Votum

MULTIFUNCTIONAL TESTING INSTRUMENT DAMI-C09

Operation's manual

VLNG 990109 RE

2011

“Votum” company pays permanent attention to development of the multifunctional testing instrument DAMI-C09. The developers are always ready to hear the opinions and remarks about the DAMI-C09 device operation as well as the desires for its further development. We invite to the cooperation all those who are interested in the development of nondestructive testing devices.

Informational, technical support and key specialists’ advice are available via

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1.INTENTION

The present **OPERATION'S MANUAL** applies to the multifunctional testing instrument DAMI-C09.

DAMI-C09implements the following testing methods:

- **impedance method** – acoustic testing of multilayer bonded and soldered constructions as well as of the constructions with honeycomb filler to detect such defects as delaminations and disbonds;

- **eddy current method** – detection of surface cracks and discontinuities in the non-magnetic and ferromagnetic metal and alloy parts;

- **impact method** – detection of such defects as delaminations and disbonds in the complex composite materials;

The possibility to build two-dimensional plane projections of defects and save the images in the device archive is provided for all DAMI-C09 testing methods. Saved images can be transmitted into the computer to form a testing report.

As for the operator's participation in the testing process, this instrument belongs to manual devices.

As for the operational completeness, this instrument belongs to the third-order products according to GOST 52931-2008.

As for the design and dependence on the perceived mechanical effects, this instrument belongs to portable products.

Climatic design of DAMI-C09 is C3 according to GOST 52931-2008.

DAMI-C09operating temperatures: from -20 to +50°C if the upper value of relative humidity is 95% at +35°C without moisture condensation.

Degree of protection against penetration of dust and water inside DAMI-C09 corresponds to IP54 according to GOST 14254.

As for the atmospheric pressure impact stability, this instrument belongs to the group R1 according to GOST 52931-2008.

As for the mechanical effect stability, this instrument is vibration-proof under the group N1 according to GOST 52931-2008.

DAMI-C09 can be operated in any position, which is suitable for the operator.

2. TECHNICAL DATA

DAMI-C09 must have the conventional sensitivity (i.e. it must detect defects, having the parameters as pre-set):

– **in the impedance testing mode** – detection of defects, which area is at least (12mm x 12mm), on the TS-1 testing specimen;

– **in the eddy current testing mode** – detection of defects, which depth is at least 0.2mm, on the RSA-0,2-0,5-1 and RSS-0,2-0,5-1 specimens;

– **in the impact testing mode** – detection of defects, which area is at least (12mm x 12mm) on the TS-2 testing specimen.

Nominal value of the excitation pulse amplitude: 9 ±1V.

Number of the periods in the excitation pulse packet: adjustable – from 1 to 8.

Pulse repetition frequency (PRF) for all operating modes: 500 Hz (if frequencies are lower than 5kHz, PRF=1/T where T - packet length).

Operating frequency range of the DAMI-C09 generator: from 200Hz to 1,0MHz;

Gain control range of the receiver: not less than 50dB.

Power is supplied to DAMI-C09 from an ac network (90 ÷ 240) V, (50 ÷ 60) Hz and/or with built-in batteries, having 7.4 V rated voltage and 4.4 A×h capacity.

DAMI-C09 alternating-current power consumption does not exceed 15 VA.

DAMI-C09 continuous operating time is not less than 24 hours while power is supplied from an ac network of (90 ÷ 240) V, (50 ÷ 60) Hz. DAMI-C09 continuous autonomous operating time is not less than 7 hours if power is supplied with newly-charged built-in batteries, under normal climatic conditions (environment temperature (20±5)°C, relative humidity (65±15)%, atmospheric pressure (100±4) kPa) and 50% screen brightness.

Maximum permissible error of the coordinates determination of the scanning device “Slider-M2” (further – “Slider”): not more than ±5 mm.

DAMI-C09 operating mode setting time: not more than 15 minutes.

DAMI-C09 overall dimensions: not more than 180x110x45 mm.

Device weight is not more than 1,0 kg.

Reliability indexes:

- DAMI-C09 average error-free running time is not less than 10000 hours if the technical service is provided;

- DAMI-C09 average serviceability restoration time is not more than 6 hours;

- DAMI-C09 average operation lifetime (excluding the transducer and battery) is not less than 5 years.

3. DELIVERY SET

Standard composition of the DAMI-C09 delivery set is given in the table 1.

Table 1

No.	Description	Number
1	DAMI-C09 multifunctional testing instrument. Main unit.	1 piece
2	Power pack of 90-240V / 12V, 2,5A	1 piece
3	PADI-8-02 transducer for the impedance testing method	1 piece
4	USB interface cable	1 piece
5	Headphones	1 piece
6	TS-2 testing specimen	1 piece
7	Carrying case	1 piece
8	Software compact disk: “Impedance defectoscope” software, “DAMI-C09 Operator’s workbench” software (Win 98, 2000, XP)	1 piece
9	DAMI-C09 multifunctional bond testing & eddy current testing instrument. Operation’s manual VLNG990109RE.	1 piece
10	SW “Impedance defectoscope”. Operation’s manual (**APPENDIX B**).	1 manual

4. SAFETY REQUIREMENTS

4.1. The device meets the general safety requirements according to GOST 12.2.007.0.

4.2. As for the degree of protection against electric shock, the device belongs to the 01 class products according to GOST 12.2.007.0.

4.3. In order to prevent a possible electric shock, DAMI-C09 must be plugged only into a grounded outlet.

4.4. Production safety requirements.

Safety requirements to the DAMI-C09 manufacturing and packing processes must correspond to GOST 12.3.002.

Production equipment must meet the safety requirements according to GOST 12.2.003.

Production facilities must be provided with ventilation according to GOST 12.4.021.

Working zone air of production facilities must meet the requirements of GOST 12.1.005.

Fire safety requirements must correspond to GOST 12.1.004.

4.5. The requirements of GOST 12.3.019 must be observed while testings and electrical measurements are carried out.

5.SETTING-UP PROCEDURES, CONTROLS AND INDICATION

Study the present DAMI-C09 Operation's manual and follow its instructions.

DAMI-C09 location place must be protected against direct impact of dust, moisture, hostile environment and must be sufficiently illuminated with artificial or natural light sources.

Radio-frequency interference (RFI) field intensity in the **DAMI-C09** location place must not achieve the values, breaking its operability. If the radio-frequency interference field intensity is high, it is necessary to take measures for shielding of the **DAMI-C09** location place as well as of its supply and connecting cables.

While working from an alternating current network, DAMI-C09 location place must be supplied with power network (voltage from 90 to 240 V, frequency from 50 to 60Hz).

If switching interference appears in the supply line, it is necessary to connect a **line filter** to the **DAMI-C09** power network.

To prevent moisture condensation inside DAMI-C09 while taking it away from the cold, it must be kept in a warm place during 1 hours until it is completely dried.

If air temperature is lower than 10ºC, a DAMI-C09 device must be warmed up during at least 15 minutes after it is **turned on**.

DAMI-C09 controls and indicators are located on the front panel (**Fig. 1**).

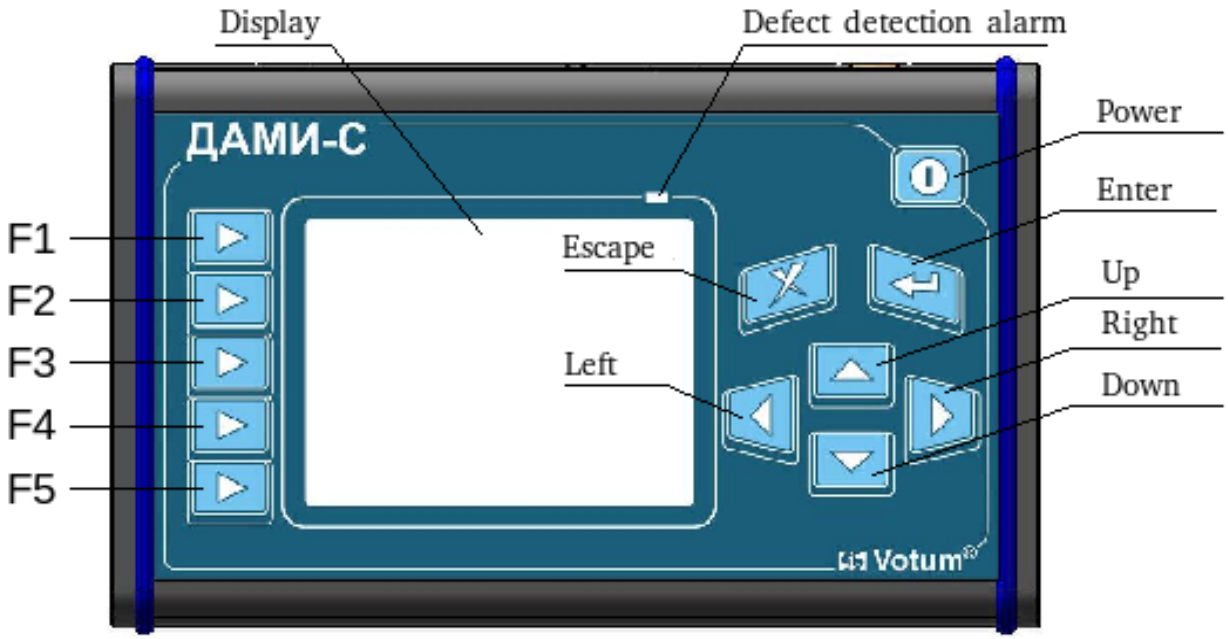


Fig. 1 Front panel.

Following controls and indicators are located on the **DAMI-C09** front panel:

- TFT display;
- Red-colored light-emitting diode – defect detection alarm.
- Keyboard panel with the following keys:
  - Escape - ✕;
  - Enter - ↵;
  - Left - ◄;

- Up - ▲;
- Right - ▶;
- Down - ▼;
- Power - ⏻ (device on\ off);
- Group of functional keys (F1, F2, F3, F4, F5), which functionality is determined by the operating program.

Further, the mnemonic symbols placed on the **DAMI-C09** keyboard will be used to indicate the **DAMI-C09** keys.

All DAMI-C09 keys have an autorepeat feature, i.e. a signal of repeated pressing is automatically generated, while keeping a key pressed.

ATTENTION! Further, the indication to press the key “A” + “B” will mean that it is necessary to press firstly the key “A” and, keeping it pressed, press additionally the key “B”. Keys can be released in random order.

Following sockets are located **on the DAMI-C09 top side:**

- transducers connection socket;
- scanning device connection socket;
- headphones connection socket;
- power pack connection socket;
- USB connection socket to connect the device to the computer;
- power pack socket.

Fig. 2 DAMI-C09 sockets for connection of different devices.

The base is located on the DAMI-C09 backside (see **Fig. 2**); it serves to fix the device in the tilt position while placing it on the flat surface. Being folded, the base is fixed with a special latch.

Attention! To prevent failure of the base and hold it correctly “in the tilt position”, following actions must be done:

- pull the base ear (deactivate the latch) - **Fig. 3**, pos. 1;
- turn the base 90 degrees away from the device - **Fig. 3**, pos. 2;

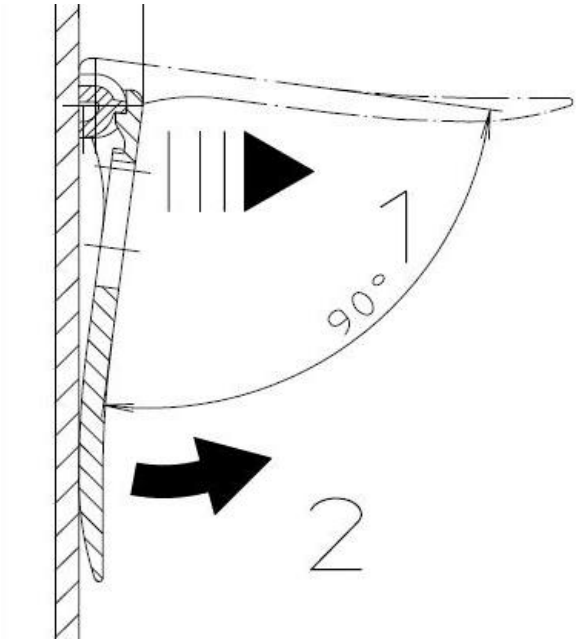


Fig. 3 Using of the base.

Attention! Following actions must be performed to prevent the connectors' failure:

- while connecting, make sure that the registration marks (red-colored points) of the plug and socket are joined and only then snap the connector (Fig. 4);

- while disconnecting, pull only the ribbed part of the plug. NEVER pull a plug cable.

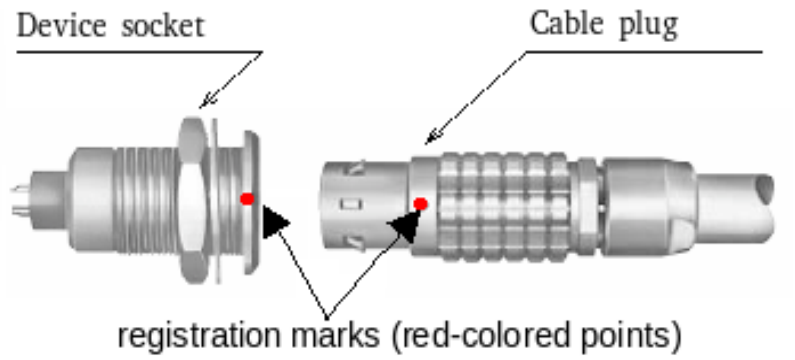


Fig. 4 LEMO company connectors used in the device

6. WORK ORDER

6.1 **DAMI-C09 turn-on.**

6.1.1 Press the button ⏻ on the DAMI-C09 front panel (**Fig. 1**) and keep it pressed during 1 second; the red light-emitting diode will simultaneously light on the front panel. If the device is not turned on after pressing of the button (a battery is completely discharged), it is necessary to connect the power pack and press ⏻ again.

6.1.2 The splash screen will appear on the DAMI-C09 display in 1-2 seconds (**Fig. 5**). DAMI-C09 is ready for operation.

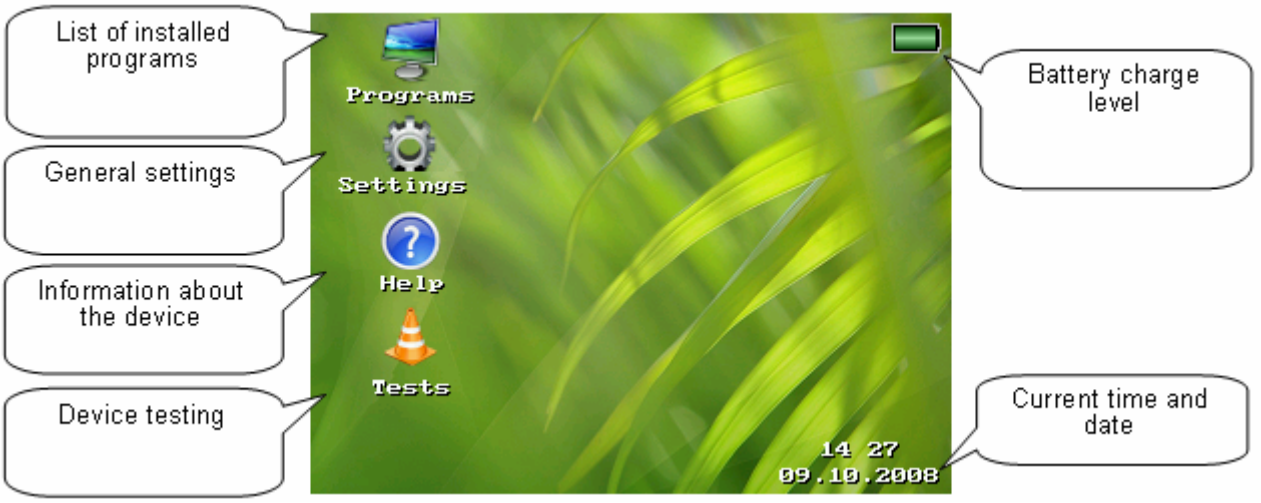


Fig. 5 Splash screen

6.1.3 Built-in battery charge level is displayed in the right upper corner of the splash screen (**Fig. 5**).

6.2 Built-in battery charging.

To charge a built-in battery, it is necessary to connect the power pack from the DAMI-C09 delivery set to the power supply network; the charging process will be indicated with “blinking” of the charge level. For complete charging of the battery, not more than 5 hours are required; after the charging process is completed, “blinking” will be stopped. The device can be charged in all operating modes (without any loss of functionality), even if it is off.

6.3 DAMI-C09 turn-off.

To turn DAMI-C09 off, press the button ⏻ and keep it pressed during 1 second.

Note: If one of the program hangs during the device operating, keep the key ⏻ pressed during 3 seconds to turn off the device. Then turn the device on again (see p. **6.1**)

6.4 Splash screen.

After DAMI-C09 is turned on, the splash screen will be displayed (**Fig. 5**). In this mode, the user is able to:

- Perform the general device settings: set the screen brightness level, choose the user interface language, set current time and date, etc.;
- View the list of installed device programs and load a necessary program;
- View information about the device and manufacturer company;
- Test the device (test a screen, keyboard).

6.5 Graphical user interface.

All DAMI-C09 programs have a single graphical interface, which means the method of user interaction with the program. Main interface widgets are as follows:

- Feature menu;
- Main menu;
- Status line;
- Saving window;
- Message windows;

Feature menu is a group of control items located in the left part of the screen (**Fig. 6**). Each menu item has a corresponding functional button (**Fig. 1**).

