English

User Manual

PCE-USC 30

User manuals in various languages (Deutsch, français, italiano, español, português, nederlands, türk, polski, русский, 中文) can be downloaded here:

www.pce-instruments.com

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Contents

English

Thank you for purchasing a PCE-USC 30 from PCE Instruments.

1 Safety notes

Please read this manual carefully and completely before you use the device for the first time. The device may only be used by qualified personnel and repaired by PCE Instruments personnel. Damage or injuries caused by non-observance of the manual are excluded from our liability and not covered by our warranty.

- The device must only be used as described in this instruction manual. If used otherwise, this can cause dangerous situations for the user and damage to the meter.
- The instrument may only be used if the environmental conditions (temperature, relative humidity, …) are within the ranges stated in the technical specifications. Do not expose the device to extreme temperatures, direct sunlight, extreme humidity or moisture.
- Do not expose the device to shocks or strong vibrations.
- The case should only be opened by qualified PCE Instruments personnel.
- Never use the instrument when your hands are wet.
- You must not make any technical changes to the device.
- The appliance should only be cleaned with a damp cloth. Use only pH-neutral cleaner, no abrasives or solvents.
- The device must only be used with accessories from PCE Instruments or equivalent.
- Before each use, inspect the case for visible damage. If any damage is visible, do not use the device.
- Do not use the instrument in explosive atmospheres.
- The measurement range as stated in the specifications must not be exceeded under any circumstances.
- 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.
- In operation with the flaw detector an operator should be governed by the safety standards in effect at the enterprise.
- Non-observance of the safety notes can cause damage to the device and injuries to the user.

We do not assume liability for printing errors or any other mistakes in this manual.

We expressly point to our general guarantee terms which can be found in our general terms of business.

If you have any questions, please, contact PCE Instruments. The contact details can be found at the end of this manual.

Safety symbols

Safety-related instructions the non-observance of which can cause damage to the device or personal injury carry a safety symbol.

Symbol	Designation / description
	General warning sign. ATTENTION! Non-observance can cause damage to the device and injuries to the user.

2 Specifications

2.1 Technical specifications

- Range of operating frequencies adjustment – from 10 Hz to 16 MHz.
- Setup of the max. sampling frequency – 10 kHz.
- Setup of the range of adjustment of ECP excitation signal voltage (double amplitude) – from 0.5 to 6.0 V.
- Preamplifier adjustment – from minus 6 to plus 40 dB with a step of 0,1; 1; 10 dB.
- Gain adjustment – from 0 to 30 dB with a step of 0,1, 1 and 10 dB.
- Horizontal gain adjustment – from -30 to 30 dB with a step of 0.1, 1 and 10 dB.
- Vertical gain adjustment – from -30 to 30 dB with a step of 0.1, 1 and 10 dB.
- 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.
- There is automatic LED and sound flaw alarm (ALARM) in the flaw detector.
- 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).

- Time of continuous operation of the flaw detector from fully charged storage battery – no less than 8 hours.
- Average mean time between failures – no less than 40000 hours.
- Defined no-failure operating time – 4000 hours.
- 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.
- The flaw detector is powered from the in-built storage battery with rated voltage of 12 V.
- Weight of the flaw detector with a storage battery (without ECP set, cables and casing) – no more than 0.9 kg.
- Overall dimensions of the flaw detector – no more than 230 mm x 135 mm x 98 mm.

English

3 System description

3.1 Device

User manual of PCE-USC 30 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 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 measurement.
- 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.
- 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.
- 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.

  The evaluation of resistance of the flaw detector and ECP functioning quality to the impact of electromagnetic interferences of "B" criterion according to

3.2 Display and Side Panels

Rear panel of the flaw detector:

Fig. 1 – PCE-USC 30 Rear Panel

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

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

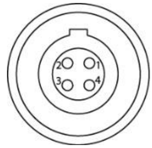
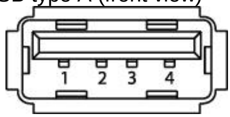
Contact	Description	Ethernet
1	Data of transmitter «+»	 ERA.0S.304.CLL (front view)
2	Data of transmitter «–»	
3	Data of receiver «+»	
4	Data of receiver «–»	

Table 2 – Description of connector for the instrument connection to external USB flash drive

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

Front Panel

Fig. 2 – PCE-USC 30 Front Panel

Left side panel of the flaw detector:

Fig. 3 – PCE-USC 30 Left Side Panel

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

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

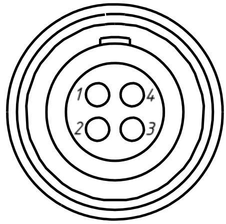
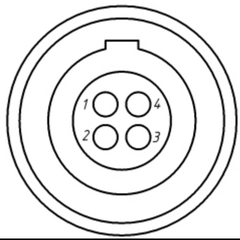
Cont.	Signal	EGG.0B.304.CLL (front view)
1	Input signal from the microphone	
2	Right audio output	
3	Common	
4	Left audio output	

Table 4 – Description of charger connector

Cont.	Signal	EGG.1B.304.CLL (front view)
1	Charging device -	
2	Not used	
3	Charging device +	
4	Sync signal output	

Right side panel of the flaw detector:

Fig. 4 – PCE-USC 30 Right Side

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

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

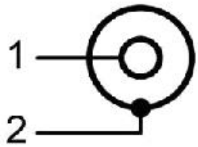
Cont.	Signal	Lemo ERA.00.250CLL
1	Parametric ECP	
2	Common for parametric ECP	

Table 6 – description of encoder (Enc) connector

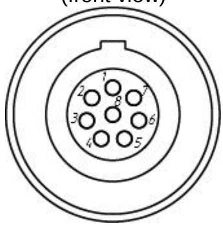
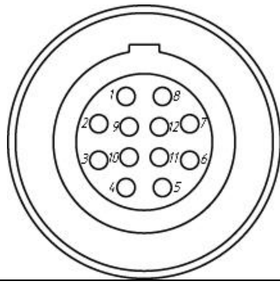
Cont.	Signal	Lemo EGG.1B.308CLL (front view)
1	Positive signal input "A"	
2	Power "+5V"	
3	Negative signal input "Z"	
4	Positive signal input "Z"	
5	Negative signal input "B"	
6	Positive signal input "B"	
7	Negative signal input "A"	
8	Common	

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

Pin	Signal	Lemo EGG.2B.312CLL (front view)
1	Gen Ret	
2	Gen Out	
3	+12V Battery	
4	Motor -	
5	Motor +	
6	Gnd	
7	Dif Input 1	
8	Dif Input 2	
9	Synchro Input	
10	Motor On	
11	Rotary On	
12	Alarm LED	

3.3 Function keys

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.

Function keys

Respectively:
"F1 Balancing", "F2 Full-screen mode", "F3 Centering"– in "TEST" menu;
"F1 Import data", "F2 Export data "– in “MEMORY” menu;
"F1 Load", "F2 Create/ Save","F3 Delete"– in "RESULTS"/"SETTINGS" submenu;
"F1 An" (An - amplitude noise) – in "VIEW" menu;
"F2 OK” save calibration curve – in "CALIBRATION" menu.

