencing epees, made of austenitic steels.

* - probes in a protective case with the wearproof protector.

New types of probes can be developed according to the Customer`s requirement.

NDT Supply.com, Inc.
7952 Nieman Road
Lenexa, KS 66214-1560 USA

Phone: 913-685-0675, Fax: 913-685-1125
e-mail: sales@ndtsupply.com, www.ndtsupply.com