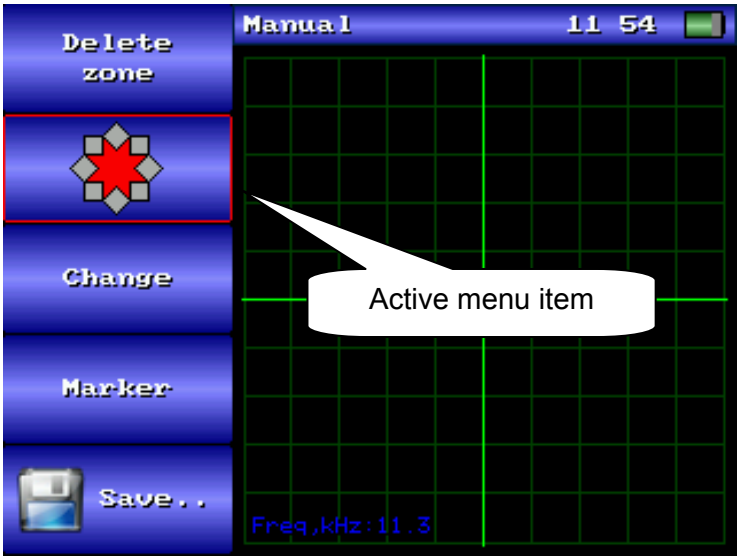


Fig. 6 Feature menu.

At every point of time, only one of the feature menu items is selected – it is red-framed. To select a necessary item, either press the corresponding functional button (the selection of simple items will also call the actions connected with them) or use the keys ▼,▲ - up/down to navigate through the items. The selected item has an input focus, i.e. it reacts on pressing of the keys ◀,▶, ↵. This reaction depends on the item type.

As for the functionality, control items are divided into:

- **Simple item** – calls one certain action. Press a functional button or key ↵ to call the action. A simple item can have a signature and an icon, explaining the action;

Fig. 7 Simple item

- **List item** – allows to select one of the listed values (numerical or text values). Except the inscription, this item has a special field where a current selected value is displayed. Use the keys ◀(back) and ▶(forward) to navigate through the list. If the item is highlighted, a new pressing of its corresponding functional button or of the key ↵ will also lead to the one-value-forward navigation of the list.

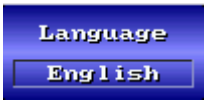


Fig. 8 List item.

- **Numerical item** – allows to change a number. Press either a functional button or the key ↵ to go into the number edit mode; the current edited number (digit) position will be red-colored. Use the keys ◄,► to navigate through number digits, keys ▼,▲ - to change a digit, key ✕ - to cancel the digit editing or press another functional button. If the item is not highlighted, the edited position will be yellow-colored.

Fig. 9 Numerical item.

- **Combined item** – by activating this item, the submenu with the list of additional items will appear. One of these items can be activated. Use the keys ▼,▲ to highlight the necessary item (the highlighted item will be black-marked) and the key ↵ to activate the action. To cancel selection and close the submenu, press the key ✕. Pay attention that the first pressing of the combined key will call the submenu, the second pressing will activate the selected item.

Fig. 10 Submenu item.

- **Special item** – allows to input data in a specific way, which is to be explained separately in the DAMI-C09 application place.

Fig. 11 Special item.

Main menu serves to select the program submodes. Usually, it is called (if it exists) by pressing of the key ✕.

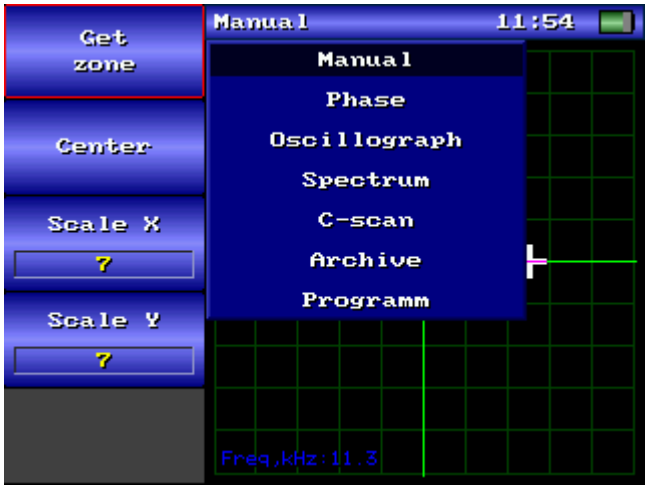


Fig. 12 Main menu.

Use the keys ▼,▲ to navigate through the main menu items, key ↵ - to call a submode, key ✕ - to return from the main menu to the current submode.

The setting's saving window is displayed when the setting or testing result is displayed (see **Fig. 12**).

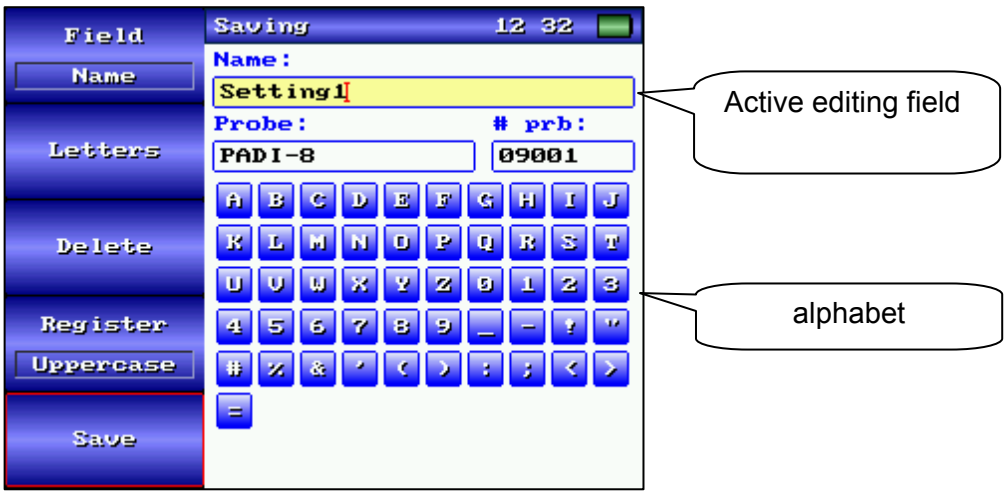


Fig. 13 Setting's saving window.

The screen will display the setting (or result) name editing fields, name and number of the applied probe (by saving the testing result, the scanning device number field is displayed as well). There are two types of editing fields – the text and number fields. To edit the field data, shift the input focus on the necessary field by pressing the key "Field" (the field, having the input focus, is yellow-colored).

Text field editing.

Except the input focus, the text field is also activated by pressing the key "Field" (see **Fig. 14**). Press the keys ◀,▶ to move cursor on the edited text letters.

a) active input field

b) passive input field

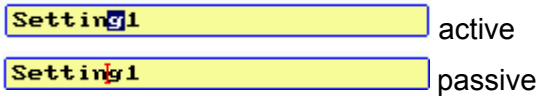


Fig. 14 Text input window.

To insert letters into the field text, press the key "Letters". The focus will be shifted onto the alphabet placed under the input fields. To move on the alphabet letters, press the keys ◀, ▶, ▲, ▼. To insert a letter before the cursor, press ↵.

To delete a letter before the cursor, press the key “Delete”. To input capital or small letters, set the necessary value in the “Register” parameter.

Number field editing.

When the focus is shifted onto the number field, the current edited digit is red-colored 09001. To move the cursor on the number digits, press the keys ◀, ▶. To increase\decrease the current digit value, press the keys ▲, ▼.

To save setting or result in the corresponding archive, press the key “Save”.

Status line is usually placed in the upper right part of the screen and serves to display:

- The name of selected submode;
- Current time;
- Battery charge level.

Message windows – appear on the screen to display messages as well as to select one of the suggested actions.

6.6 List of installed programs.

Activate the item “Programs” in the main menu of the splash screen window. The screen will display the list of installed device programs (**Fig. 15**). Press the keys ▲ and ▼ to select the necessary program from the list, press the key ↵ to load the program.

#	Name	Vers.
1	Eddy Current Defectoscope	1.03
2	Impedance Defectoscope	1.06

Total:2 Free space:89%

Fig. 15 List of installed programs.

6.7 Program registration

During manufacturing, the complete software set is recorded into the device. The programs, which are not purchased by the user, are delivered as demo versions, i.e. they have a limited number of launches (usually 50 launches). In the list of programs, demo versions are indicated with a key mark, registered programs are indicated with a check mark (see **Fig. 15**).

While launching an unregistered program, the number of left launches and proposal to register are displayed (see **Fig. 16**).

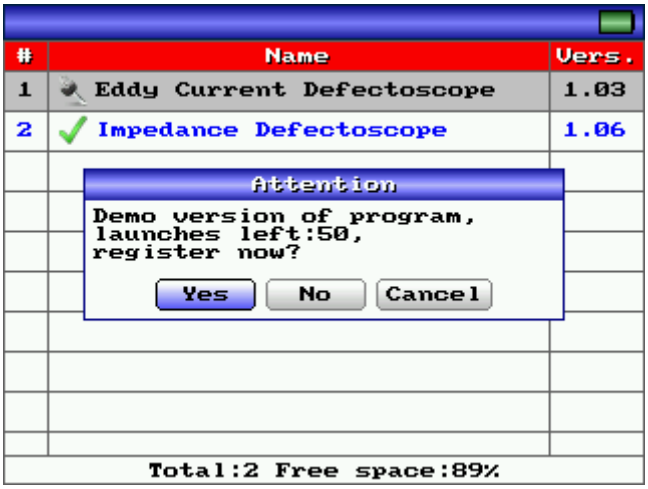


Fig. 16 Launch of unregistered program.

To register the program, it is necessary to press the key “Yes” and enter the key in the appeared window.

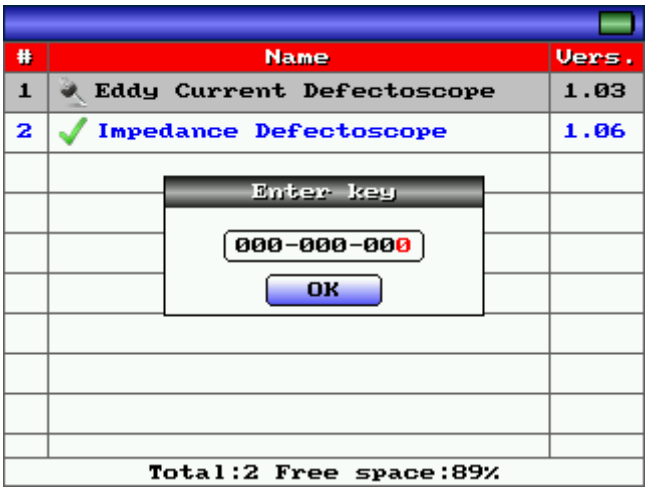


Fig. 17 Entering a registration key.

Use ▲ , ▼ to edit the registration key, use ◀,▶ to navigate through the key digits. Press ↵ to finish entering of the registration key, press ✘ to cancel entering of the registration key.

6.8 General settings of the device.

Activate the item “Settings” in the main menu of the splash screen window. The screen will display the menu of the general device settings (**Fig. 18**). Here, the user can set up:

- **“Language”** – selection of the user interface language;
- **“Brightness”** – screen brightness control;
- **“Backlight”** - Backlight auto-off time (Tab) – if the device has not been active during the Tab period (keys have not been pressed), screen backlight is automatically shut down to save energy. Backlight auto-off feature can be disabled if the parameter is set to “No”.
- **“Auto off”** - device auto-off feature (Ta) – if the device has not been active during the Ta period (keys have not been pressed), the device is automatically turned off.
- **“Time”** - current date and time setting. After the menu item “Time” is activated, the focus is shifted onto the edit line placed in the upper right part of the screen. Press ◀,▶ to navigate through the digits’ positions, ▲,▼ - to change digits, ✘ - to cancel editing and go to the feature menu.

- **“Sound alarm”**. There are 2 sound defect alarm sources in the device: sound alarm via the connected head phones and sound alarm through the buzzer inside the device frame. The sound alarm via connected head phones is always active. To switch on/off the defect alarm sound signal transmission into the buzzer, select Yes/No for the “Sound alarm” parameter.
- **“AASD time”** – defect alarm actuation time. When placing the transducer on a defect, defect alarm will be activated for the time adjusted within 0.1-3 seconds.
- **“Autostart”**. If this parameter is set to “Yes”, the last used program will be automatically loaded.

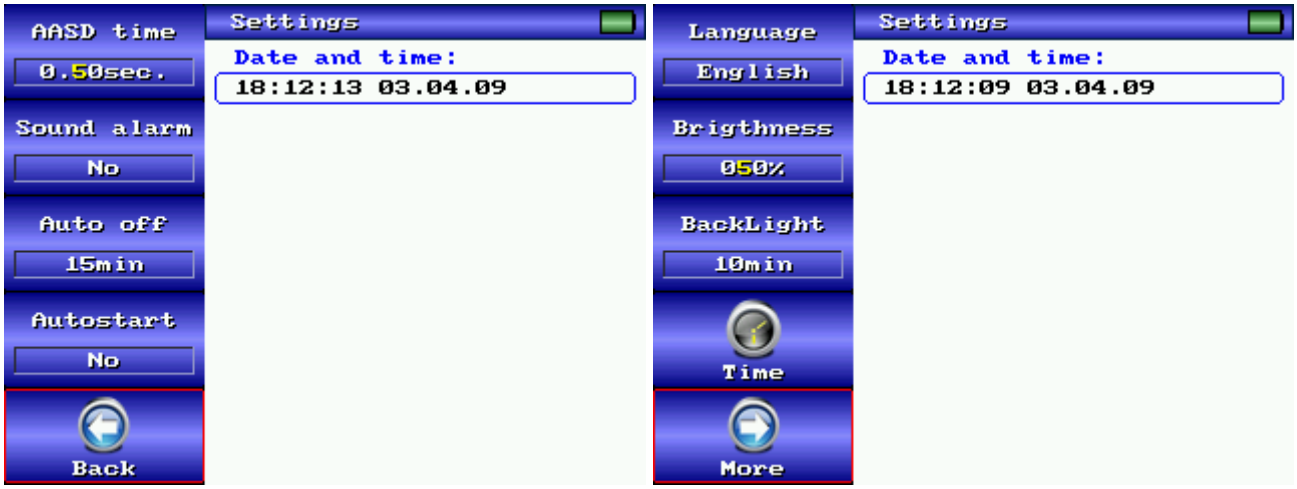


Fig. 18 General settings of the device (main and additional pages).

6.9 Device testing.

Screen testing.

Activate the item “Tests” in the main menu of the splash screen window. The screen will display the three-colored gradient-fill handling (see **Fig. 19**). Press the key **F1** to check accuracy of the primary colors displaying. Press the key ✘ to escape into the splash screen mode.

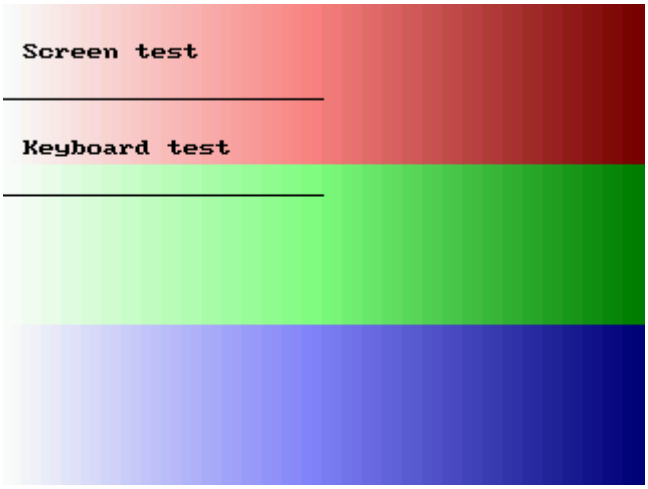


Fig. 19 Screen testing

Testing of the keyboard, sound and light alarm.

Activate the item “Tests” in the main menu of the splash screen window and press **F2**.

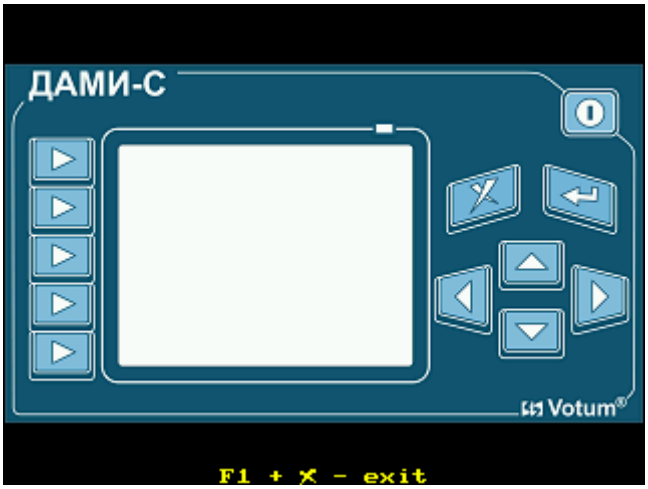


Fig. 20 Keyboard testing.

Press sequentially all keys to check operability of the keyboard. While pressing, an active key image will be red-colored on the screen; if it doesn't happen, a keyboard is considered to be faulty.

Besides that, the light and sound alarm must be automatically actuated at the frequency of 1Hz (alarm switch-on is duplicated by drawing of the red LED rectangle on the screen).

To escape from the keyboard testing mode, press the combination of keys F1+✕.