Key	Function
	- 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
	- changes the parameter variation step; - in the mode of name editing – selects a digit/letter
	- increases the selected parameter; - in the mode of name editing – selects a digit/letter
	- changes the frequency; - in the mode of name editing – selects a digit/letter
	- moves up through the menu; - in the mode of name editing – selects a digit/letter
	- decreases the selected parameter; - in the mode of name editing – selects a digit/letter
	- 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; - delete point in “CALIBRATION" menu; - freeze the display in the test menu
	- moves down through the menu; - in the mode of name editing – selects a digit/letter
	- 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); - add point in “CALIBRATION" menu
	- quick access to "TEST" menu
	- quick access to "SETTINGS" menu
	- quick access to "VIEW" menu

	- quick access to "MEMORY" menu; - confirms the saving of the entered name of the file or folder while operating in "MEMORY" 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

4 Design of the Flaw Detector

4.1 Instrument Appearance

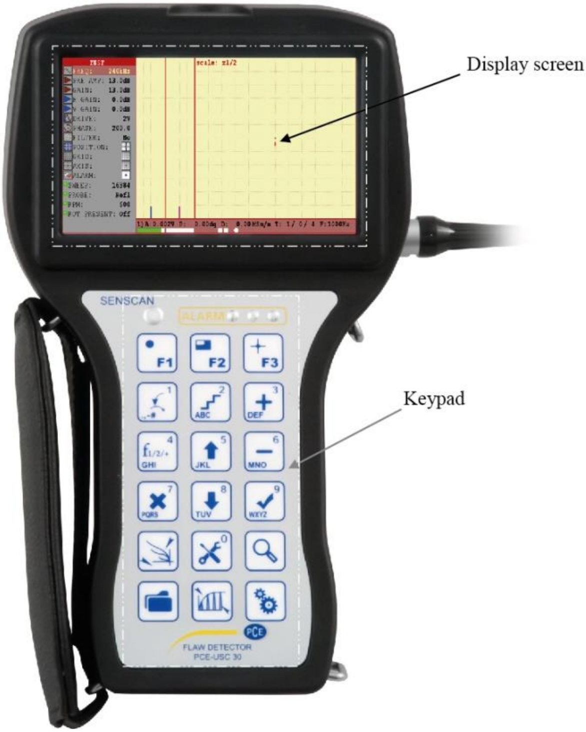


Fig. PCE-USC 30 eddy current flaw detector

4.2 Structural Scheme

Structural scheme of the flaw detector.

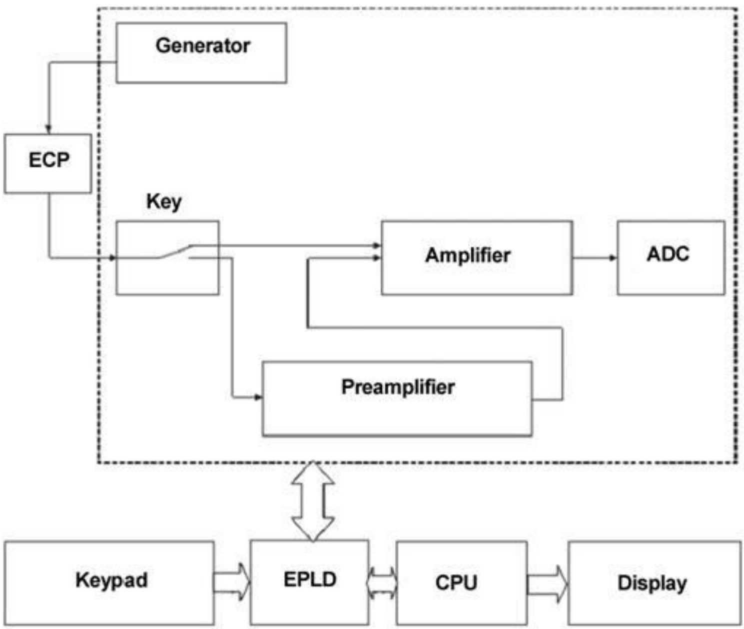


Fig. 6 – Structural Scheme of the Flaw Detector

Structurally, the flaw detector consists of:
a) casing and cover plate with the membrane keypad, indicators of ALARM and overloading, Ethernet 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.

4.3 Appearance of the Flaw Detector Screen

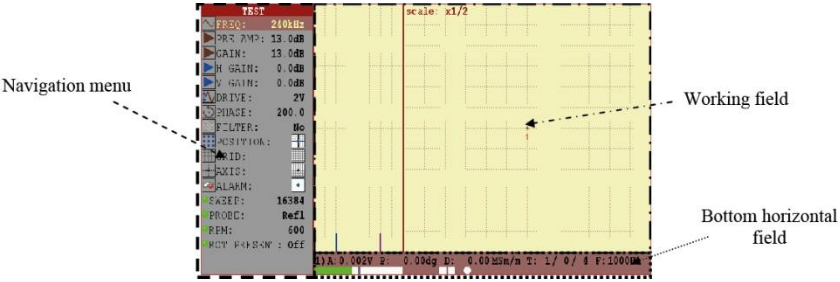


Fig. 7 – Display Appearance after switching on the Flaw Detector

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:

o FREQ – test frequency;

o PRE AMP – preamplifier gain;

o GAIN – main gain;

o H GAIN – horizontal gain;

o V GAIN – vertical gain;

o DRIVE – probe drive level;

o PHASE – phase adjustment;

o FILTER – filter type;

o POSITION – spot position;

o GRID – grid;

o AXIS – axis;

o  ALARM – short cut to ALARM Setting;

o SWEEP – number of points in a screen scan;

o PROBE – type of connector;

o RPM – rounds per minute for the eddy current rotary scanner;

o 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.

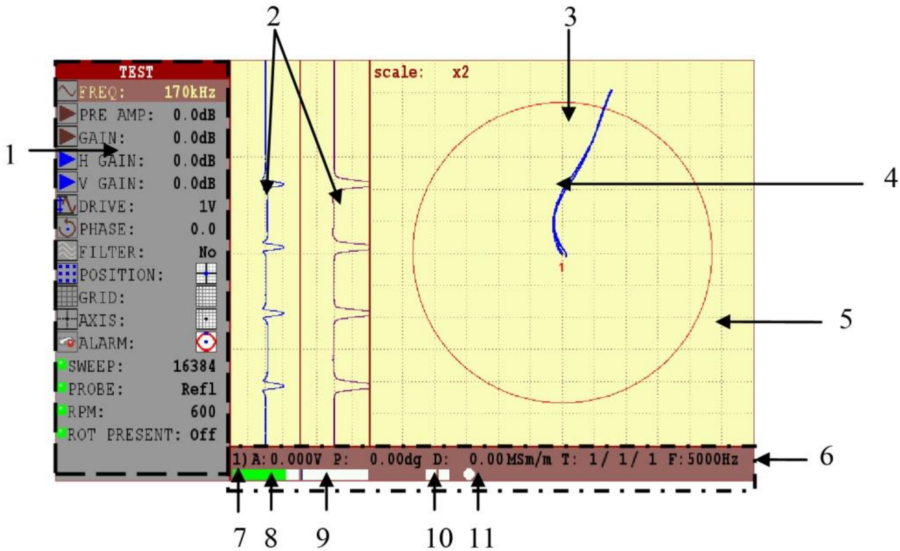


Fig. 8 – The Flaw Detector Interface

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)

***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.

English

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 exceeds the threshold of 90% is unacceptable and requires the adjustment of flaw detector parameters.

Lighting of a left overload indicator (pos. 10, Fig. 8) – indicates that unacceptably large amplitude signal came to the input of the receiving circuit.
The flaw detector electronic unit displays the signal in the complex plane that allows to foil defects by waveform analysis (Fig. 9):

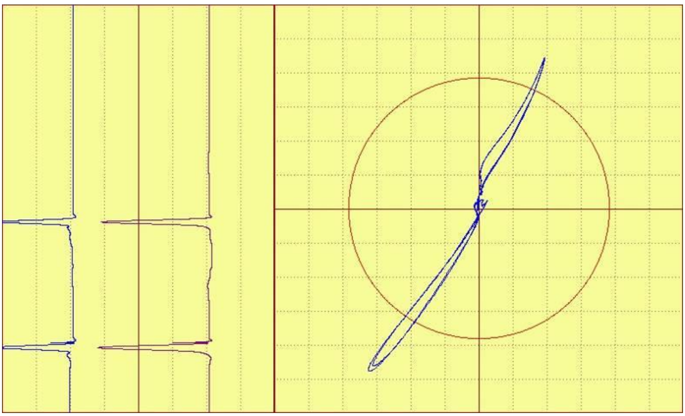


Fig. 9 – Display of signal in the complex plane (XY)

Fig. 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 Figure 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 - 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 Fig. 4) provide the possibility of ECP connection of various constructions (see Fig. 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.

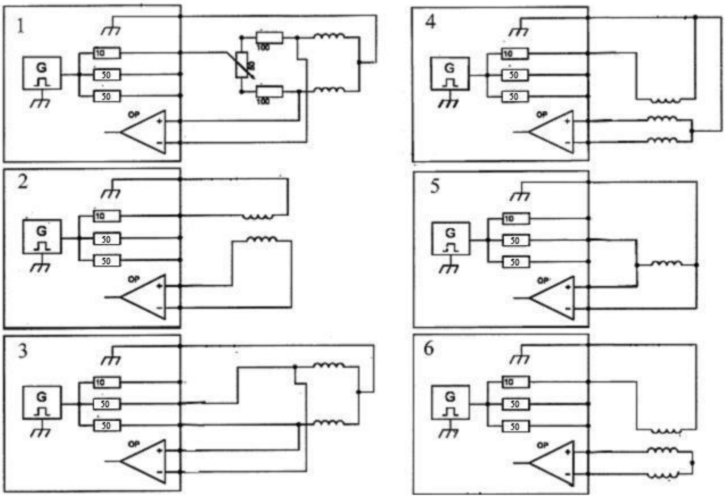


Fig.11 – Circuits of probe connection

4.4 Menu Structure

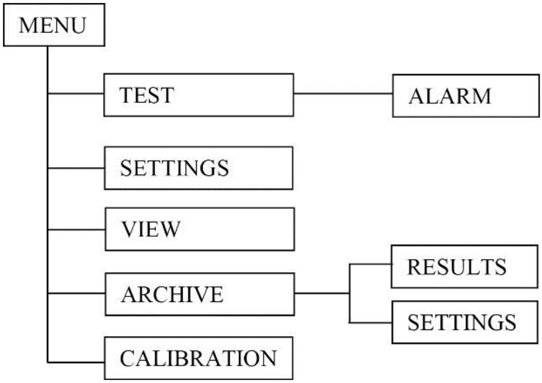


Fig. 12 – Menu Structure

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", "MEMORY", "CALIBRATION", the first and the fourth ones are also divided in submenus.

4.5 "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.

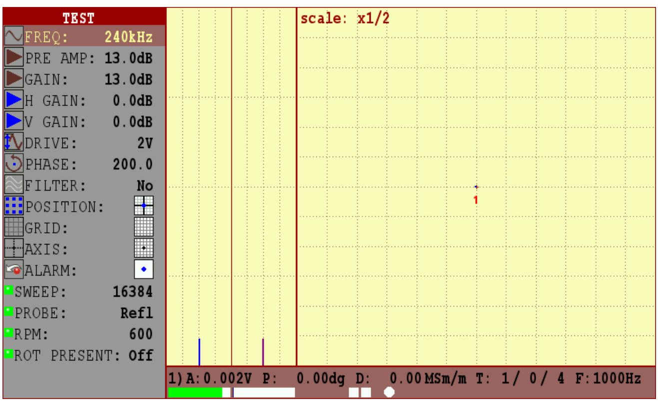


Fig.13 – "TEST" menu

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", "MEMORY", "CALIBRATION" inserts is carried out by pressing  keys.

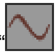
"Hot keys" which are operated by "F1", "F2", "F3" function keys are situated on the keypad of the flaw detector:
- F1 (Balancing)[1] – to balance the signal (place it in the screen center) and clear the flaw detector screen;
- F2 (Full-screen mode) – the complex plane and time chart is maximized to fill the entire screen.
- F3 (Clearing) – 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.

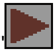
Balancing should be applied in case if:
- ECP type was changed;
- One of following parameters was changed: ECP frequency, gain coefficient, preamplification coefficient, ECP excitation voltage;
- Testing object was changed;
- The auto-adjustment of ECP was activated (if Single input was used).

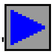
Clearing should be used if persistence is switched off.

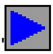
[1] Balancing of the flaw detector is required after the ECP operating frequency was set or changed. Also, the balancing should be carried out after the ECP replacement. If the flaw detector was once balanced and its operating frequencies were not changed, it is possible to carry out centring.

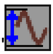
1. “ F, Hz"- operating frequency of probe[2]; varied in the range from 10 Hz to 16 MHz with a step of 1, 10, 100, 1000, 10000, 100000, 1000000, 10000000 Hz. Here you adjust the test frequency of the probe that is connected to the instrument. The frequency depends on the probe you use and the application 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.

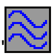
3. " GAIN" - gain for amplifying the probe voltage; varied in the range from 0 to 30 dB with a step of 0,1; 1; 10 dB. Here you adjust the signal amplitude for the best possible display of the eddy current signal by moving the probe across a reference defect while slowly increasing the gain. You can adjust 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.

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[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 4000 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;

$$F \leq \frac{\text{Fsampling}}{2}$$

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 the other filter makes the earlier selected filter inactive within the set frequency.*

9. " " - selection of the position of complex plane centre. Can be set in the following positions: - complex plane centre, - in the right centre of the screen, - in the right upper corner, - in the upper centre of the screen, - in the left upper corner, - in the left centre of the screen, - in the left bottom corner, - in the the bottom centre 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, - cut-off 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-02 or MINI DRIVE.

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).

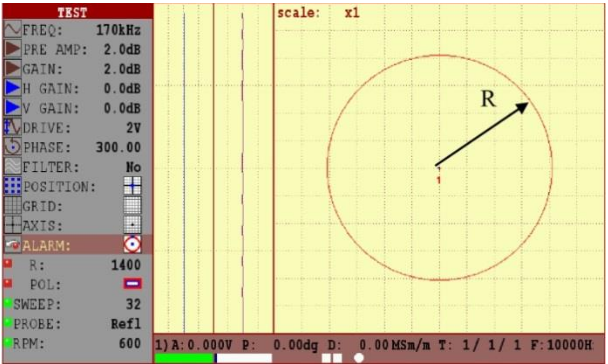

Fig. 14 – Setup of "Type:  " threshold level

"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 Fig.14).

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

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

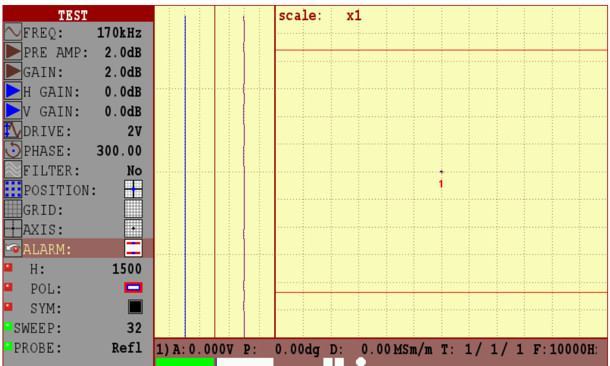

Fig. 15 – Setup of "Type: " threshold level

"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 Fig. 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).