6.10 Device data accessing.

Activate the item "Help" in the main menu of the splash screen window. Following parameters are displayed in the appeared "Help" window (**Fig. 21**):

- "Software version" – splash screen program version;
- "Hardware version" – device hardware version;
- "FPGA version" – programmable logic firmware version;
- Serial number of the device;
- Device manufacturing date.

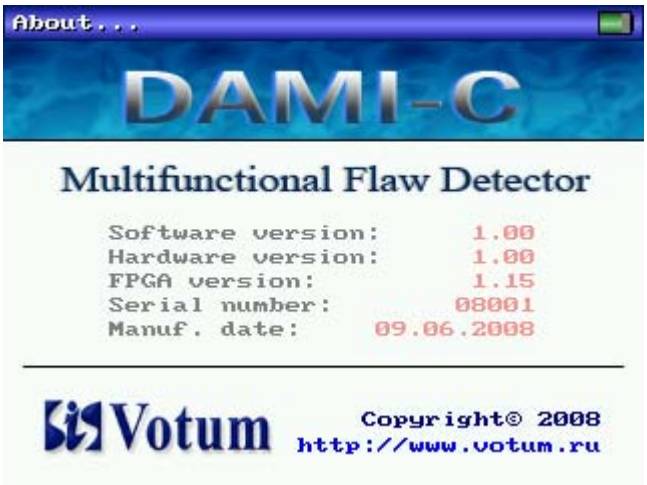


Fig. 21 "Help" window.

7.TECHNICAL SERVICE

Preventive works are carried out to provide the normal DAMI-C09 functioning during the operation process. The DAMI-C09 operational environment determines how often the preventive works are to be carried out.

Following terms of preventive measures are recommended:
- visual examination - every 3 months;
- external cleaning of the device frame - every 6 months.

8. TRANSPORTATION AND STORAGE

8.1 Packed DAMI-C09 devices are transported in closed transport vehicles of any kind, protecting the devices against moisture in accordance with the GOST 52931-2008, GOST 15150 (conditions 1.2) and in accordance with the rules and regulations prescribed for the corresponding kind of transport.

8.2 When transported by air, packed DAMI-C09 devices are to be placed in hermetically sealed and heated compartments. If the devices are transported by sea, transportation conditions must meet the storage conditions 1.2 according to GOST 15150.

8.3 During transportation, loading, unloading and storage, DAMI-C09 devices must not be struck, pushed, moistened. Packing positions must correspond to the package inscriptions.

8.4 Placing and fastening of shipping containers with the devices within vehicles must prevent their displacement, pushing, striking, jamming.

8.5 Packed DAMI-C09 devices must be stored in the room where the temperature and moisture are regulated in accordance with the storage conditions 1.2 under GOST 15150 at the temperature from 5°C to 15°C, upper value of relative humidity must not exceed 55% and the average annual value must not exceed 40% at 15°C. The storage room must be free of current-conducting dust, acid vapors, alkali as well as of corrosion-causing and insulation-breaking gases.

8.6 If DAMI-C09 devices are to be stored during more than 6 months, they must be taken out of shipping container and stored in accordance with the storage conditions 1.2 under GOST 15150. Unpacked devices must be put on the shelves: the distance between walls, storage floor and devices must not be less than 1 m; the distance between heating equipments and devices must not be less than 1 m.

8.7 Additional transportation and storage conditions can be stipulated in the contract with the recipient.

9. UTILIZATION

DAMI-C09 does not contain harmful substances. There are no special requirements to its utilization.

10. WARRANTIES AND RECLAMATIONS DATA

The manufacturer warrants the correspondence of DAMI-C09 to the requirements of the TU 427610-002-72932985-07 if the operation, transportation and storage conditions correspond to those prescribed by the TU 427610-002-72932985-07 specifications and the present OPERATION'S MANUAL VLNG 990109 RE.

DAMI-C09 **warranty period of storage** – 6 months from the day of its manufacturing.

DAMI-C09 **warranty period of operation** – 18 months from the day of its putting into operation within the warranty period of storage.

No warranty service is provided for the DAMI-C09 devices damaged in result of flat violations of the operating rules:

- mechanical damages of the device frame and connectors;
- screen damages owing to the device placing under too low (minus 35°C) or too high (plus 60°C) temperatures.

Warranty service or replace are not provided for:

- all kinds of transducers;
- batteries;
- connecting cables.

“Votum” company provides both warranty and post-warranty service for DAMI-C09 devices during their whole lifetime period. The warranty and post-warranty service address is:

RUSSIA, city Moscow
P/b 52
VOTUM Ltd,
Kronstadt boulevard, 7.
Tel./fax:
+7(495) 225-99-60
+7(495) 518-94-32
Internet: www.votum.ru
e-mail: votumbox@gmail.com

11.CERTIFICATES OF TEST AND INITIAL VERIFICATION

Certificate of test

Multifunctional testing instrument DAMI-C09, number _____ under the manufacturer's numbering system, corresponds to the TU 427610-002-72932985-07 specifications and is ready for operation.

Date of issue ___ _____ _____

Signature

P. S.

Certificate of initial verification

Multifunctional testing instrument DAMI-C09, number _____ under the manufacturer's numbering system, passed the initial verification and corresponds to the TU 427610-002-72932985-07 specifications.

Date of issue ___ _____ _____

Signature

P. S.

12. PACKING DATA AND CERTIFICATE

Packing data

A consumer package for the multifunctional testing instrument DAMI-C09 is a carrying case.

A consumer package contains DAMI-C09 device, operation documentation and mandatory delivery set components in the individual package.

A loaded consumer package, list of consumer package contents and shipping documentation are put into the shipping container.

Gaps between the walls, shipping container bottom and consumer package are filled with cushioning material, providing immobility of items in the shipping container.

Handling signs “Fragile. Handle with care!”, “Do not moisten!”, “Up”, “Do not turn over!” according to GOST 14192 are included into the shipping data sheet, which is adhered to the side surface of a shipping container and covered with a transparent protective film, providing the clearness and safety of inscriptions during the transportation within the given storage period.

Packing certificate

Multifunctional testing instrument DAMI-C09, serial number _____ is packed in accordance with the requirements of the TU 427610-002-72932985-07 specifications.

Date of packing

Packed by

P.S.

13.TROUBLE RECORDING DURING OPERATION

Date and time of the device or its component's failure. Operating mode, loading condition.	Kind (outer fault symptom) of the trouble	Trouble (failure) cause, number of working hours of the failed component	Measures taken for trouble elimination and note of reclamation	Position, name and signature of the person, responsible for the trouble elimination	Note

14. VERIFICATION METHOD

The present chapter establishes the methods and tools for the initial and periodic verification of the DAMI-C09 multifunctional instrument and auxiliary equipments from the DAMI-C09 delivery set.

The initial and periodic verifications are carried out by services of the National institution. Verification periodicity – once a year.

Volume and sequence of operations during the initial and periodic verifications must correspond to the table 2.

Table *2*

Operation	Verification's paragraph no.	Operation mandatoriness:		
		after the manufacturing	after repair	during the operation and storage
External examination	14.1	Yes	Yes	Yes
Testing	14.2	Yes	Yes	Yes
DAMI-C09 pulser verification				
Nominal values testing of the pulser amplitude	14.3.1	Yes	Yes	Yes
Testing of the excitation pulser operating frequency	14.3.2	Yes	Yes	Yes
Verification of auxiliary equipments from the DAMI-C09 delivery set (if they are available in the verified DAMI-C09 set)				
Conventional sensitivity testing of the PADI-8-02 impedance transducer per TS-2 testing specimen	14.3.3	Yes	Yes	Yes
Conventional sensitivity testing of the eddy-current transducer VTP-2-02 per standard specimen RSA-0,2-0,5-1.	14.3.4	Yes	Yes	Yes
Conventional sensitivity testing of the eddy-current transducer VTP-3-02 per standard specimen RSS-0,2-0,5-1.	14.3.5	Yes	Yes	Yes
Conventional sensitivity testing of the UDP-10-02 impact transducer on the TS-2 testing specimen	14.3.6	Yes	Yes	Yes
Estimation of the limit of admissible relative measurement error of the artificial defects square per TS-2 testing specimen.	14.3.7	Yes	Yes	Yes
Estimation of the limit of admissible measurement error of the defects coordinates	14.3.8	Yes	Yes	Yes

VERIFICATION TOOLS

During the verification, it is necessary to apply the tools indicated in the table 3.

All tools must be verified in the metrology service in accordance with the established procedure.

Verification tools and auxiliary equipments indicated in the table 3 can be replaced with identical ones, providing the necessary accuracy rating.

Table 3

Paragraph No. of the verification procedure instructions	Description of the working standard or auxiliary measurement tool; no. of the document, regulating technical requirements; metrological performance and main technical characteristics
14.3.1, 14.3.2	Oscilloscope C1-99 Frequency range from 0 to 100 MHz Researched signal amplitude with the 200 V divisor 150 ohms loading
14.3.3, 14.3.6 14.3.7	TS-2 testing specimen (**APPENDIX 2**).
14.3.4, 14.3.5	Standard specimens RSA-0,2-0,5-1 и RSS-0,2-0,5-1 (**APPENDIX 3**).

SAFETY REQUIREMENTS

During verification, the safety requirements of GOST 12.3.019 and sanitary norms SN 245 must be observed.

VERIFICATION CONDITIONS ACCORDING TO GOST 8.395

Verification must be carried out under the following conditions:

Environmental temperature (25 ± 10)°C.

Relative humidity (65 ± 15) %.

Atmospheric pressure from 84 to 107 kPa.

Power supply from an alternating-current mains (220±15)V, maximal high harmonic content is not more than 5%.

Alternating-current mains frequency – (50 ± 0,5) Hz.

External electrical fields and magnetic fields must be within the limits, in which they do not have an impact on the DAMI-C09 operation.

The environment must be free of gases, vapors, suspended particles, actively destroying the DAMI-C09 materials and components.

VERIFICATION PREPARATION

Before the start of verification, DAMI-C09 must be kept under normal conditions during at least 8 hours.

Before the verification, DAMI-C09 and verification tools are prepared for operating according to their OPERATION'S MANUAL.

Before measurement of parameters, DAMI-C09 must be warmed up during at least 15 minutes.

VERIFICATION PROCEDURE

14.1 EXTERNAL EXAMINATION

External examination must establish the correspondence of DAMI-C09 to the following requirements:

- delivery set composition according to the OPERATION`S MANUAL;
- absence of evident mechanical damages of DAMI-C09 and its components.

14.2 TESTING

During the DAMI-C09 testing, the operations are carried out, which are indicated in the OPERATION`S MANUAL chapter "Setting-up procedures, controls and indication".

Launch the "Impedance Defectoscope" program;

Connect the PADI-8-02 transducer (further PADI-8), proceed to the main menu item "Spectrum", read the spectrum, holding the transducer in the air and make sure that the received spectrum has a clearly expressed resonance peak within 10 kHz;

Select the item "Oscillograph", changing the parameters "number of periods", "gain" and make sure that these parameters change the signal on the screen and the device is operable.

14.3 **DAMI-C09 PULSER VERIFICATION**

14.3.1 **Testing of the pulser amplitude nominal values.**

14.3.1.1 Assemble the stand according to the scheme illustrated in **Fig. 22**.

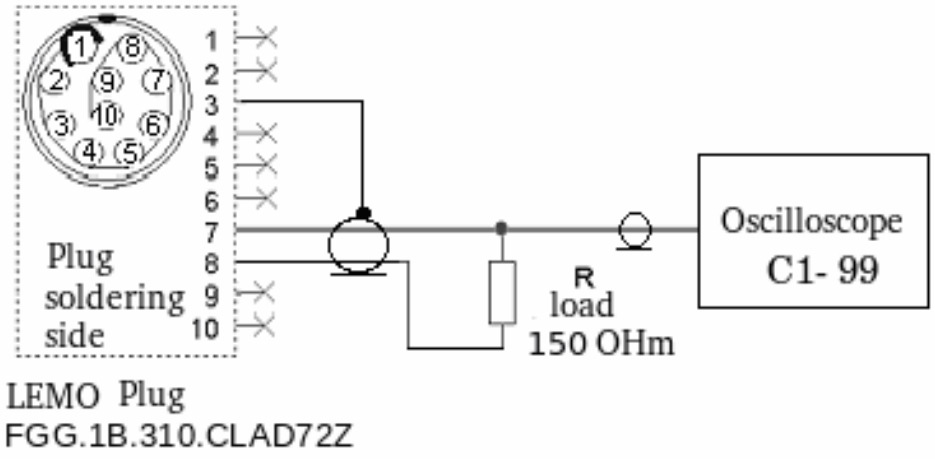


Fig. 22 Workbench scheme for the amplitude and pulse-repetition frequency nominal value testing.

14.3.1.2 Connect the LEMO plug of the stand to the DAMI-C09 transducer socket, connect DAMI-C09 and oscilloscope to the network and warm up during 10 minutes.

14.3.1.3 Start the “Impedance defectoscope” program, select the main menu item “Oscillograph”, set the parameter “Frequency” to be equal to 10 kHz.

14.3.1.4 Measure the excitation pulse A-range (Fig. 23) of one pulser output (7 or 8) relative to the common point, using the oscilloscope’s CRT. This value corresponds to the excitation pulse amplitude measured between the two pulser outputs.

14.3.1.5 Repeat the **p. 14.3.1.4** measurements for the frequencies of 200 Hz and 50 KHz.

14.3.1.6 DAMI-C09 is considered to stand testing if the measured excitation pulse amplitude values are within (5 ± 1) V.

14.3.2 Testing of the excitation pulser operating frequency range

14.3.2.1 Assemble the stand according to the scheme given in the **Fig. 22.**

14.3.2.2 Connect the LEMO plug of the stand to the DAMI-C09 transducer socket, connect DAMI-C09 and oscilloscope to the network and warm up during 10 minutes.

14.3.2.3 Start the “Impedance Defectoscope” program, select the main menu item “Oscillograph”, set the parameter “Frequency” to be equal to 1 kHz.

14.3.2.4 Measure the T (s) length of the excitation pulse packet at the C1-99 oscilloscope’s CRT as depicted in the **Fig. 23** and determine the number of packet periods (N). Estimate the pulse repetition frequency F, Hz, using the formula: F=N/T.

14.3.2.5 Set the DAMI-C09 parameter “Frequency” to be equal to 40 kHz and perform **p. 14.3.2.4**.

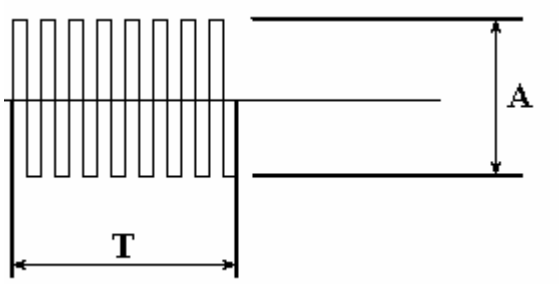


Fig. 23 Evaluation of the pulse packet repetition frequency

14.3.2.6 Download the “Eddy current defectoscope” software. Select the main menu item “Oscillograph”, set the parameter “Frequency” to be equal to 100kHz and perform the **p. 14.3.2.4**.

14.3.2.7 Set the parameter “Frequency” to 1MHz and perform the **p. 14.3.2.4**.

14.3.2.8 DAMI-C09 is considered to stand testing if the value F has less than 10% difference from the preset frequency in each of four cases.

14.3.3 Conventional sensitivity testing of the PADI-8 impedance transducer per TS-2 testing specimen

14.3.3.1 Connect the PADI-8 transducer, turn DAMI-C09 on and start the “Impedance defectoscope” program.

14.3.3.2 Perform the setting on the TS-2 testing specimen according to the **p. B.2.2 (APPENDIX B).**

14.3.3.3 Conventional sensitivity of PADI-8 corresponds to the required norms if a defect with the 7 mm x 7 mm size is surely detected on the TS-2 testing specimen.

14.3.4 Conventional sensitivity testing of the eddy-current transducer VTP-2-02 per RSA-0,2-0,5-1 standard specimen.

14.3.4.1 Connect the VTP-2-02 transducer (further VTP-2), turn DAMI-C09 on and start the “Eddy-current defesctoscope” program.

14.3.4.2 Perform the setting on the RSA-0,2-0,5-1 specimen according to the p. **C.2.2 (APPENDIX C)**.

14.3.4.3 Conventional sensitivity of DAMI-C09 corresponds to the required norms if a 0.2 mm deep defect is surely detected on the enterprise’s RSA-0,2-0,5-1 standard specimen.

14.3.5 Conventional sensitivity testing of the eddy-current transducer VTP-3-02 per RSS-0,2-0,5-1 standard specimen.

14.3.5.1 Connect the VTP-3-02 transducer (further VTP-3), turn DAMI-C09 on and start the "Eddy-current defesctoscope" program.

14.3.5.2 Perform the setting on the RSS-0,2-0,5-1 specimen according to the p. **C.2.2 (APPENDIX C)**.

14.3.5.3 Conventional sensitivity of DAMI-C09 corresponds to the required norms if a 0.25mm deep defect is surely detected on the enterprise's standard specimen RSS-0,2-0,5-1.

14.3.6 Conventional sensitivity testing of the UDP-10-02E transducer on the TS-2 testing specimen.

14.3.6.1 Connect the transducer UDP-10-02E, turn on DAMI-C09 and launch the "Impedance defectoscope" program.

14.3.6.2 Perform the setting on the TS-2 testing specimen according to p. **D.2.4** (**APPENDIX D**).

14.3.6.3 Conventional sensitivity of UDP-10-02E corresponds to the required norms if the defect sized 7mm x 7mm is surely detected on the TS-2 testing specimen.

14.3.7 Testing of the limit of admissible estimation error of the artificial defects square. Check of the light and sound defect alarm.

14.3.7.1 Connect the PADI-8 transducer, turn DAMI-C09 on and start the "Impedance defectoscope" program.

14.3.7.2 Perform the setting on the TS-2 testing specimen according to the **p. B.2.2 (APPENDIX B).** Save the received setting in the device archive.

14.3.7.3 Connect the scanning device "Slider" according to the **p. B.2.7 (APPENDIX B).** Determine the defect squares (12 mm x12 mm) and (20 mm x20 mm). Perform not less than three measurements.

14.3.7.4 Estimate the limit value of admissible relative error (in per cent) for determination of each defect square (12 mm x12 mm) and (20 mm x20 mm), using the formula:

$$\delta = 100*\max(|S1-Sst|/Sst, |S2-Sst|/Sst, |S3-Sst|/Sst); \quad (1)$$

where:

Sst - calibrated value of the defect area;

Si, i=1, 2, 3 – measurements of the defect area.

14.3.7.5 DAMI-C09 is considered to stand the relative error estimation testing of the artificial defects square per TS-2 testing specimen if δ is $\leq$ 30% for each of the defects (12 mm x12 mm) and (20 mm x20 mm). The image of these defects is formed on the DAMI-C09 display; the light and sound defect alarms are switched on if the transducer is in the defected area.

14.3.8 Estimation of the limit of admissible relative measuring error of the defect coordinates.

14.3.8.1 Connect the PADI-8 transducer, turn DAMI-C09 on and start the "Impedance defectoscope" program.

14.3.8.2 Perform the setting on the TS-2 testing specimen according to the **p. B.2.2 (APPENDIX B).**

14.3.8.3 Save setting in the archive, pressing the menu item "Save..".

14.3.8.4 Activate the main menu item "C-scan", load the setting saved in the **p.14.3.8.3**.

14.3.8.5 Place the transducer in the upper left hole of the TS-2 testing specimen, press "Point1"; place the transducer in the lower right hole of the TS-2 testing specimen and press "Point2".

14.3.8.6 Scan zone is displayed on the screen; its actual sizes are displayed in mm (A – width, B - height). Perform not less than three measurements.

14.3.8.7 Evaluate the relative estimation error for each of the distances in per cent (%), using the formula:

$$\delta = 100*\max(|D1-Dct|/Dct, |D2-Dct|/Dct, |D3-Dct|/Dct); \quad (2)$$

where:

Dst . calibrated value of distances;

Di, i=1,2,3 – measured distances.

14.3.8.8 DAMI-C09 is considered to stand testing if the relative error δ does not exceed 5%.

REGISTRATION OF VERIFICATION RESULTS

Verification results are recorded in the protocol (verification protocol form - **APPENDIX 1**).

If verification results are positive, a certificate of verification in accordance with PR 50.2.006 is issued.

If verification results are negative, DAMI-C09 or corresponding auxiliary equipments from the DAMI-C09 delivery set are considered to be faulty; a certificate of failure according to PR 50.2.006 is issued, containing the trouble causes.

APPENDIX 1 DAMI-C09 VERIFICATION PROTOCOL FORM

PROTOCOL NO. _____from "_____"_____

about the verification of the multifunctional testing instrument DAMI-C09

_____

(serial number, manufacturer)

_____

1. Verification conditions:
- ambient air temperature, _____°C;
- relative humidity,_____%

2. Applied measurement instruments :

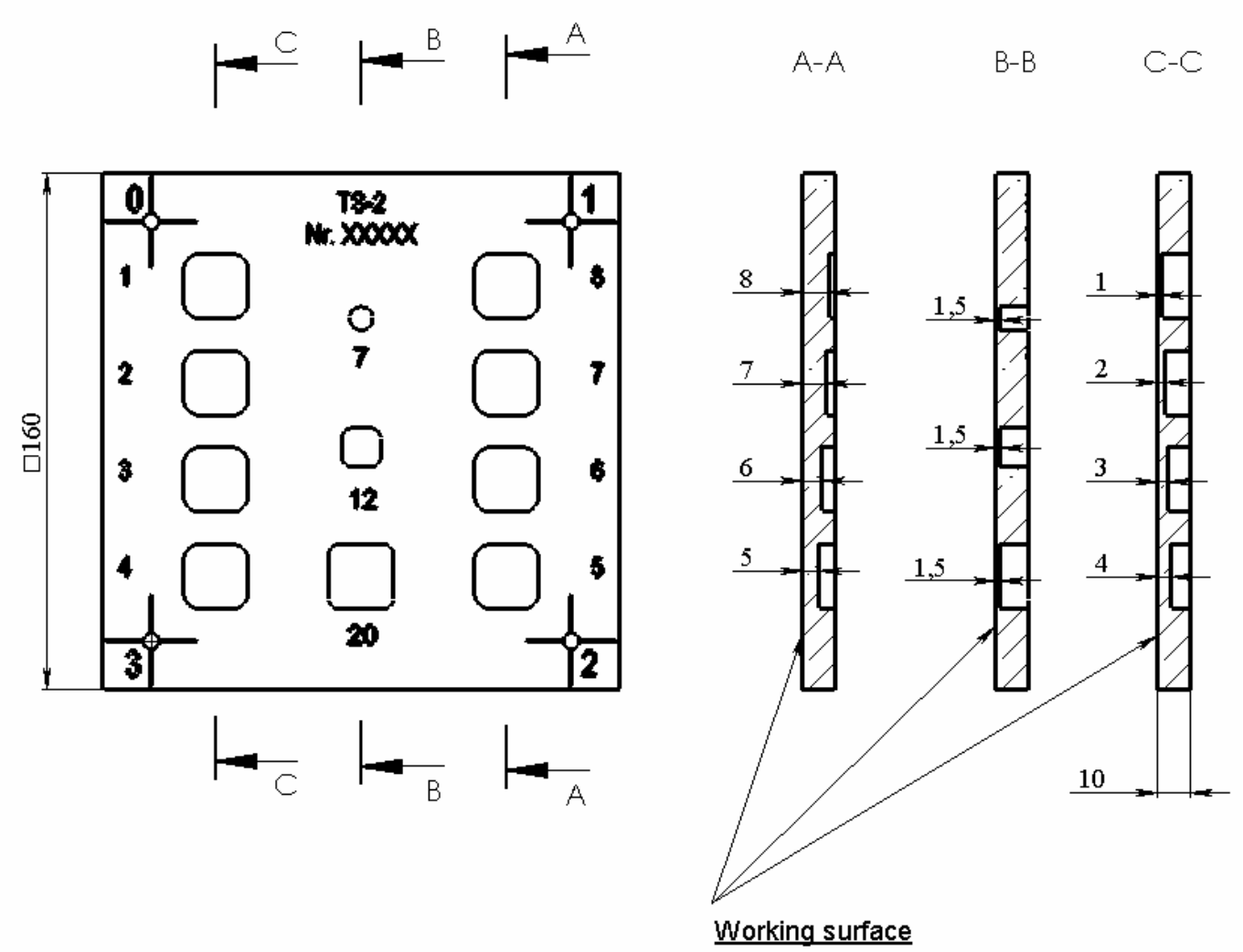
3. Verification results:

Verified parameters	Norm	Real value	Conclusion

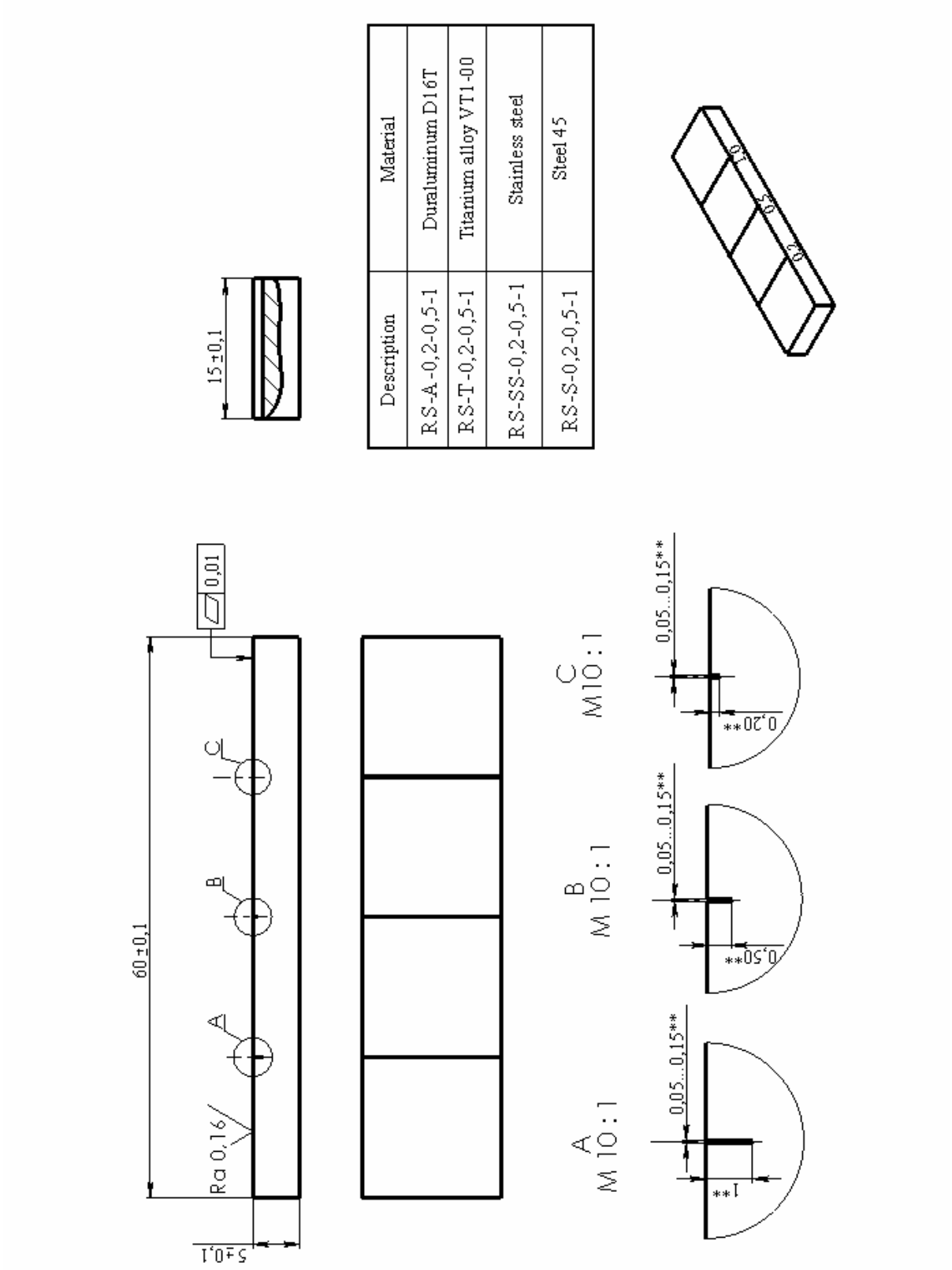
4. General conclusion:

Verified by _____

APPENDIX 2 TS-2 TESTING SPECIMEN



APPENDIX 3 EDDI CURENT TESTING SPECIMENS OF THE “RS”-SERIES



APPENDIX A "OPERATOR'S WORKBENCH". OPERATOR`S MANUAL

A.1 Intention of the "Operator's workbench" program

The DAMI Operator's workbench software, further – Operator's workbench, allows to set up connection via USB protocol between the DAMI-C09 device (further - device) and personal computer (PC) for the:

- device software control (installation/removal);
- uploading of testing results from the device into the computer database and their presentation as reports (testing protocols).

A.2 Minimal system requirements

"Operator's workbench" is compatible with any computer controlled with one of the following operating systems: Windows 98, NT4.0, 2000, XP, Vista.

Minimal computer requirements:

- processor Pentium-200 and higher;
- Operating system: Windows 98, 2000, XP, Vista;
- At least 32 Mb main memory;
- At least 20 Mb free hard disk space;
- Standard keyboard;
- Standard mouse;
- Free USB socket.

A.3 Program installation and removal

A.3.1 How to install the "Operator's workbench" program.

To install the Operator's workbench program on PC, run the file **"AWP DAMI\setup.exe**", which is placed on the installation compact disk and follow the installation program instructions. The dialog box with indication to connect DAMI-C09 to PC for USB driver installation will be displayed in one of the installation steps (see **Fig. A. 1**).

Fig. A. 1 USB driver installation.

Connect the device to one of accessible USB ports of PC, using the USB cable from the DAMI-C09 delivery set; turn on the device. Make sure that the splash screen program is activated (see **Fig. 5**). After the device is turned on, the screen will display a message that a new USB device is found (see **Fig. A. 2**).

Fig. A. 2 New USB device is found.

Press “Cancel” in the device update wizard window, appeared:

Fig. A. 3 Device update wizard.

Press “Next” in the USB driver installation window (see **Fig. A. 1**); finish installation of the “Operator’s workbench” program, following the installation instructions.

A.3.2 How to remove the “Operator’s workbench” program.

To remove the “Operator’s workbench” from PC, use the standard Windows feature "Add\Remove programs" of the Control Panel.

A.4 Work order

Launch the program from the taskbar “Start\All Programs\AWP DAMI-C”. The screen will display the program operating window (**Fig. A. 4**Ошибка! Источник ссылки не найден.). Connect the device to one of the accessible USB ports of PC, using the USB cable from the DAMI-C09 delivery set.

All actions for the device software control (installation, update, removal) as well as uploading of testing results from the device are available only in the DAMI-C09 “File Manager” program. The loaded programs (“Impedance defectoscope”, “Eddy current defectoscope”, etc.) only enable to take screenshots.

A.4.1 Device connection indicator

The first toolbar item is the device connection indicator. The connection is automatically set at the moment when the USB cable is connected to PC. If the DAMI-C09 device is connected to PC and the program can set connection with it, the indicator will be green-colored (**Fig. A. 5**). If not, it will be red-colored (**Fig. A. 4**).

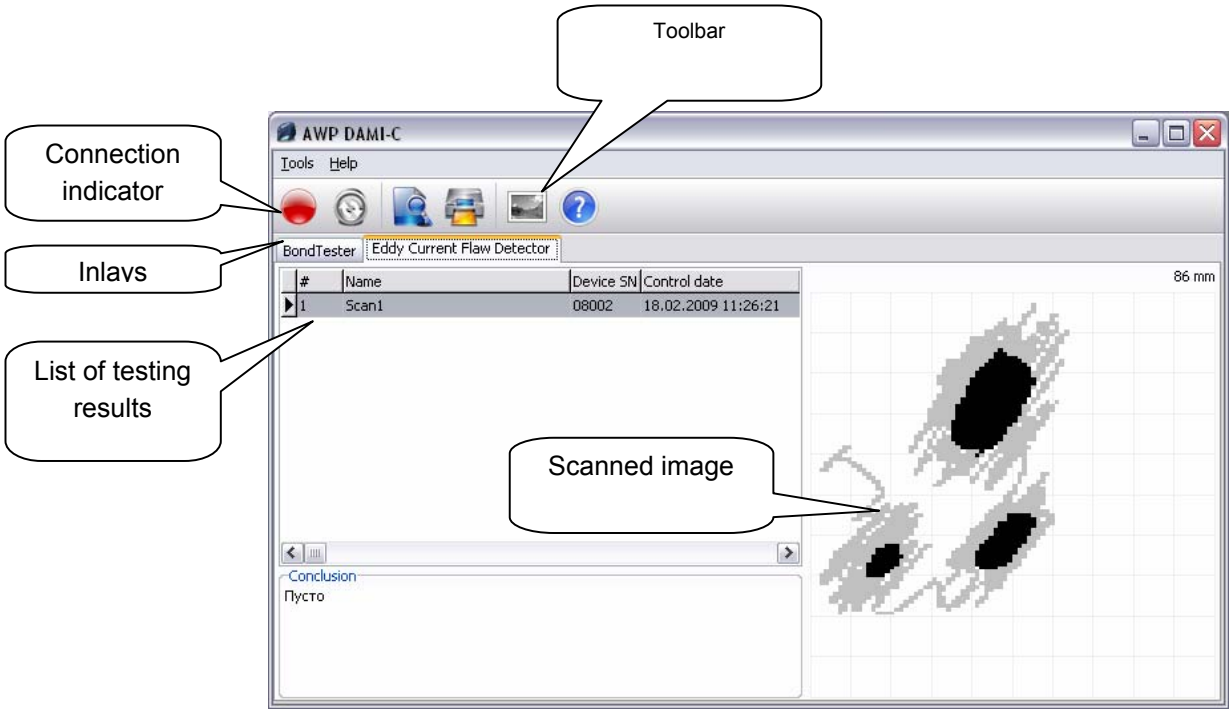


Fig. A. 4 Program operating window.