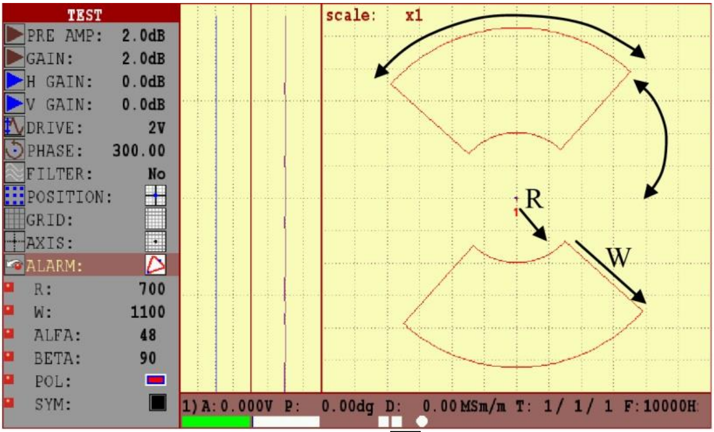

Fig. 16 – Setup of “Type: “ threshold level

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

- **Setup of "Trapezium" type frame**

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

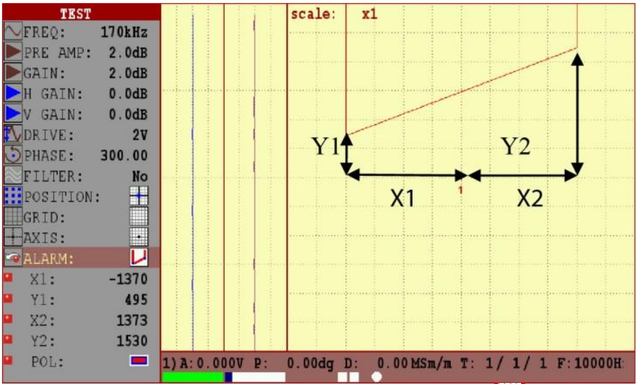

Fig. 17 – Threshold level setup "Type: "

"X1:" parameter variation allows to change 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 Fig. 17).
"X2:" parameter variation allows to change 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 Fig. 17).
"Y1:" parameter variation allows to change 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 Fig. 17).
"Y2:" parameter variation allows to change 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 Fig. 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.

4.6 Guidelines for Overload Processing

4.6.1 For the Input – "Refl", "Bridge":

1. Reduce the probe drive;
2. Perform the probe balance by pressing F1 key.

4.6.2 For the Input – "Single":

1. Choose the capacitor by pressing key
2. Perform the probe balance by pressing F1 key;
3. If the recommendations specified in paras 4.6.2.1-4.6.2.2 didn`t resolve the overload, then it is necessary to reduce the probe drive and repeat paras 4.6.2.1-4.6.2.2.

Lightning of the right overload indicator *(pos. 10, Fig. 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).*

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

1. If the left indicator lights, then repeat the steps described for overload processing for the left indicator (see above);
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 F1 key.

4.7 "Conductivity" Mode

<u>Basics of Conductivity</u>

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 10^7 S/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 PCE-USC 30 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 PCE-USC 30 for Conductivity measurement requires the following:

- PCE-USC 30 flaw detector;
- Standard 60 kHz Probe (CP-13) and Cable (Lemo 12 - Lemo 04 Conductivity).

Conductivity standards of known value in a range from 0.59 MS/m (1.02 % IACS) to 63.8 MS/m (110 % IACS). To connect the flaw detector with Cable and the eddy current probe CP-13 for measuring the electrical conductivity.
Connect the flaw detector with cable and the eddy current probe CP-13 for measuring the electrical conductivity.

ATTENTION! THE INSTRUMENT SETUP AND ELECTRIC CONDUCTIVITY MEASUREMENT SHOULD BE CARRIED OUT AT AN AMBIENT AND TEST OBJECT TEMPERATURE OF 20 ˚ C (68 ˚ F). BEFORE CARRYING OUT THE SETTING UP PROCEDURE AND ELECTRIC CONDUCTIVITY MEASUREMENT, IT IS REQUIRED THAT THE INSTRUMENT TO BE OPERATED AT LEAST OF 15 MINUTES AT A TEMPERATURE OF 20 ˚ C (68 ˚ F).

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

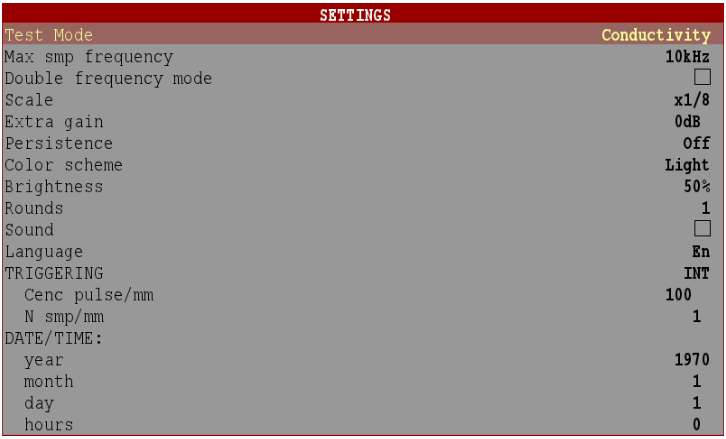

Fig.18 – "Conductivity" Test Mode

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».

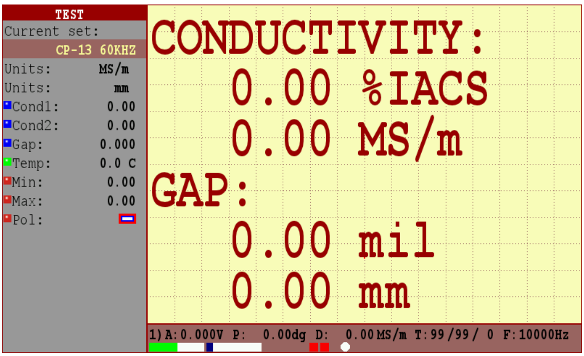

Fig. 19 – Choosing and activating Settings "CP 13 – 60 KHZ"

After settings activation make calibration at standard samples

Note – *For setting up procedure, use certified calibration blocks only.*

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 to 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 mm] 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 .

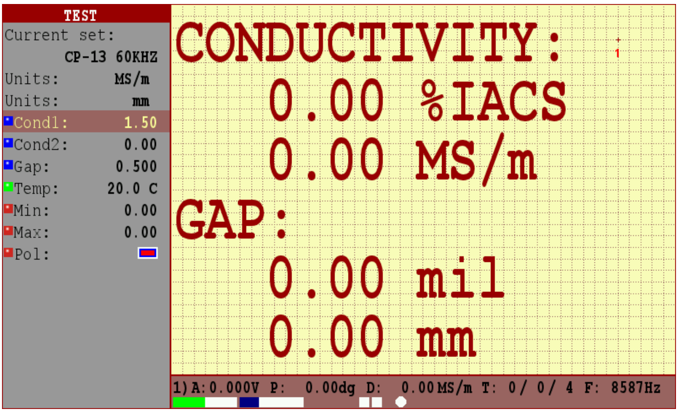

Figure 20 – Entering the conductivity value for the sample Cond 1

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

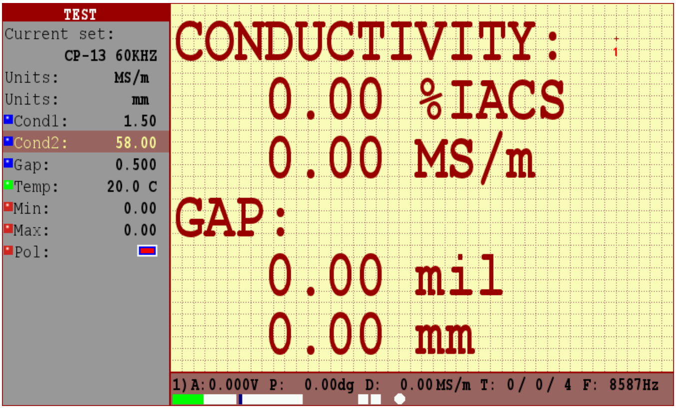

Figure 21 – Entering the conductivity value for the sample Cond 2

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 .