A.4.2 List of installed DAMI-C09 programs and the connected device data

After the DAMI-C09 connection is set, the "Operator's workbench" program finds the list of installed DAMI-C09 programs as well as the general data of the device (**Fig. A. 5**). Received information is displayed in the inlay "Device" (if the connection is not set, this inlay is unavailable (**Fig. A. 4).**

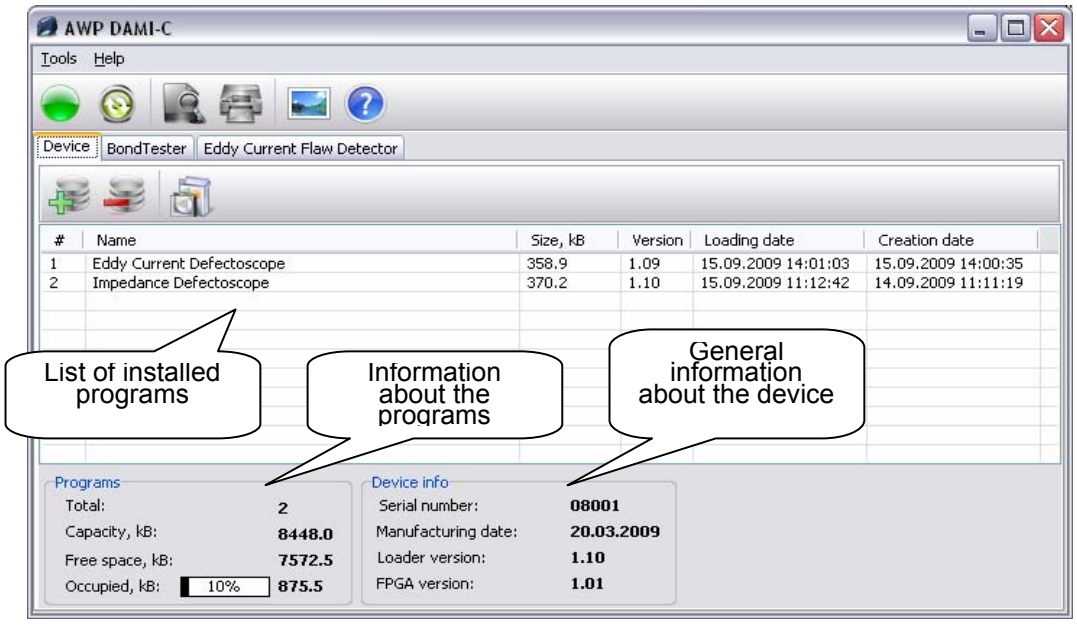


Fig. A. 5 Inlay "Device".

The list of installed programs provides information about each of installed DAMI-C09 programs:

- size in Kbyte;
- program version;

- date of program uploading into the device;
- date of program creation.

In the lower part of the inlay, the information about the DAMI-C09 programs archive is displayed:

- programs archive capacity ;
- free\busy memory of the programs archive

and information about the DAMI-C09 device:

- manufacturing date;
- serial number;
- loader version – shell program version installed in the device and providing the application software start and general settings;
- FPGA version – firmware version of the programmable logic (is used to control the receiver\generator path of the device).

A.4.3 Program installation on DAMI-C

To install the program on the device, enter the inlay “Device” and press the toolbar key “Install program”. The dialog box with a proposal to select the program package file - *.PKG extension file will be displayed. If the DAMI-C09 programs archive does not have enough memory for program installation, a corresponding message will be displayed.

A.4.4 DAMI-C09 programs updating

Updating means the program installation over an earlier version. The user gets a possibility to store the saved settings and results. Last versions of the DAMI-C09 software can be found in the website www.votum.ru, “Software\DAMI-C09 updating”.

Note: to update the DAMI-C09 programs correctly, the software updating must be performed as follows:

- Make sure that the last “Operator’s workbench” software is installed on PC. If not, remove the “Operator’s Workbench” and upload the last version from the producer’s website;
- Make sure that the last “File manager” program version is installed into the device (the file manager version is displayed in the “Operator’s Workbench”, inlay “Device”, device info). If not, update the file manager (see **p. A.4.5**);
- Update the program;

To update the program, it is necessary to perform the same actions as described in **p.A.4.3**. But the window with a query to save settings and results will be displayed. If “Save settings and archives” is ticked off, saved testing results and settings will be saved for a new program version (**Fig. A. 6**.

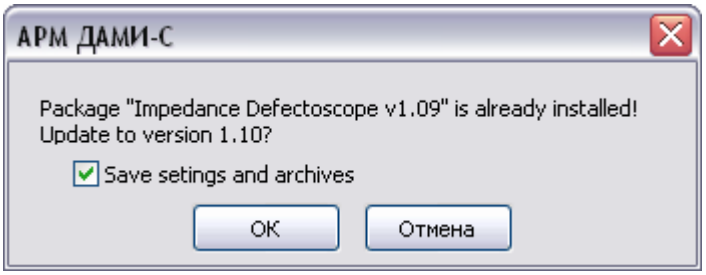


Fig. A. 6 Program update query.

A.4.5 File manager updating

To update the file manager (splash screen program), enter the inlay “Device” and press the toolbar key “Update File Manager”. A dialog box with a proposal to select the program package file - *.SPG extension file will be displayed.

A.4.6 DAMI-C09 program removal

To remove an installed program, enter the inlay “Device” and press the toolbar key “Remove program”. The program and all program data (settings, testing results, etc.) will be removed.

A.4.7 Testing results transmission from DAMI-C09 into PC

To upload testing results from DAMI-C09 into the PC database, press the main toolbar key “Synchronization”. Received results are compared with the PC database under certain criteria to prevent the duplication of records.

A.4.8 How to view testing results on PC

Except the inlay “Device”, there is a range of inlays that correspond to each of the programs, which can be installed into the device. Each inlay displays the list of testing results.

When activating a testing result with a mouse click, a scanned two-dimensional image is displayed in the right upper part. The operator has a possibility to add a conclusion about the received results in the field “Conclusion”.

A.4.9 How to print the testing protocol from PC

To print a protocol, select a record in the results list, which protocol must be printed and press the toolbar key “Print control protocol”. For the report preview, press the key “Preview control protocol”.

A.4.10 How to take screenshots

To take a DAMI-C09 screenshot, enter the main toolbar and press the key “Take DAMI-C09 screenshot”. The screen will display a window with a received screenshot (see **Fig. A. 7),** giving a possibility to save screenshot on the disk (“Save screenshot” key). There is also a possibility to update screenshot (“Update screenshot” key).

Fig. A. 7 Taking a DAMI-C09 screenshot.

4.1 How to get information about the “Operator’s workbench” program

Press the toolbar key “About…”. The screen will display a window with information about the program version and manufacturer company.

APPENDIX B "IMPEDANCE DEFECTOSCOPE". OPERATOR`S MANUAL

B.1 INTENTION OF THE “IMPEDANCE DEFECTOSCOPE” PROGRAM

The “Impedance Defectoscope” program is intended for:

- impedance testing of composite materials and honeycomb structures to detect delaminations and disbonds, frequency anomalies, etc. (frequency range 200Hz-50KHz).
- working with a single PADI-8-02 (further PADI-8) probe and a dual PC-1-02 (further PC-1) probe.
- creating of testing object settings with a possibility of their saving in the device archive for further use;
- building of two-dimensional defect images (C-scan) with a possibility of their saving in the device archive and uploading into PC for saving and representing them as reports.

B.2 WORK ORDER

B.2.1 Program control

Read p. 6.5 “Graphical user interface” of the Multifunctional bond testing & eddy current Operation’s manual to learn the general principles of the DAMI-C09 program operation.

The principal functions of the program are available through the main menu (**Fig. B. 1**).

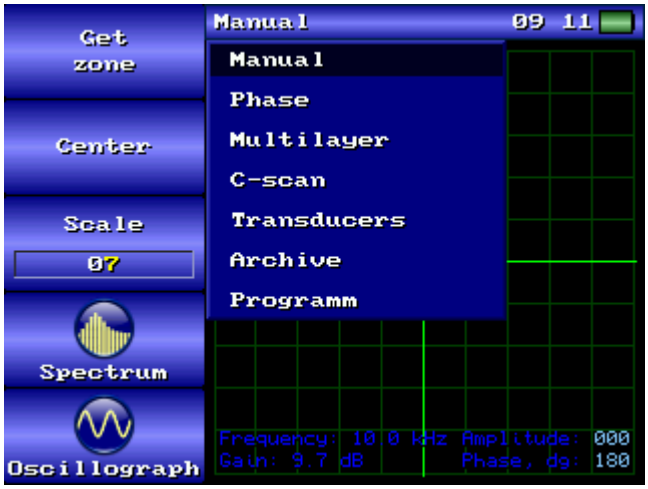


Fig. B. 1 Program main menu

Main menu items:

- **“Manual”** - setup and testing mode based on the amplitude-phase method, using a complex plane;
- **“Phase”** - setup and testing mode based on the phase method;
- “**Multilayer”** – the testing is simultaneously performed by several settings (manual or phase settings);
- **“C-scan”** – build of two-dimensional defect images;
- “**Transducers**” – the archive of non-intellectual transducers;
- **“Archive”** – archive of saved settings and testing results;
- **“Program”** – the “Program” info, exit from the program into the splash menu as well as displaying of the intellectual probe’s data (if that is connected).

B.2.2 Manual setting.

In the manual setting, the signal received from the transducer is analyzed, using the amplitude-phase method. The signal is represented on the complex plane as a marker.

Some additional parameters are displayed in the lower part of the complex plain:

– current frequency and gain;

– name of the setting, description and number of the probe (is displayed if the setting is saved);

– distance from the marker till the origin of coordinates estimated in pixels (parameter “Amplitude”, pixels) and the angle of marker inclination relative to the horizontal axle estimated in degrees (parameter “Phase”).

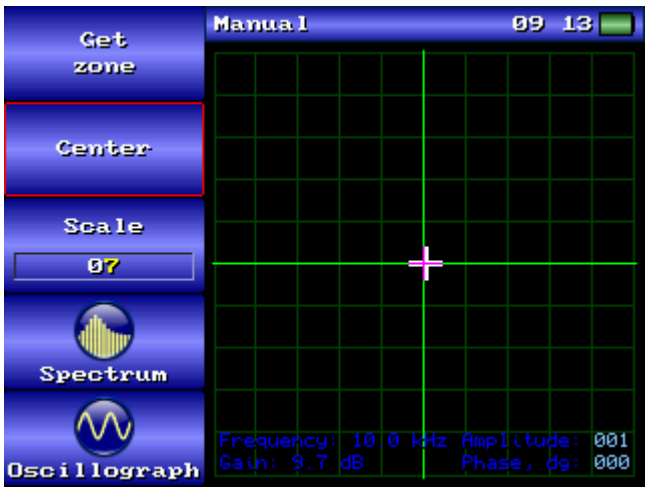


Fig. B. 2 Complex plane

Work order:

– go to the manual setting mode. Select the main menu item “Manual”;

– go to the phase setting mode – select the main menu item “Phase”;

– set the probe operating frequency. For this purpose, place the probe on the defect-free area and activate the spectrum analyzer mode by pressing the key “Spectrum” (see p.**B.2.5**). If the operating frequency is already known, it can be manually set in the oscillograph mode. To go to the oscillograph mode, press the key “Oscillograph” (see p. **B.2.6**);

Note: *if the operating frequency is manually set (in the oscillograph mode), set the optimal gain. For this purpose, go to the “Oscillograph” mode (see p.* **B.2.6** *). Determine the specimen’s area, on which the maximum signal amplitude of the oscillograph graph is observed. It can be both defected and defect-free area. Place the probe on the area, having the maximal amplitude, and press the key “Optimal gain”.*

- place the transducer on the known defect-free area of the specimen. Select the necessary scale so that the marker does not go beyond the border of the imaginable rectangle when moving on the defect-free area. The side length of the imaginable rectangle is equal to 4 divisions of the complex plain grid. If necessary, center the marker by pressing the menu item “Center”. Holding the probe on the defect-free area, activate the menu item “Get zone”;

- move the transducer (several back-and-forth motions) on the specimen’s defect-free area; the marker movement trajectory will be simultaneously displayed (blue-colored), forming the friction noise zone (FNZ). Press the menu item key **“Fill zone”** to fill the friction noise zone.

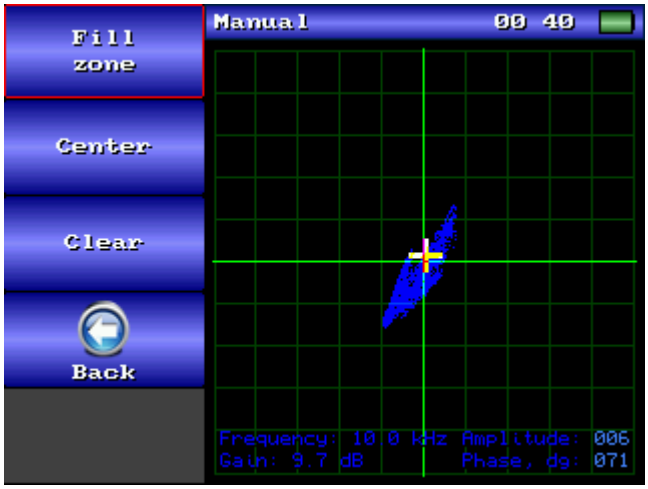


Fig. B. 3 Getting of the friction noise zone.

Note 1: *if a probe is taken away from the surface during formation of the friction noise zone, the zone can be deleted by pressing of menu item key "Clear" and then formed again.*

Note 2: *if the scale was wrongly selected (the zone is too large or the marker goes beyond the screen border), there is a possibility to return and adjust the complex plane scale, pressing the menu item key "Back".*

- desensitize (widen) the friction noise zone so that no defect alarm actuations happen while moving the transducer on the defect-free area (the marker must not go beyond the zone edge). For this aim, use the direction key to select direction for the area change.

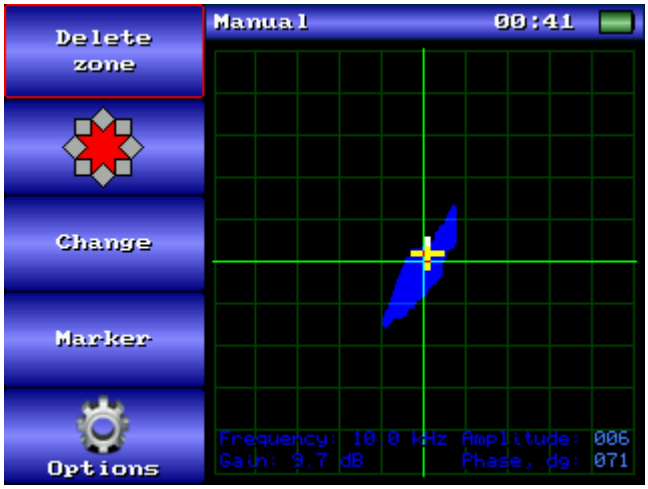


Fig. B. 4 Selection key for change of the FNZ direction.

Note: *while activating the functional menu item illustrated in the* **Fig. B. 4**, *press the keys ◀,▲,▶,▼ to move the (red-colored) indicator inside the "star" to select the necessary direction for the FNZ widening.*

Activate the menu item "Change" – increase/decrease the zone in the selected direction (key ◀ - decrease the zone, ▶ - increase the zone).

After the zone desensitization, the setting is ready for operation. While placing the transducer on the defected area, the marker will go beyond the FNZ edge; the light\sound defect alarm will be actuated.

While working at the maximum high sensitivity, the marker drift can be observed with a lapse of time, i.e. the marker may go beyond the zone edge (although the transducer is placed on the defect-free area). The marker position can be corrected manually, using the menu item "Marker". While pressing the keys ◀,▲,▶,▼, the marker is moved in the corresponding direction.

A received setting can be saved in the archive of settings for the reuse. For this purpose, activate the item “Options”\“Save”.

To view the saved setting’s signal in the oscillograph mode, press the key “Options”\“Oscillograph”.

B.2.3 Phase setting.

Informational parameter of the phase setting is the phase of the signal received from the transducer. In the pie chart, a phase is the vector's tilt angle (white radial line) relative to the X-direction.

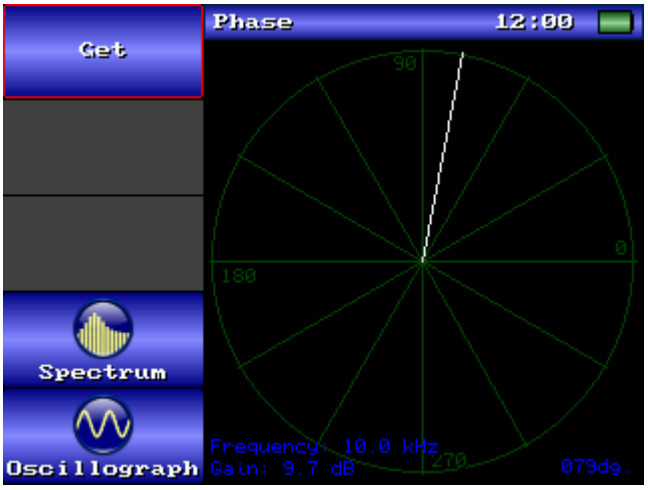


Fig. B. 5 Pie chart of the phase setting.

Work order:

- Go to the phase setting mode – select the main menu item “Phase”.
- Set the probe operating frequency. For this purpose, place the probe on the defect-free area and activate the spectrum analyzer mode by pressing the key “Spectrum” (see **p. B.2.5**). If the operating frequency is already known, it can be manually set in the oscillograph mode. To go to the oscillograph mode, press the key “Oscillograph” (see **p.B.2.6**).

Note: *if the operating frequency is manually set (in the oscillograph mode), set the optimal gain. For this purpose, go to the “Oscillograph” mode (see p.* **B.2.6***). Determine the specimen’s area, on which the maximum signal amplitude of the oscillograph graph is observed. It can be both defected and defect-free area. Place the probe on the area, having the maximal amplitude, and press the key “Optimal gain”.*

- Place the probe on the defect-free area, activate the menu item “Take”. Get FNZ, making several back-and-forth motions of the probe on the defect-free surface of the specimen. FNZ will be displayed as a sector (blue-colored).

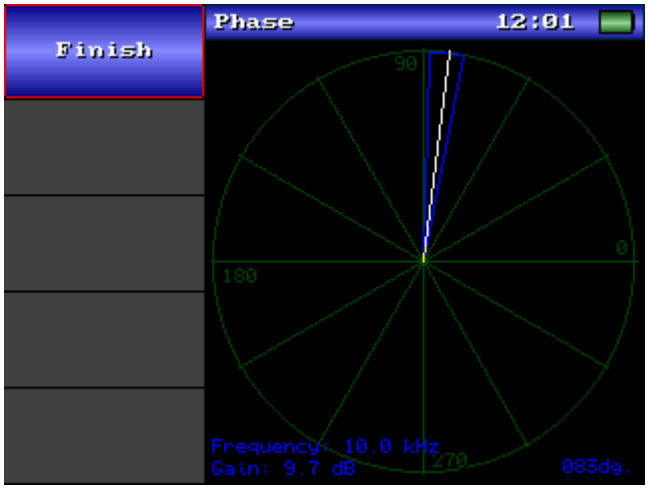


Fig. B. 6 Formation of the friction noise zone.

-Finish formation of the friction noise zone, activating the menu item “Finish”. The screen will display the menu items with the start\end FNZ angle.

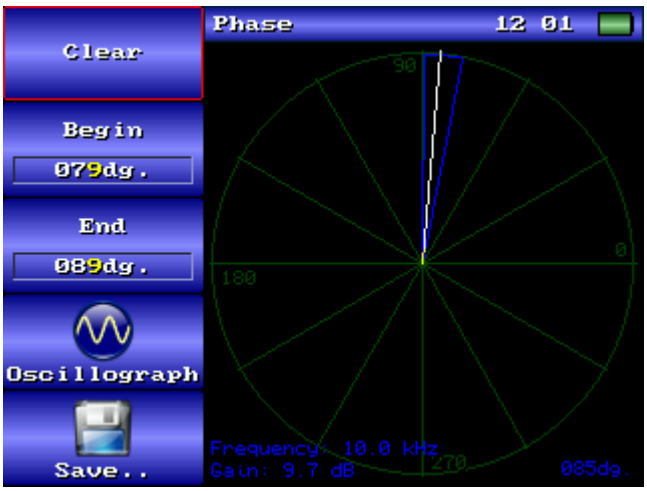


Fig. B. 7 Zone “desensitization”

-- “Desensitize” (increase) FNZ, using the menu item keys “Begin” and “End” – i.e. start and end angles of the FNZ sector to prevent false alarm actuations.

A received setting can be saved in the archive of settings for the reuse. For this aim, it is necessary to activate the item “Save..”.

To view the saved setting’s signal in the oscillograph mode, press the key “Oscillograph”.

B.2.4 Multilayer setting

Multilayer setting enables to simultaneously test under using of several settings (manual or phase settings). The total number of settings can reach three ones.

Work order:

- Go to the multilayer setting mode by selecting the main menu item “Multilayer”.

Fig. B. 8 Multilayer setting mode.

- Add the pre-made manual and phase settings into the list of settings (layers). I.e., the archive of settings must have the necessary number of settings. To add, press the key “Add”. The screen will display the archive settings selection frame.

Fig. B. 9 Selection of the added setting from the archive.

- Use the key “Record” to select the necessary setting and download it by pressing the key “Load”.

Fig. B. 10 List of the multilayer setting’s layers.

- Finish creation of the multilayer setting by pressing the key “Finish”. Go to the testing mode.

Fig. B. 11 Multilayer setting testing mode.

Then the setting is available to carry out testing. By placing the probe on the defected area, the light\audible alarm is activated. The defect alarm indicator of each layer is displayed above the settings list.

Additionally, the multilayer setting mode provides opportunities to:

– save setting in the archive of settings. To repeatedly use the saved setting, save it in the archive of settings by pressing the key “Save..”.

– create a new setting. To create a new multilayer setting, press the key “Clear”. The list of layers will be cleared. The program will start editing the layers.

– edit the current setting. To edit the current setting, press the key “Change”. The program will go to the layer editing mode.

– view settings from the list of layers. Use the key “Layer” to select the necessary setting. To view the setting, press the key “Show”. Return from the settings view mode by pressing the key “Table”.

B.2.5 “Spectrum analyzer” mode

The “Spectrum analyzer” mode serves to find the probe operating frequency, showing the maximal difference of signals of the defected and defect-free areas (i.e. maximal response level).

The “Spectrum analyzer” mode can be activated from the manual or phase setting by pressing the key “Spectrum”. The spectrum will be taken on the defect-free area by pressing the key “Take” (i.e., before pressing, the probe must be placed on the defect-free area). The screen will display the graph of the defect-free area (green-colored). Place the probe on the defect area and activate the item “Take\Defect”. The screen will display the graph of the amplitude-phase spectrums difference on the defected and defect-free areas (red-colored). The received frequency value will be displayed in the functional menu item “Frequency, kHz”.

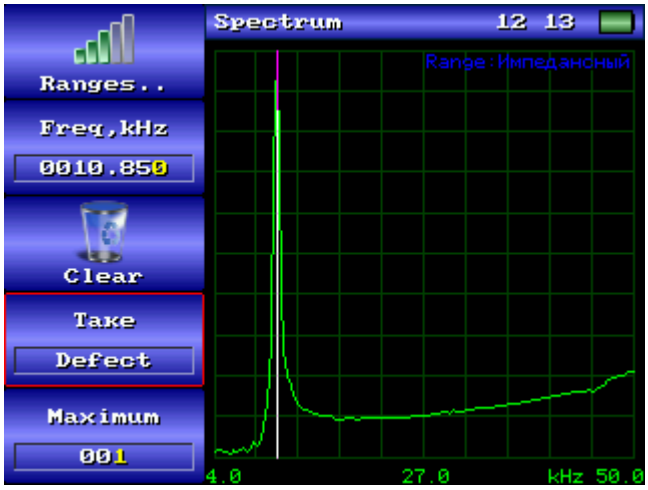


Fig. B. 12 Spectrum taken on the defect-free area.

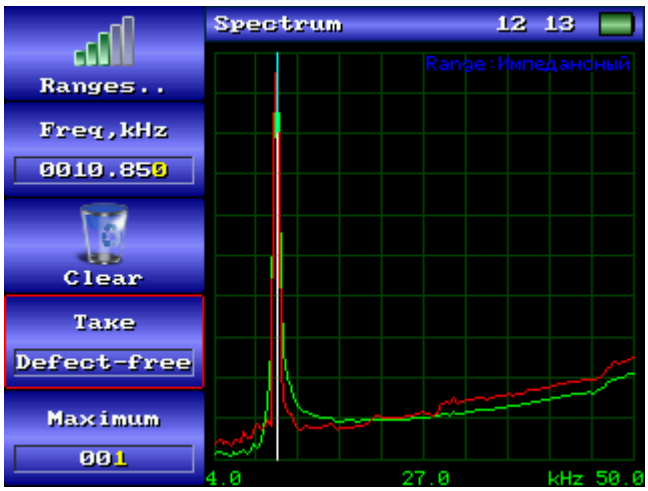


Fig. B. 13 Difference spectrum on the defect-free and defected areas.

The found frequency will be marked with a white-colored vertical line on the graph. Its numeric value will be displayed in the functional menu item “Freq, kHz”. This menu item can be used for manual correction of the received frequency. If there are several resonance peaks in the received spectrum, select between them by pressing the key “Maximum”. If the spectrums must be newly taken, press the key “Clear” and take the spectrums, starting with the defect-free area.

The spectrums are taken in the current selected frequency range. By default, the “Impedance” range is set that is appropriate for all types of impedance probes. If necessary, the user can select another frequency range by going into the archive of frequency ranges and pressing the key “Ranges..”.

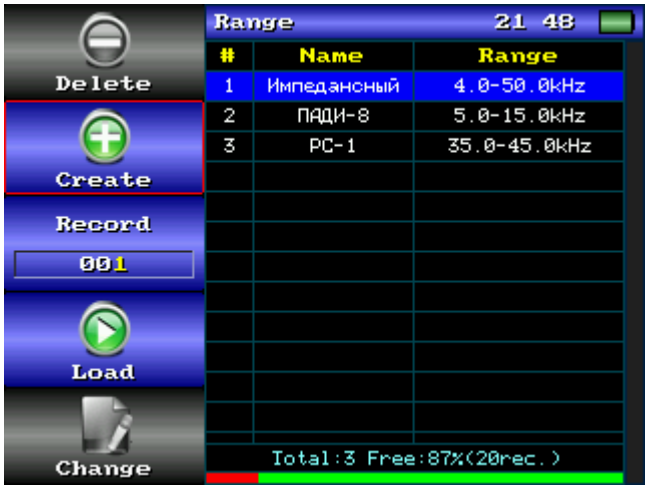


Fig. B. 14 Archive of frequency ranges.

Use the key “Record” to select the necessary frequency range. Press the key “Load” to load the selected range and go to the spectrum analyzer mode. The scale of the spectrum analyzer graph will highlight the start and end frequencies of the range (in the lower part of the graph) and the range name (in the upper part of the graph);

B.2.6 “Oscillograph” mode.

The oscillograph mode serves to visualize the signal received from the transducer. It also serves to set up the receiver and generator parameters:

- **“Frequency, kHz” –** excitation frequency of the transducer (generator). While selecting the generator’s frequency manually, signal length is automatically corrected to enable the collection buffer to contain at least 8 periods. At lower frequencies, the number of periods is automatically decreased to increase the repetition frequency of the packets.
- **Optimal gain –** while pressing this key, the automatic adjustment of the received signal level is actuated so that its amplitude is set at the level of 80% (or 4 cells of the vertical graph scale);
- **Gain –** can be set up in the range (0-50dB);
- **Number of packet periods.** If necessary, this value can be adjusted manually, but only for decreasing (from one to eight periods);
- **Scaling –** oscillograph graph scale by X axis. Is adjusted in the range 0.5 –2.

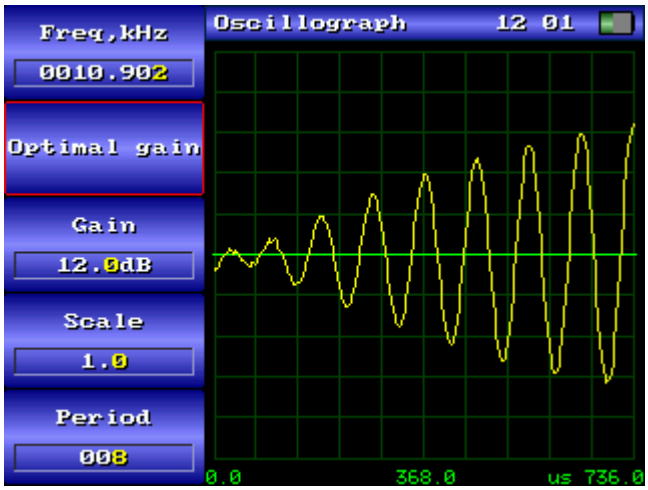


Fig. B. 15 Oscillograph mode.

B.2.7 “C-scan” mode.

C-scan mode is intended to build two-dimensional images of defects, using such scanning devices as “Slider” (further - scanner).

Work order:

- Connect the scanner to DAMI-C, fix the scanner on the testing object, using a suction cap or magnet; the X axis of the scanner must be parallel to one of the scan area sides. Fix the transducer in the scanner;

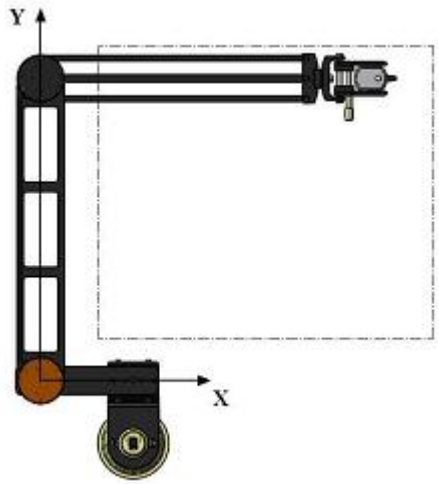


Fig. B. 16 Positioning of the “Slider” relative to the testing zone.

- Select the main menu item “C-scan”;
- Load the setting created earlier in one of the testing methods; press the key “Load…”. If a scanning device is not connected, the key “Load…” will be inactive;

Fig. B. 17 C-scan mode.

- Choose the scanning step in the menu item “Step”. While scanning, the workspace is divided into square cells; a cell side is equal to a scanning step. If a defect is found even in one point within the cell, the whole cell will be marked as defected.
- “Take” two control points - place the transducer sequentially in the upper left corner of the tested area and press “Point1”, place the transducer in the lower right corner and press “Point 2”. After that, the screen will display the scan zone as a grid. Actual sizes of the received area are highlighted on the grid (minimal size -10x10 mm). The current scanner position will be shown with a white marker (cross);

Fig. B. 18 Taking the control points.

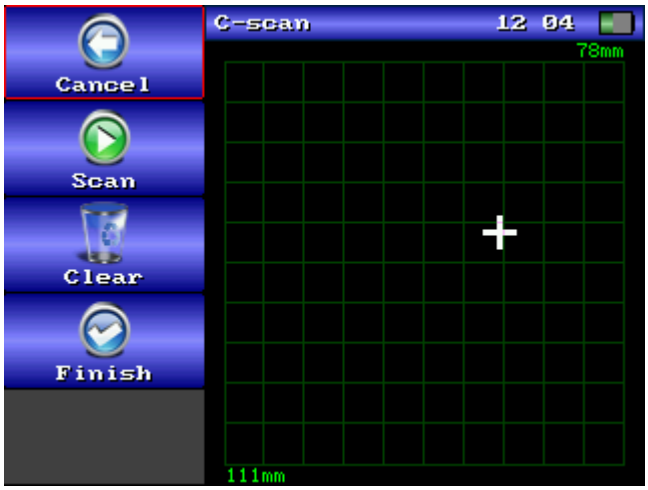


Fig. B. 19 Scan zone.

- Press the key “Scan” to start scanning. Move the transducer on the testing area. Passed area will be red-colored if the defect alarm has been actuated; if not – it will be green-colored. If necessary, stop scanning, pressing the key “Pause” and then start scanning again, pressing the key “Scan”. To clear the zone, press the key “Clear” – the whole scanned image will be deleted. If it is necessary to return to taking control points or loading of the other setting, press “Cancel”;

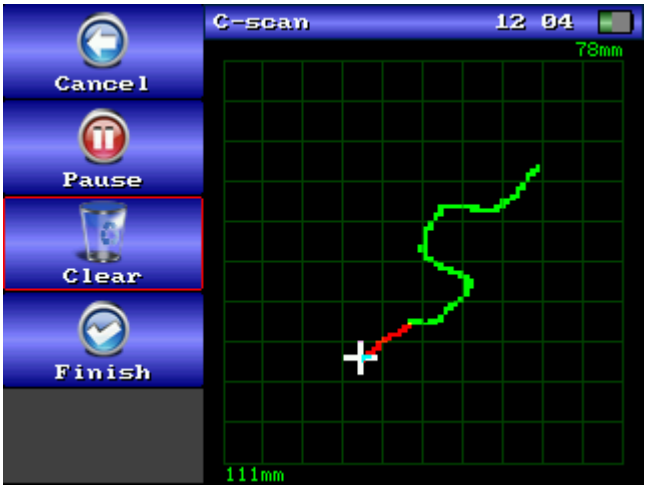


Fig. B. 20 Scanning process.

- After the scan is completed, press the key “Finish..” and proceed to the defects square measurement mode.

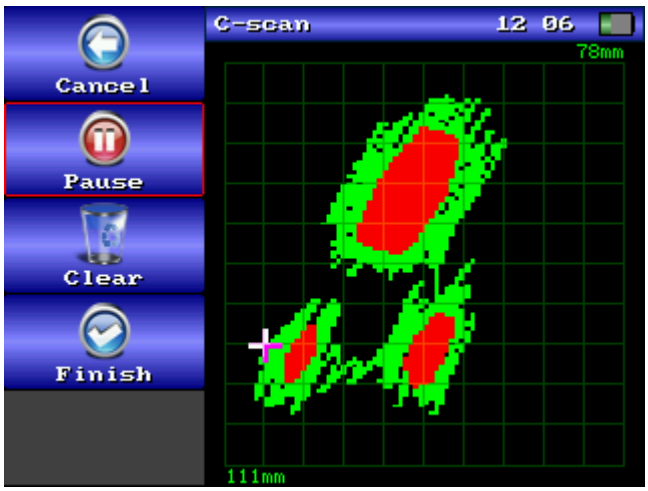


Fig. B. 21 Received scanned image.

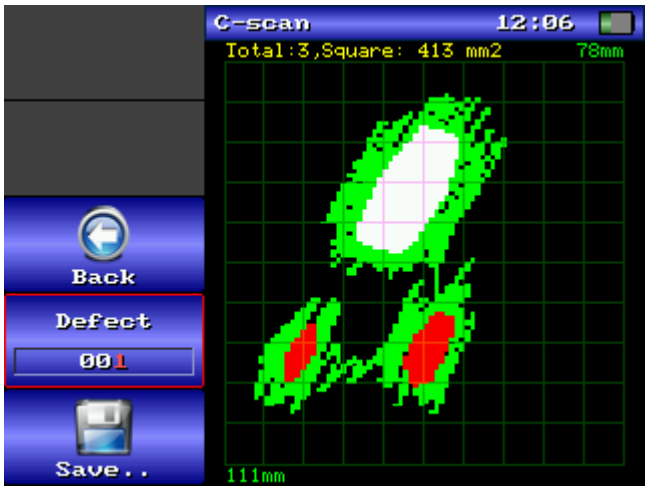


Fig. B. 22 Defects square measurement mode.