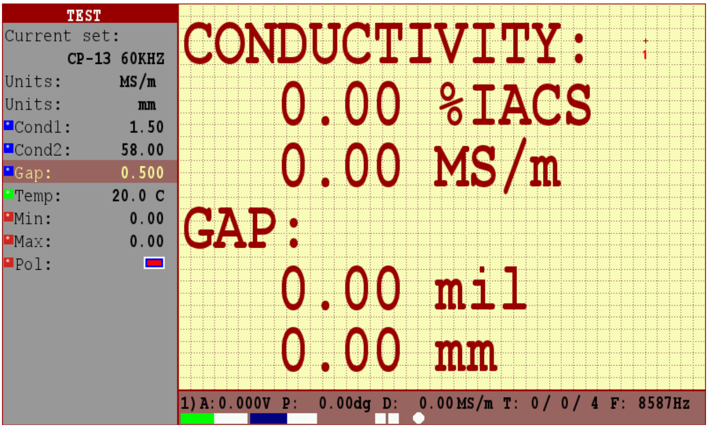

Figure 22 – Entering the gap value for setting on the Cond 1 sample

After carrying out the setting up procedure, you can proceed with the measurement of electric conductivity at real objects. During the operation it is required periodically to check the accuracy of measurement of electric conductivity at calibration blocks.
In case, the value measured at calibration block differs from the nominal one and exceeds the measurement tolerance, then it is required to reactivate the operating setup and perform the adjustment at calibration blocks.

Note. *In case, the ambient and test object temperature will be different from 20 ˚C (68˚ F), then the displayed value will be with an error.*

Setting up the threshold level in the mode of electric conductivity measurement

- set up the low value of electric conductivity Min;
- set up the high value of electric conductivity Max;
- set up the trigger logic for threshold level:

-light and sound ALARM shall be triggered, when the measured value of electric conductivity gets into the middle of a selected range
Min – Max;
light and sound ALARM shall be triggered, when the measured value of electric conductivity gets beyond the selected range
Min – Max.

Measuring Conductivity and Coating Thickness with the PCE-USC 30

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.
- The electric conductivity measurement should be carried out at an ambient and test object temperature of 20 ˚ C (68 ˚ F).

English

4.8 “General Settings” Menu

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

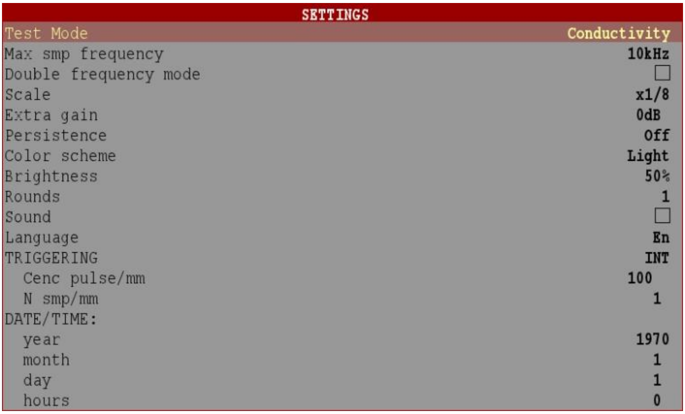

Fig. 23 – “General Settings" menu

An operator sets the following values in the corresponding menu lines:
- "Test mode" – test mode. Can be "Expert" and "Simple". In "Simple" mode the 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 measurement set 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 to10000 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)

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[4] Cenc value (pulses/mm) is indicated in the registration certificate for the scanning device where an encoder (Enc) is used

4.9 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.

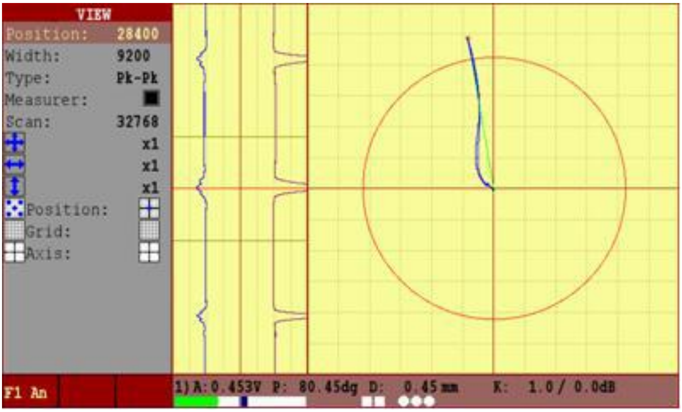


Fig. 24 – "VIEW" menu

Note. To view previously saved testing results, it is necessary to press  *key, choose the "RESULTS" submenu and press*  *key. Then, move the cursor to the certain result and press*  *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 centre and the point situated at the max. distance from the centre in cursor width.
° Cnt-K - the measurements are made between the centre and the cross point of cursor centre 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 millimetres 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

English

in the strip chart and press – defect free area "F1 An" key, then move the centre 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 millimetres 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. 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!

4.10 “Memory” 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.

Fig. 20 – "RESULTS" menu

4.11 “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 26). The list of results contains catalogues (folders) and files. The catalogues 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 catalogues, in their turn, can comprise subdirectories and files.

A new catalogue is created by placing the cursor on the line with colon or on the existing catalogue and pressing key ("F2 Create"). The existing catalogue 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.

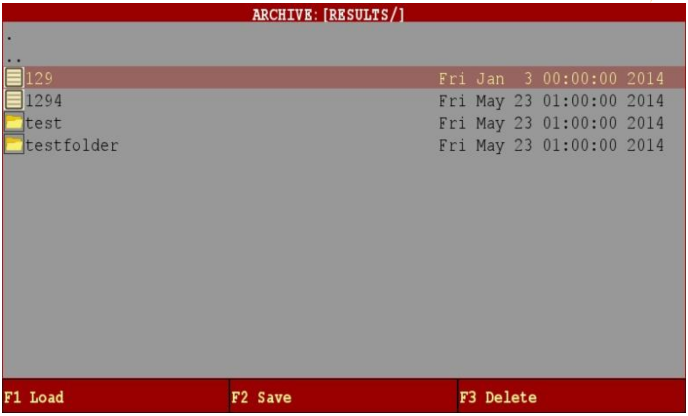


Fig. 26 – "RESULTS" menu. List of catalogues and files

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 to 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.

Fig. 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".

4.12 “Settings” Menu

When selecting "Settings" menu the flaw detector displays the window with a list of settings (see Figure 23). The given menu allows the testing results saving and loading.
After a setups file loading, automatic enter in "Testing" menu is carried out.

Fig. 28 – "Settings" menu

4.13 Set up of “Calibration” Menu

The calibration curve plotting will be illustrated using the calibration block. 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 (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.

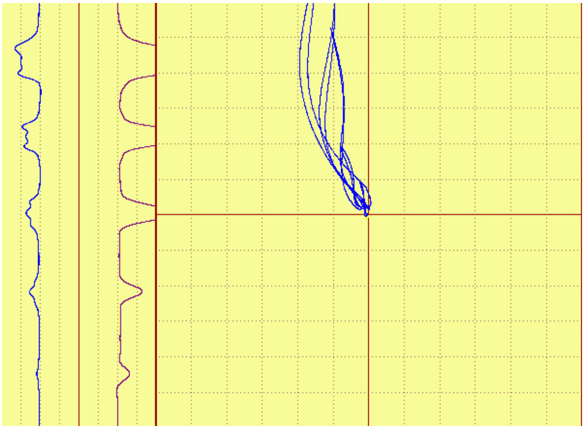


Fig. 29 – Appearance of defectogram for the calibration curve plotting

After the acquisition of defectogram, press  key, for the quick transition to "CALIBRATION" menu.