In the defects square measurement mode, the total number of detected defects as well as the square of the current selected defect will be displayed in the upper part of the scan zone. A selected defect will be white-colored on the screen. To navigate through the list of defects, use the key “Defect”. Defects will be listed by decrease of their square, i.e. the first defect is the biggest, the second is smaller, etc.

To save a received scanned defect image, press the key “Save..”; then input a name in the appeared saving window. Received scanned images can be further seen in the archive of results.

If it is necessary to continue scanning or scan any other object, return to the scanning mode, pressing the key “Back”.

B.2.8 Intellectual transducers and the “Transducers” mode

DAMI-C09 supports operating of intellectual transducers. By connecting them, the device automatically determines their data (name, serial number, etc.); the status line displays the intellectual transducer’s indicator 

. These data are further used for saving of the settings and testing results and makes their manual input unnecessary.

The data of the currently connected intellectual transducer can be viewed in the “Program” mode, menu item “Transducers”.

Fig. B. 23 Intellectual transducer’s data.

In order to facilitate operating of the non-intellectual transducers, the “Transducers” mode can be used. This mode is alternative to the manual input of the currently connected transducer’s data by saving settings or testing results.

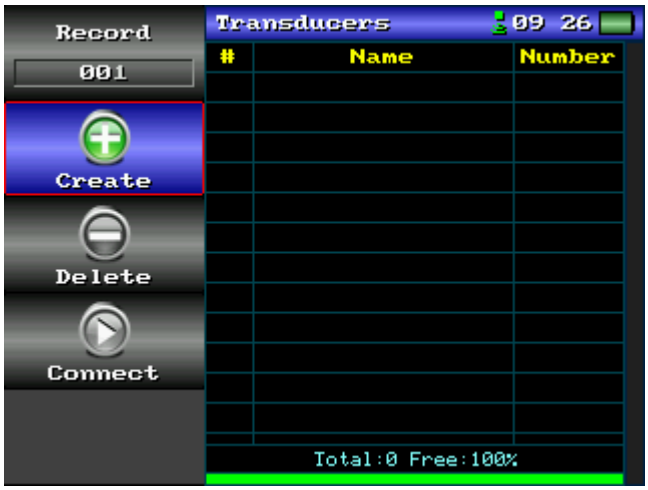


Fig. B. 24 “Transducers” mode.

The “Transducers” mode is the list of all connected non-intellectual transducers. One of the listed non-intellectual transducers can be currently connected. The list of non-intellectual transducers is originally created by the operator and can be added. When changing the non-intellectual transducer, the operator just needs to enter the “Transducers” mode and connect the needed non-intellectual transducer.

– **Creating** of non-intellectual transducers. In order to create a non-intellectual transducer, press the key “Create”. The screen will display the window with the fields for input of the transducer’s data. To edit the data in the window, do the same actions as for saving of settings or testing results;

– **Deletion** of non-intellectual transducers. If necessary, a non-intellectual transducer can be removed from the list by pressing the key “Delete”;

– **Connection** of non-intellectual transducers. In order to connect a non-intellectual transducer, select the necessary item from the list and press the key “Record”. Connect a non-intellectual transducer by pressing the key “Connect”. The selected item will be green-colored. The status line will display the nonintellectual transducer’s connection indicator 

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B.2.9 Archive of settings and testing results.

The archive of settings serves to view and load earlier saved settings.

Fig. B. 25 Archive of settings – main parameters.

Fig. B. 26 Archive of settings – additional parameters.

The archive mode has two sets of parameters – main and additional. To switch between them, press the keys “More” and “Back”.

In the archive mode workspace, there is a numbered table with the list of records. Date of saving in the archive, name and probe number are provided for each record.To the right from the table, there is a scroll bar; below, there is a status line with information about the archive state:

- Total number of saved settings;
- Free space in per cent from the total archive capacity as well as approximate number of records, for which this free space is sufficient;

- The additional band with graphic information about filling of the archive. Green color means free space of the archive, red color – busy space, yellow color – free space, which will be available after defragmentation of the archive.

While displaying the list of the settings archive records, every record has a corresponding icon, meaning a type of setting, by which it has been created. “Cross” means manual setting, “sector” means phase setting.

Main capabilities of the archive:

“Archive” – switching between the archives of settings and results; different data are placed in one table;

“Load” – is active only in the settings archive mode – loading of setting with further proceeding to the corresponding testing mode (manual or phase);

“Record” – selection of a record from the list;

“View” – view of a setting or scanned image;

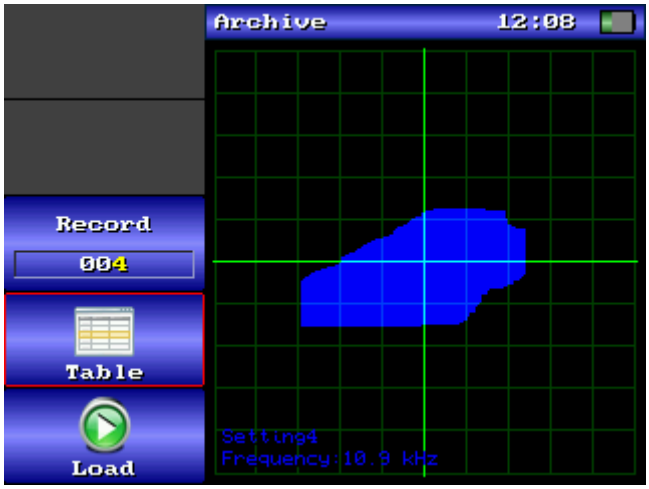

Fig. B. 27 View of a setting.

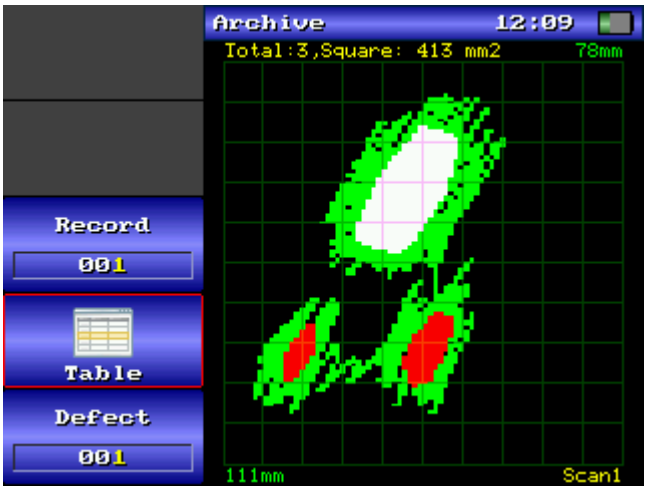

Fig. B. 28 View of the image.

“Delete” – record deletion from the archive;

“Sort”- sort records in the table by selected criteria (name, date, setting type)

B.2.10 Program

Fig. B. 29 Menu item “Program”.

- “Exit” – exit from the program into the splash screen menu;
- “About” - displaying of the program information.

B.3 STANDARD TESTING PROCEDURE WITH THE USE OF DAMI-C09

Typical sequence of testing steps required for testing with DAMI-C:

a) Turn DAMI-C09 on and make sure that the built-in clock and calendar data are right set. These data are used by processor to keep the archives of settings and testing results parameters.

b) *Choose the transducer according to the testing technology and connect it to DAMI-C.*

c) Perform DAMI-C09 setting on the testing object in accordance with **p. B.2.2** or **p. B.2.3** and save it in the device archive. Performed setting will be used in the current testing session. Saved setting can be invoked and repeatedly used while testing equal workpieces. If an appropriate setting is already available in the archive, instead of creating a new setting it is possible to go into the archive of settings and load it according to **p. B.2.9**.

d) *Test an object without a scanner device.* This mode allows to detect defects without building of their image.

e) *Test an object, building defect images according to the* **p.B.2.7**. In this mode, the transducer’s movement on the object surface is displayed on the DAMI-C09 screen. The points, in which the signal level exceeds the threshold value determined during the setting, are red-colored on the screen; the points, in which the signal level is lower than the threshold value, are green-colored. So, the image of detected defects is red-colored on the DAMI-C09 screen; the trajectory of the transducer’s movement is green-colored.

f) *Working with the archive.* The archive is intended for operative saving and accumulation of testing results during the testing, transmission of accumulated results into PC as well as for saving and quick invoking of the saved settings during the testing of different objects. Selective removal of settings and testing results is provided as well.

g) *Uploading of testing results into PC.* With a lapse of time, the archive of testing results is filled with the defects data. Every time when it is necessary, all results from the device archive can be uploaded into PC, using the OPERATOR`S WORKBENCH software, for their further saving, visualization and/or printing as a document.

B.4 ESTIMATION OF THE DAMI-C09 OPERABILITY ON THE TS-2 TESTING SPECIMEN

TS-2 testing specimen (see **APPENDIX 2**) is used for the daily express estimation of the DAMI-C09 impedance defectoscope with a connected transducer.

When using PADI-8-02 transducer, it is necessary to perform setting on the artificial defect “3” according to **p. B.2.2** of the present Appendix to the DAMI-C09 Operation’s manual. Then it is necessary to check detectability of the “1-4” defects. DAMI-C09 and PADI-8-02 transducer are considered to be operable if the “1-3” defects are surely detected.

When using PC-1-02 transducer, it is necessary to perform setting on the artificial defect “6” according to p. 2.3 of the present DAMI-C09 appendix. Then it is necessary to check detectability of the “4-8” defects. DAMI-C09 and PC-1-02 transducer are considered to be operable if the “4-7” are surely detected.

APPENDIX C “EDDY CURRENT DEFECTOSCOPE”. OPERATOR`S MANUAL

C.1 Intention of the “Eddy current defectoscope” program

The “Eddy current defectoscope” program implements the eddy current testing method for detection of surface and subsurface cracks, discontinuities, cavities, sheet backside corrosion, etc. in magnetic and non-magnetic electroconductive materials (frequency range 10Hz– 1MHz). The electrical conductivity range of tested materials from 0,4 to 40 MS/m. Maximal admissible gap between the transducer and tested surface – 0.2 mm.

This application is intended for:

- working with the eddy current probes;

- VTP-1S-02 (further VTP-1) — low-frequency eddy current transducer, having operating frequency range 1,5-2,0 kHz – for detection of corrosion on the backside of non-magnetic electroconductive sheets;
- VTP-2-02 (further VTP-2) — high-frequency eddy current transducer, having operating frequency range 1,0-6,0 MHz, for detection of surface and subsurface cracks, discontinuities and cavities on electroconductive non-ferromagnetic parts;
- VTP-3-02 (further VTP-3) — high-frequency eddy current transducer, having operating frequency range 0,4-0,8 MHz for detection of surface and subsurface cracks, discontinuities and cavities on ferromagnetic and non-ferromagnetic parts;

- creation of settings with the possibility of their saving in the device archive for further use;

- building of two-dimensional defect images (C-scans) with the possibility of their further saving in the device archive and transmission into PC for further processing and representation as reports.

C.2 Work order

C.2.1 Program control

Read **p. 6.5** “Graphical user interface” of the DAMI-C09 Multifunctional bond testing & eddy current Operation’s manual to learn the general principles of the DAMI-C09 program operation.

Main program functions are available through the main menu (**Fig. C. 1**).

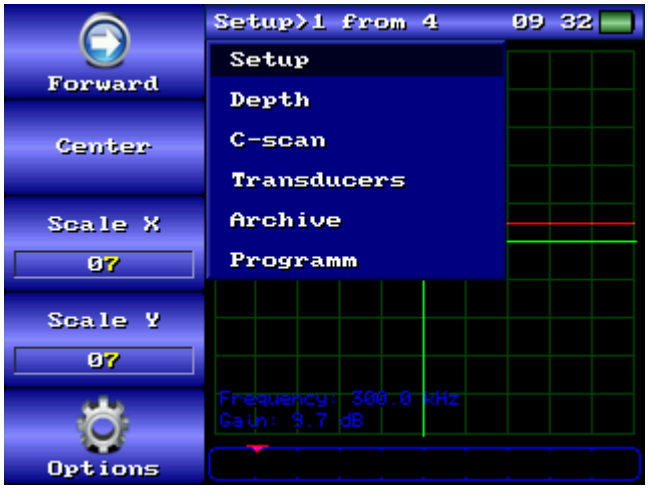

Fig. C. 1 Program main menu

Main menu items:

- **“Setup”** – eddy current operating mode setting;
- **“Depth”** – crack depth evaluation mode;
- **“C-scan”** – building of two-dimensional defect images;
- “**Transducers**” – the archive of non-intellectual transducers;

- **“C-scan”** – building of two-dimensional defect images;
- “**Archive**” – archive of saved settings and testing results;
- **“Program”** – information “About…” and exit from the program into the splash screen menu.

C.2.2 Setting.

The signal received from the transducer is analyzed in the eddy current setting, using the amplitude-phase method. This signal is represented as a point on the complex plane, which is marked with a cruciform cursor (marker).

In order to create setting, it is necessary to have the specimen that is made of the testing object’s material and has the grooves (imitating cracks). Minimal depth of the groove must not be less than 0,2mm.

The “Setup” mode consists of four screen forms. Certain parameters can be changed in each of these forms. To switch between the screen forms, press the keys “Forward”\“Restart” and “Back” (pressing “Back” leads to the previous form).

Use the key “Record” to select the necessary frequency range. Press the key “Load” to load the selected range and go to the spectrum mode. The spectrum chart scale will display the start and end frequencies of the range (in the lower part of the chart) and the description of the range (in the upper part of the chart).

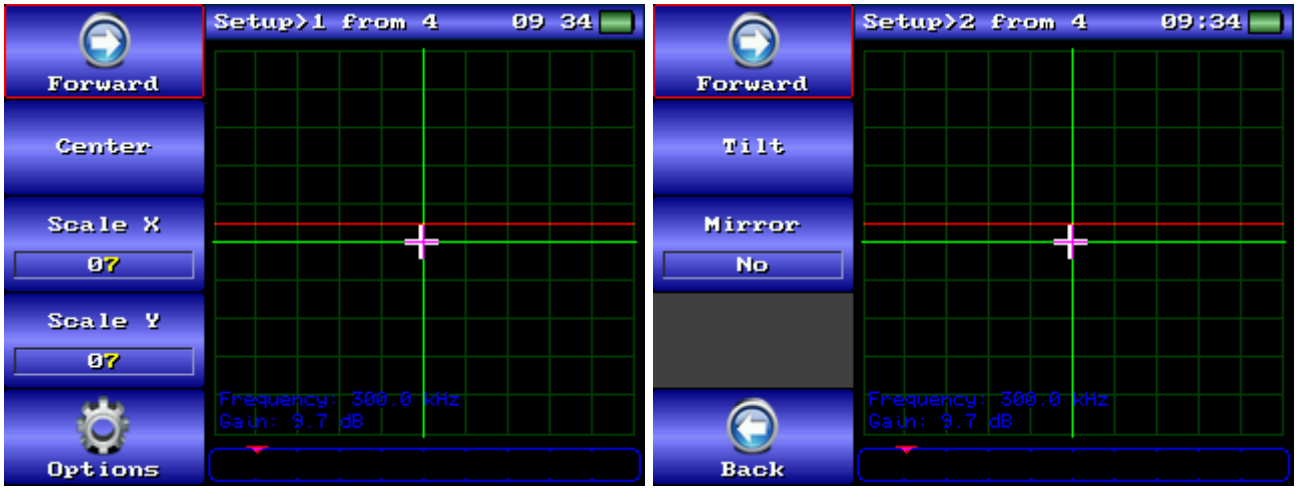

Fig. C. 2 Eddy current setting – Screen 1-2.

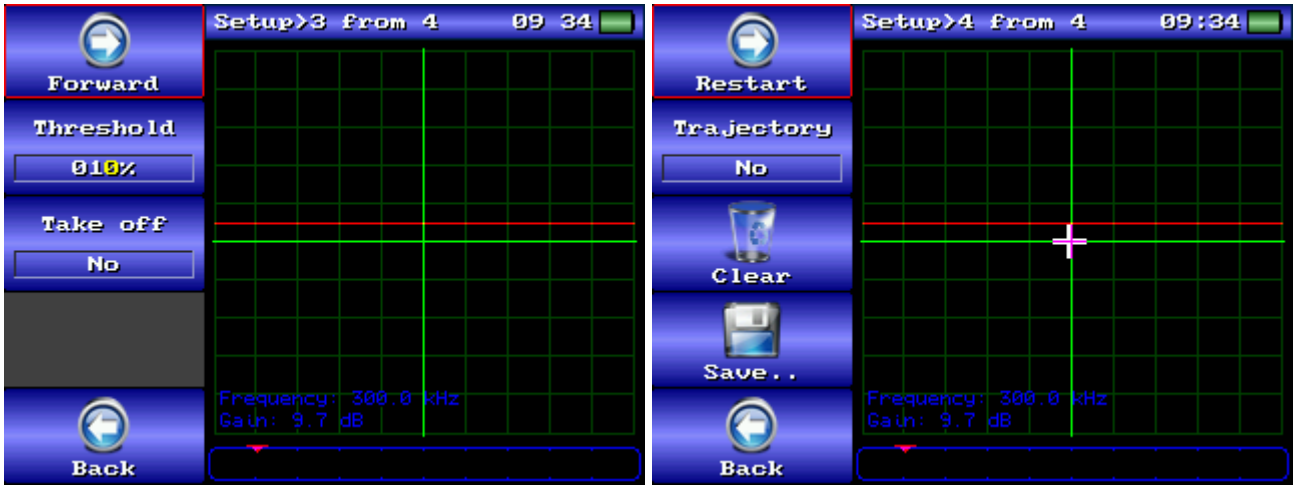

Fig. C. 3 Eddy current setting – Screen 3-4.