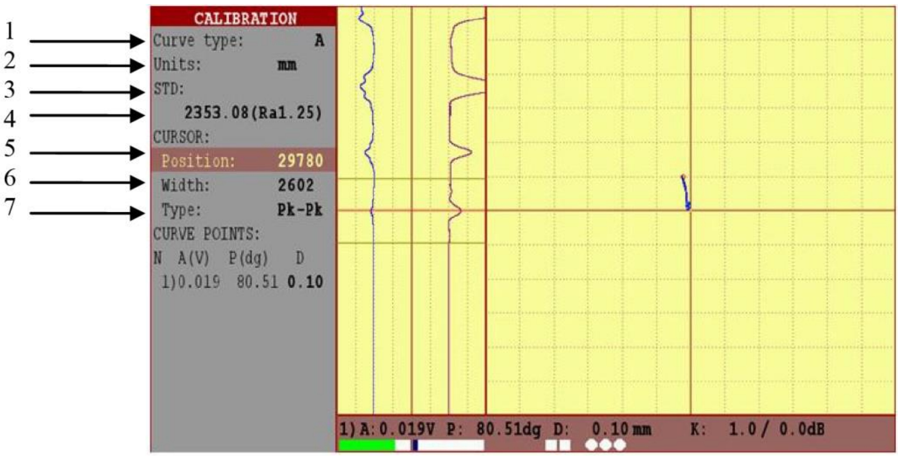


Fig. 30 – "Calibration" menu

1 - Set a curve for evaluation of the defect depth (Amplitude, Phase);
2 - Select the units of defect measurement (mm, %);
3 - Calibration marker by the registered calibration blocks;
4 - Calibration block selection
5 - Position of the measuring cursor on the time chart;
6 - Width of the measuring cursor on the time chart;
7 - The type of the measuring cursor, see item 3.9

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 to delete all points of previous calibration curve by pressing key.

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 31). Having placed the cursor on a defect, press the key – 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 Fig. 31). Then it is essential to perform similar operations for all other defects by setting corresponding depth.

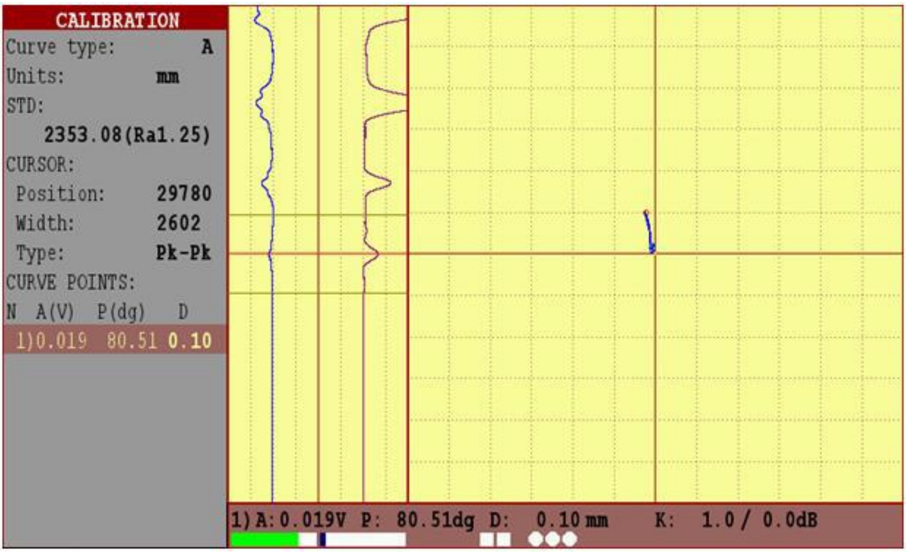


Fig. 31 – Plotting of the calibration curve

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 – 128.

Note. If calibration is carried out on any of the listed calibration blocks in pos. 4, Figure 30, then an operator can easily activate marker STD (pos.3, Fig. 30) and 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 calibration block and the flaw detector will automatically assign the wanted depth to the defects.

4.14 PCE-USC 30 software

The PC software for the PCE-USC 30 is used to view and analyze saved measurements and operating setups. Furthermore it is possible to generate a print-out and to create a report.

4.14.1 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 ".exe". 

4.14.2 Program Description

The operating window of the program includes the following areas (Fig. 32):

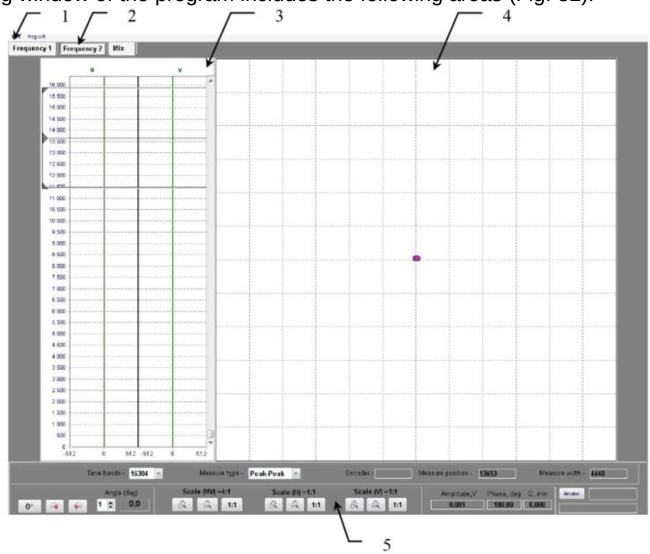


Fig. 32 – Active window of PCE-USC 30 program

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

4.14.2.1 Main Menu

Main menu bar includes the following menu items:
- File;
- Report.

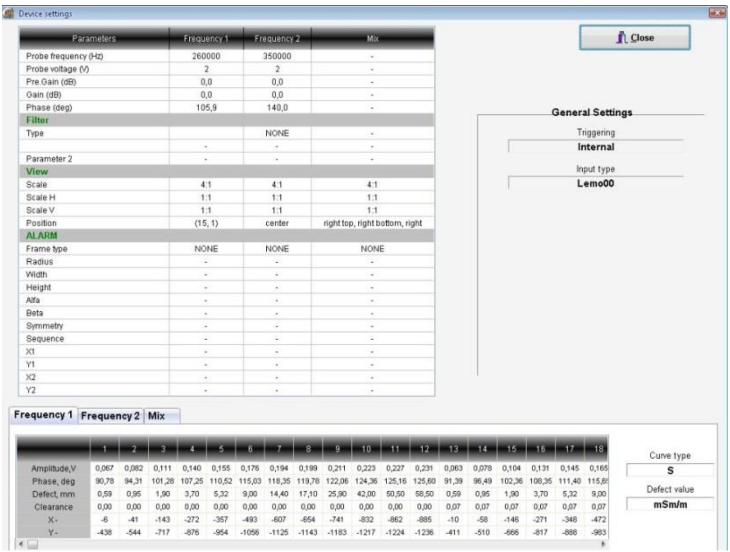
"File" menu item includes the subitems:

Fig. 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 «PCE-USC 30»). This file can be located on a USB flash drive or on the hard disk drive of the PC if the data has been previously copied to the hard disk drive (see 4.14.3). Double-click of the left mouse button opens the file.

“Loading” subitem allows to view the files of all testing results saved on a USB drive and to copy them to the hard disk drive.

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



Parameters	Frequency 1	Frequency 2	Mix
Probe frequency (Hz)	260000	350000	-
Probe voltage (V)	2	2	-
Pre.Gain (dB)	0,0	0,0	-
Gain (dB)	0,0	0,0	-
Phase (deg)	105,9	140,0	-
Filter			
Type		NONE	-
	-	-	-
Parameter 2	-	-	-
View			
Scale	4:1	4:1	4:1
Scale H	1:1	1:1	1:1
Scale V	1:1	1:1	1:1
Position	(15, 1)	center	right top, right bottom, right
ALARM			
Frame type	NONE	NONE	NONE
Radius	-	-	-
Width	-	-	-
Height	-	-	-
Alfa	-	-	-
Beta	-	-	-
Symmetry	-	-	-
Sequence	-	-	-
X1	-	-	-
Y1	-	-	-
X2	-	-	-
Y2	-	-	-

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Amplitude,V	0,067	0,082	0,111	0,140	0,155	0,176	0,194	0,199	0,211	0,223	0,227	0,231	0,063	0,078	0,104	0,131	0,145	0,165
Phase, deg	90,78	94,31	101,28	107,25	110,52	115,03	118,35	119,78	122,06	124,36	125,16	125,60	91,39	96,49	102,36	108,35	111,40	115,6
Defect, mm	0,59	0,95	1,90	3,70	5,32	9,00	14,40	17,10	25,90	42,00	50,50	58,50	0,59	0,95	1,90	3,70	5,32	9,00
Clearance	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,07	0,07	0,07	0,07	0,07	0,07
X -	-6	-41	-143	-272	-357	-493	-607	-654	-741	-832	-862	-885	-10	-58	-146	-271	-348	-472
Y -	-438	-544	-717	-876	-954	-1056	-1125	-1143	-1183	-1217	-1224	-1236	-411	-510	-666	-817	-888	-983

Fig. 34 – “Flaw detector settings” window

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

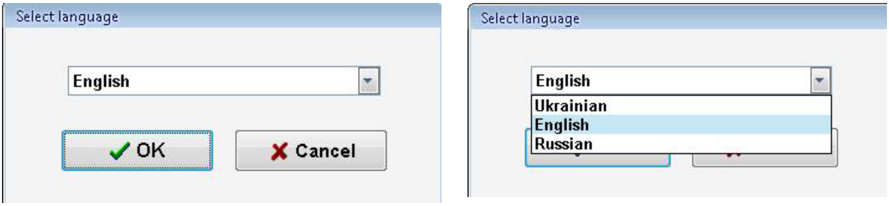


Fig. 35 – "Selecting the interface language" window

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

Select **"Exit"** subitem to finish the "PCE-USC 30" program.

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

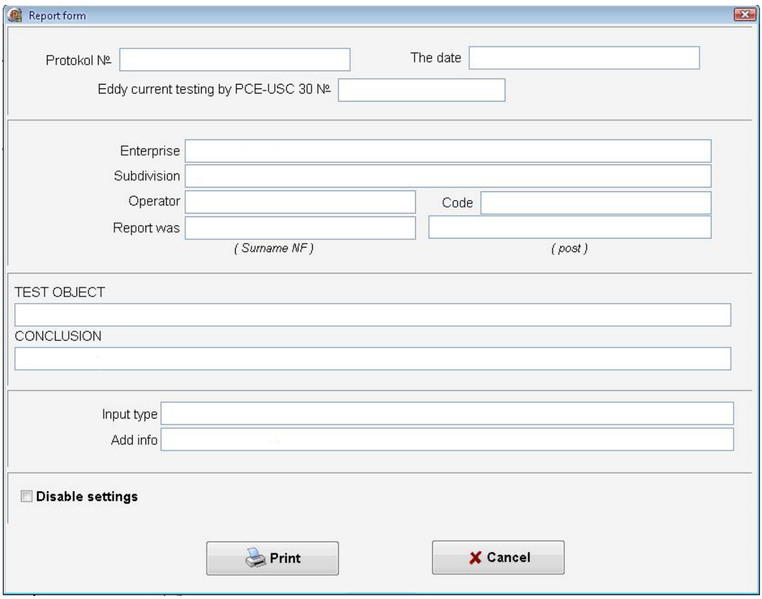


Fig. 36 – Report form of a testing carried out

English

After pressing "Print" 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 "Cancel" button.

English

4.14.2.2 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*.

4.14.2.3 Time diagram area

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

4.14.2.4 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, Fig. 32). In the active area are displayed the signals that come into the area covered by the measuring cursor.

4.14.2.5 Bottom status bar

Fig. 37 Status bar

"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*** (centre peak - the measurements is made between the cursor centre and the point situated at the max. distance from the centre in cursor width);
- ***Cnt-K*** (centre cursor - the measurements is made between the centre and the cross point of cursor centre 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.

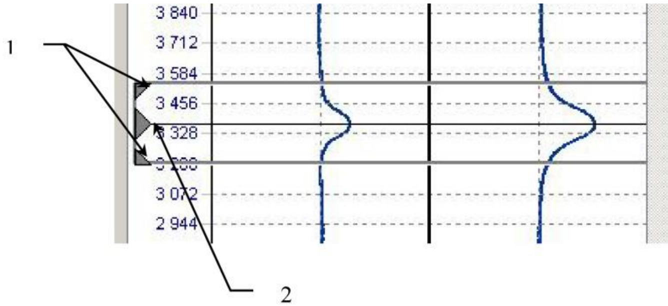


Fig. 38 Cursor

To change the cursor position, it is required to place the "mouse" cursor onto the centre of a measuring cursor (item 2, Fig. 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, Fig. 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 counter clockwise rotation considering the selected step;

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

- 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;

- 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;

- 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;

1:1 - 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.*

4.14.3 Working with the program

4.14.3.1 Transfer flaw detector memory to PC

The transfer of measurements from the flaw detector memory to a PC requires a USB flash drive. A direct connection of the flaw detector to a PC with a USB cable is prohibited in order to prevent accidental deletion of important system files of the flaw detector.

After the flaw detector has been turned off, a FAT32 formatted USB drive can be connected to the USB port of the flaw detector. The measurements are exported to the USB drive by turning on the flaw detector and selecting the MEMORY menu with the button. In this menu the shortcut button F3 “F3 Export data” copies the data from the internal memory to the USB flash drive. Before removing the USB drive it is required to turn off the flaw detector again in order to prevent memory corruption.

After the data has been transferred, the USB drive can be connected to the PC in order to view the measurements and to create a report. In the menu of «PCE-USC 30» 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.

4.14.3.2 View results of testing

In "File" item of the main menu choose the sub-item **"Open"**. In the window that appears, choose the path to USB flash drive - 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 USB drive does not store this data automatically in PC memory.*

4.14.3.3 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 (Fig. 36).
- In the preview window of testing results click "Print" .

5 Labelling and Sealing

1. The flaw detector labelling 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.
   - Labelling is performed in English.

2. Labelling is made on the flaw detector casing by polygraphic technique.

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

English

6 Composition and Delivery Set

Basic delivery set consists of the following components:

Table 8

Name and reference designation	Quantity
PCE-USC 30 defectoscope / material tester	1
SS340K09DA0 eddy current probe in protective case	1
Calibration block SOP 2353.08 (Rz 40, D16T)	1
Connection cable (Electronic unit/ECP)	1
EC Probe CP13 (for conductivity measurement)	1
Battery	1
Battery charger	1
Carrying case	1
User manual	1

7 Setting-up procedures

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

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

1. Connect the ECP to the flaw detector using a connecting cable.
2. Set the ECP frequency in a range specified in the registration certificate for the ECP.
3. Set the ECP drive not more than 2 V.
4. Press key to select the capacity.
5. Place the ECP to the flaw-free area of a calibration block.
6. Press key to balance the ECP.
7. 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 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. By 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.
9. After changing any parameter that affects the absolute value of the signal it is necessary to perform balancing by pressing key.
10. While testing aluminium 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.
11. Select the required type of a threshold level.
12. 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

1 Connect the ECP to the flaw detector using a connecting cable.
2 Set the ECP frequency in a range specified in the registration certificate for the ECP.
3 Set the ECP drive not more than recommended in a registration certificate for the ECP.
4 Place the ECP to the flaw-free area of a calibration block.
5 Press key to balance the ECP.
6 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.
7 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 After changing any parameter that affects the absolute value of a signal it is necessary to perform balancing by pressing key.
9 Select the required type of a threshold level.
10 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).

8.3 Rotation Probe

1. Connect the rotary scanner to the flaw detector using the connection cable.
2. Connect the ECP to the rotary scanner. Approximate marks on the case of the probe and scanner should coincide.
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 placed in the scanner, the o-rings should not be seen.
4. Set the ECP frequency in a range specified in the registration certificate for the ECP.
5. Set the ECP drive not more than recommended in a registration certificate for the ECP.
6. At "ROT PRESENT" position, set up "On". In displayed menu choose the type of the rotary scanner and press key.
7. At "RPM" position, firstly set the min rounds – 600.
8. Press the switched On button on the case of the rotary scanner. The ECP should be in the air.
9. To set the scanner rounds properly, press key and wait for the end of the procedure.
10. Press the switched On button of the rotary scanner.
11. Set the required rounds for the scanner.
12. Put the ECP into the hole of the calibration block.
13. Press the switched On button on the case of the rotary scanner.
14. Press key to balance the ECP.
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.
16. Increasing the gain on preamplifier and amplifier maximize the signal amplitude, but at the same monitor behind parameters of the input circuit.
17. After changing any parameter that affects the absolute value of the signal it is necessary to perform the balancing by pressing key.
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.
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

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

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.

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

4. Replacement of the battery pack.

5. Unscrew two screws (item 1 Fig. 39).

Fig. 39

English

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

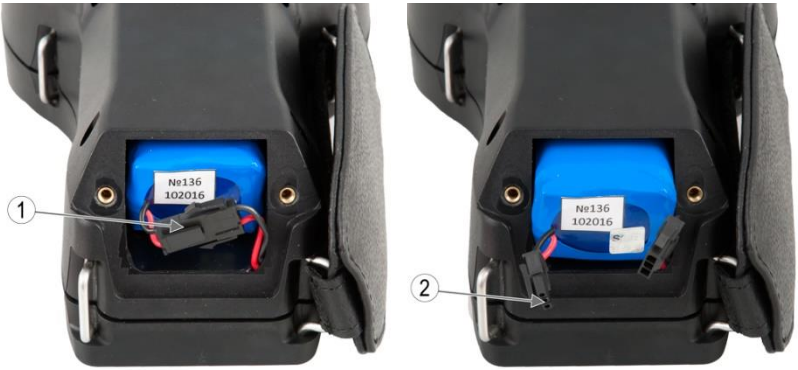


Fig. 40

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

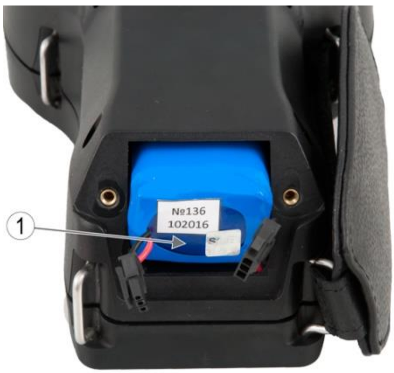


Fig. 41

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

10 Typical Failures and Troubleshooting

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

1. Climatic conditions for transportation of the eddy current flaw detector electronic unit – 2 (C) according to GOST 15150, but for operating temperature range from minus 20 °C to plus 40 °C.
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.
3. The flaw detector storage conditions in the manufacturer's packing should meet the requirements 2 (C) according to GOST 15150, but for operating temperature range from minus 20 °C up to plus 40 °C.
4. 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.
5. In storage, the flaw detector and ECP should not be affected by electromagnetic fields. Evaluation of stability of the flaw detector and ECP performance under the effect of electromagnetic interferences should correspond to "B" criterion according to GOST 29073.

12 Warranty

You can read our warranty terms in our General Business Terms which you can find here: https://www.pce-instruments.com/english/terms.

13 Disposal

For the disposal of batteries in the EU, the 2006/66/EC directive of the European Parliament applies. Due to the contained pollutants, batteries must not be disposed of as household waste. They must be given to collection points designed for that purpose.

In order to comply with the EU directive 2012/19/EU we take our devices back. We either re-use them or give them to a recycling company which disposes of the devices in line with law.

English

For countries outside the EU, batteries and devices should be disposed of in accordance with your local waste regulations.

If you have any questions, please contact PCE Instruments.

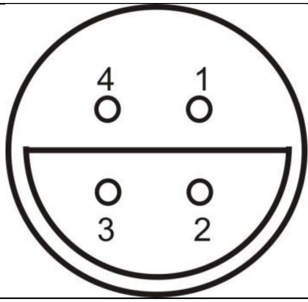
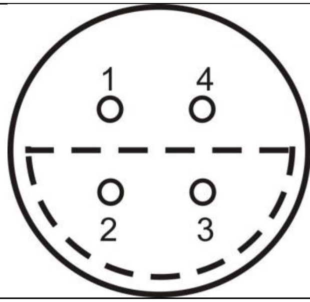
www.pce-instruments.com

APPENDIX A

Requirements to Charging Device for Portable Eddy Current Flaw Detector PCE-USC 30

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 FGG.1B.304.CLAD42

	
Front	Component side view

1	“-“ Charging device
2	-
3	-
4	“+” Charging device

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

PCE Instruments contact information

Germany
PCE Deutschland GmbH
Im Langel 4
D-59872 Meschede
Deutschland
Tel.: +49 (0) 2903 976 99 0
Fax: +49 (0) 2903 976 99 29
info@pce-instruments.com
www.pce-instruments.com/deutsch

France
PCE Instruments France EURL
76, Rue de la Plaine des Bouchers
67100 Strasbourg
France
Téléphone: +33 (0) 972 3537 17
Numéro de fax: +33 (0) 972 3537 18
info@pce-france.fr
www.pce-instruments.com/french

Spain
PCE Ibérica S.L.
Calle Mayor, 53
02500 Tobarra (Albacete)
España
Tel. : +34 967 543 548
Fax: +34 967 543 542
info@pce-iberica.es
www.pce-instruments.com/espanol

United States of America
PCE Americas Inc.
711 Commerce Way suite 8
Jupiter / Palm Beach
33458 FL
USA
Tel: +1 (561) 320-9162
Fax: +1 (561) 320-9176
info@pce-americas.com
www.pce-instruments.com/us

United Kingdom
PCE Instruments UK Ltd
Units 12/13 Southpoint Business Park
Ensign Way, Southampton
Hampshire
United Kingdom, SO31 4RF
Tel: +44 (0) 2380 98703 0
Fax: +44 (0) 2380 98703 9
info@industrial-needs.com
www.pce-instruments.com/english

Italy
PCE Italia s.r.l.
Via Pesciatina 878 / B-Interno 6
55010 LOC. GRAGNANO
CAPANNORI (LUCCA)
Italia
Telefono: +39 0583 975 114
Fax: +39 0583 974 824
info@pce-italia.it
www.pce-instruments.com/italiano

The Netherlands
PCE Brookhuis B.V.
Institutenweg 15
7521 PH Enschede
Nederland
Telefoon: +31 (0) 900 1200 003
Fax: +31 53 430 36 46
info@pcebenelux.nl
www.pce-instruments.com/dutch

Chile
PCE Instruments Chile SPA
RUT 76.423.459-6
Badajoz 100 oficina 1010 Las Condes
Santiago de Chile / Chile
Tel. : +56 2 24053238
Fax: +56 2 2873 3777
info@pce-instruments.cl
www.pce-instruments.com/chile

Hong Kong
PCE Instruments HK Ltd.
Unit J, 21/F., COS Centre
56 Tsun Yip Street
Kwun Tong
Kowloon, Hong Kong
Tel: +852-301-84912
jyi@pce-instruments.com
www.pce-instruments.cn

China
Pingce (Shenzhen) Technology Ltd.
West 5H1,5th Floor,1st Building
Shenhua Industrial Park,
Meihua Road,Futian District
Shenzhen City
China
Tel: +86 0755-32978297
lko@pce-instruments.cn
www.pce-instruments.cn

Turkey
PCE Teknik Cihazları Ltd.Şti.
Halkalı Merkez Mah.
Pehlivan Sok. No.6/C
34303 Küçükçekmece - İstanbul
Türkiye
Tel: 0212 471 11 47
Faks: 0212 705 53 93
info@pce-cihazlari.com.tr
www.pce-instruments.com/turkish

User manuals in various languages
(German, French, Italian, Spanish, Portuguese, Dutch, Turkish, Polish, Russian, Chinese)
can be downloaded here: www.pce-instruments.com

Specifications are subject to change without notice.