Work order:

– Set the transducer operating frequency. Go to the spectrum mode by pressing the keys “Options”\”Spectrum” (see p. **C.2.4**).

– Set the optimal gain. The optimal gain is only set by the user only if the operating frequency is found as the resonance frequency or the frequency is manually corrected by the user. Enter the oscillograph mode by pressing the keys “Options”\”Oscillograph” (see p. **C.2.5**), determine the area (either flawed or flaw-free area) where the maximum signal amplitude of the oscillograph chart is observed. Place the transducer on the maximum amplitude area and press the key “Optimal gain”.

– Place the transducer vertically on the flaw-free area of the specimen and center the marker by pressing the menu item key “Center”.

– Perform deviation from the transducer’s tilt. For this purpose, deviate the transducer at 5-10 degrees relative to the specimen surface. The marker will move at some distance from the center. Press the menu item key “Tilt”. After that, the transducer’s tilt relative to the surface will cause the marker movement, mainly horizontally. Select the X direction scale so that the marker does not go beyond the screen border by deviation at the angle of 5-10 degrees.

– Select the Y direction scale and the alarm activation threshold level (menu item “Threshold”,) so that the flaw alarm activation threshold is exceeded by placing the transducer on the flawed area. If the marker is deviated not up, but down, set the menu item “Mirror” to “Yes”.

– Holding the transducer in the air, press the key “Take off”; set “Yes”. The tracking of the transducer’s take-off from the specimen’s surface will be activated. If the transducer’s contact with the specimen’s surface is failed during testing, the transducer take-off alarm will be activated (light alarm blinking and discrete sound signal). If necessary, the take-off tracking mode can be switched off by setting “Take off” to “No”.

For better visualization, there is a level band under the complex plane; the Y coordinate of the marker is displayed in it in percent relative to half-height of the complex plane. The red triangle corresponds to the alarm activation threshold.

If necessary, the display mode of the marker movement trajectory can be activated. To switch on\off the trajectory tracking mode, press the menu item key “Trajectory”, set “Yes”\”No”. To clear the trajectory, activate the item “Clear”.

The received setting can be saved in the archive of settings for further use by activating the item “Save”.

C.2.3 Depth

The “Depth” mode is intended for the eddy current testing with a possibility to estimate the depth of surface cracks, using the VTP-2 and VTP-3 transducers. The depth calibrating of the artificial flaw is carried out in this mode.

Work order:

– Set the transducer operating frequency. Enter in the spectrum analyzer mode by pressing the keys “Options”\”Spectrum” (see p.**C.2.4**);

– Set the optimal gain. The optimal gain is set by the user only if the operating frequency is found as the resonance frequency or the frequency is manually corrected by the user. Enter the oscillograph mode by pressing the keys “Options”\”Oscillograph” (see p**. C.2.5**). Determine the flawed or flaw-free area on the specimen where the signal amplitude maximum of the oscillograph chart is observed. Place the transducer on the maximal amplitude area and press the key “Optimal gain”;

– Place the transducer vertically on the flaw-free area of the specimen and center the marker by pressing the key “Center”;

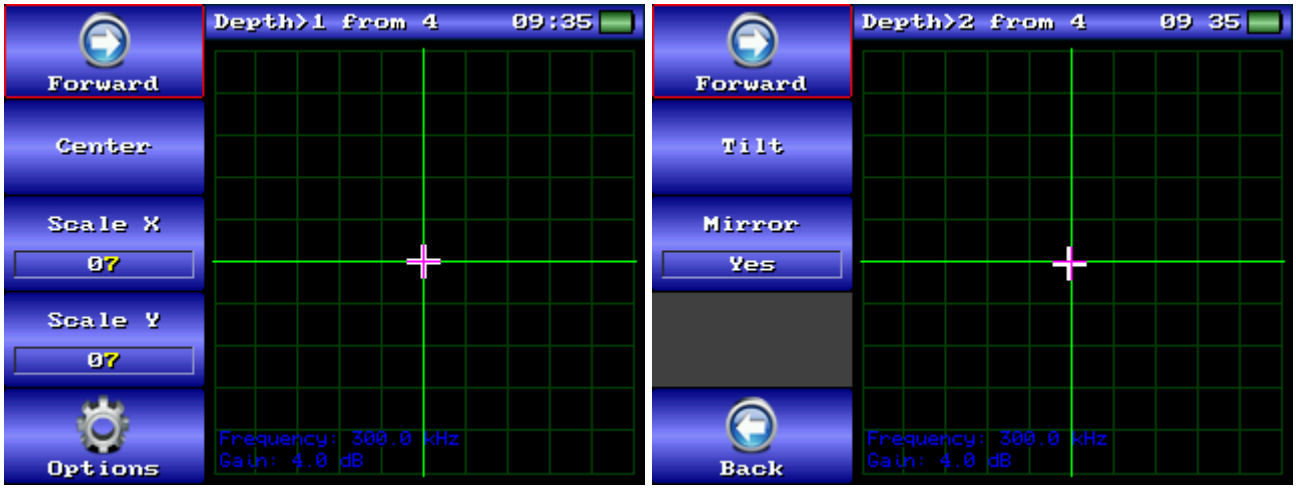

Fig. C. 4 Scale selection and deviation from the transducer's tilt.

– Perform deviation from the transducer's tilt. Deviate the marker at the angle of 5-10 degrees relative to the specimen's surface. The marker will be moved at some distance from the center. Press the menu item key "Tilt". After that, the transducer's tilt relative to the surface will cause the marker movement, mainly horizontally. Select the X direction scale so that the marker does not go beyond the screen border by deviation at the angle of 5-10 degrees;

– Place the transducer on the calibrating flaw; the marker must move vertically. Select the Y direction scale so that the marker does not go beyond the screen border. Press the key "Forward";

– If the marker is deviated not up, but down while placing the transducer on the calibrating flaw, set the menu item "Mirror" to the opposite value;

– - Set the depth of the calibrating flaw in the menu item "Depth" and its corresponding deviation in percent on the depth scale. Place the transducer on the calibrating flaw and calibrate by the flaw depth, pressing the key "Calibrate";

– If it is necessary to adjust the scale, tilt or center the marker, press the key "Back" to return to the scale selection window;

– Holding the transducer in the air, press the key "Take off"; set "Yes". The tracking of the transducer's take-off from the specimen's surface will be activated. If the transducer's contact with the specimen surface is failed during testing, the transducer take-off alarm will be switched on (light alarm blinking and discrete sound signal). If necessary, the take-off tracking mode can be switched off by setting "Take off" to "No".

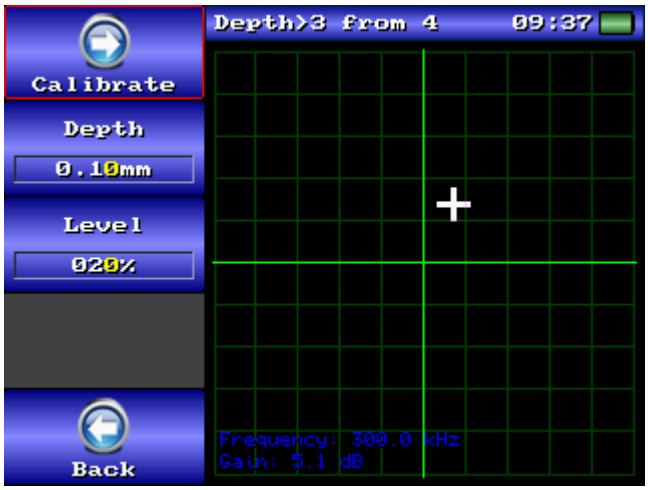

Fig. C. 5 Depth calibration.

The screen will display the depth scale in percent relative to the depth calibration level. The value of the current flaw depth in percent and mm will be displayed in the lower part of the screen.

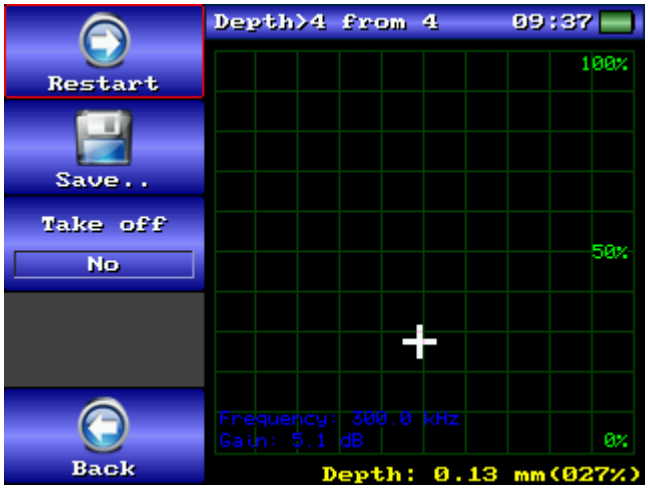

Fig. C. 6 Testing in the “Depth” mode.

The setting can be saved in the archive of settings for further use. For this purpose, press the key “Save..”. If a repeated calibration is necessary, press the key “Back” to return to the calibration window. If a new setting is necessary, press the key “Clear”.

C.2.4 **Spectrum mode**

The “Spectrum” mode is intended to find the transducer’s optimal operating frequency, at which the maximal difference between the signals received from the flawed and flaw-free areas (i.e. maximal sensitivity of the transducer) is observed.

If the applied transducer is resonance (i.e. one or some resonance peaks are observed in the amplitude-frequency characteristics), either the resonance frequency or the optimal frequency will be found for this transducer. For non-resonance transducers, the operating frequency will be set up by the user.

So, the optimal frequency will be found for the VTP-1 transducer and set up by user for the VTP-2 and VTP-3 transducers (1MHz and 400kHz respectively).

The ”Spectrum” mode can be activated by pressing the key “Spectrum”. The spectrum will be received on the flaw-free area (i.e. the transducer must be placed on the flaw-free area before pressing). The screen will display the flaw-free area spectrum chart (green-colored). Place the transducer on the flawed area and activate “Take\Defect”. The screen will display the amplitude-phase difference chart of the flawed and flaw-free areas (red-colored). The received frequency will be displayed in the functional menu item “Freq, kHz”.

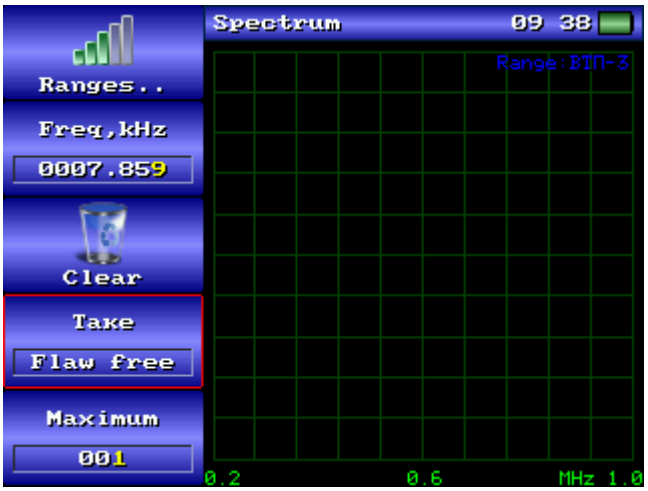

Fig. C. 7 Spectrum mode.

The found frequency will be marked with a vertical white-colored line on the chart. Its numeric value will be displayed in the functional menu item “Frq, kHz”. This menu item can be also used to manually correct the received frequency. If there are some resonance peaks in the received spectrum, press the key “Maximum” to choose between them. If the spectrums must be received again, press the key “Clear” and receive the spectrums, beginning with the flaw-free area.

The spectrums are received in the currently selected frequency range. If necessary, the user can select another frequency range. For this purpose, it is necessary to enter the archive of frequency ranges by pressing the key “Ranges”.

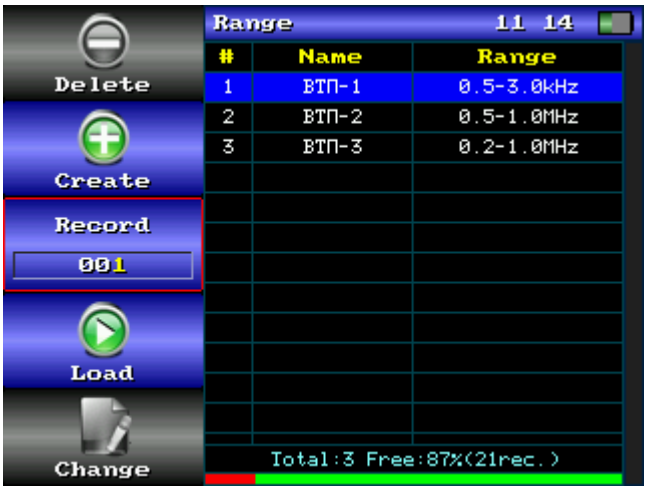

Fig. C. 8 Archive of frequency ranges.

Use the key “Record” to select the necessary frequency range. Press the key “Load” to load the selected range and go to the spectrum mode. The start and end frequencies of the range will be displayed on the spectrum chart scale (in the lower part of the chart). The description of the range will be displayed in the upper part of the chart.

C.2.5 Oscillograph mode.

The oscillograph mode serves to visualize the signal received from the transducer. It also serves to set up the following receiver and generator parameters:

- **“Frequency, kHz”-** excitation frequency of the transducer (generator). By manual selection of the generator’s frequency, signal length is automatically corrected so that the collection buffer includes at least 8 periods. At lower frequencies, the number of periods is automatically decreased to increase the packets repetition frequency.
- **Optimal gain** – while pressing this key, automatic control of the received signal level will be so actuated that its amplitude will be at the level of 80% (or 4 cells of the vertical graph scale);
- **Gain** – can be in the range of (0-50dB);
- **Number of packet periods.** If necessary, it can be manually adjusted but only for decreasing.
- **Scale –** the oscillograph graph scale by the X axis. Is adjusted in the range of 0.5 –2.

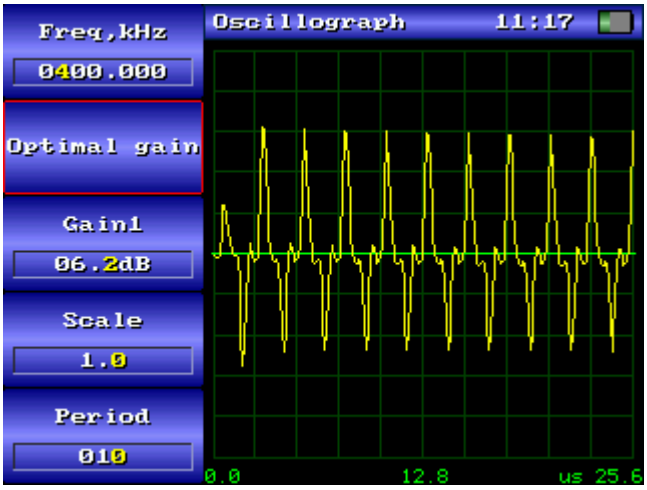

Fig. C. 9 Oscillograph mode.

C.2.6 C-scan mode.

C-scan mode is intended to build two-dimensional images of defects, using such scanning devices as “Slider” (further scanner).

Work order:

- Connect the scanner to DAMI-C; fix the scanner on the testing object, using a suction cap or magnet. The X axis of the scanner must be parallel to one of the scanned area sides. Fix the transducer in the scanner;

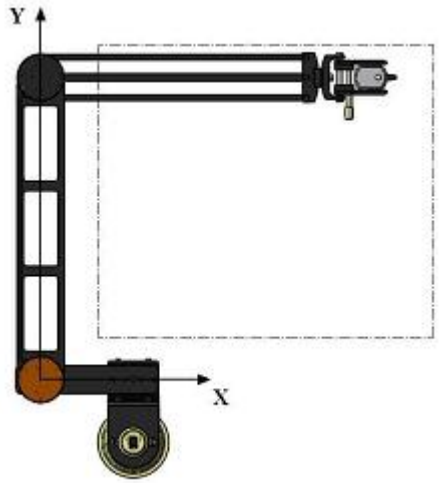

Fig. C. 10 “Slider” positioning relative to the testing zone.

- Choose the main menu item “C-scan”;
- Load a setting created earlier in one of the testing methods – press the key “Load..”. If a scanning device is not connected, the “Load” key will be inactive;

Fig. C. 11 C-scan mode.

- Choose the scanning step in the menu item “Step”. While scanning, the workspace will be divided into square cells with a side equal to a scanning step. If a defect is found in at least one point within a cell, the whole cell will be marked as defected;

- “Take” two control points – sequentially place the transducer in the upper left corner of the tested area and press “Point1”, place the transducer in the lower right corner and press “Point 2”. After that, the screen will display a scan zone as a grid. Actual sizes of the received area are highlighted on the grid (minimal size of the scan zone -10x10 mm); current position of the scanner will be indicated with a white marker (cross);

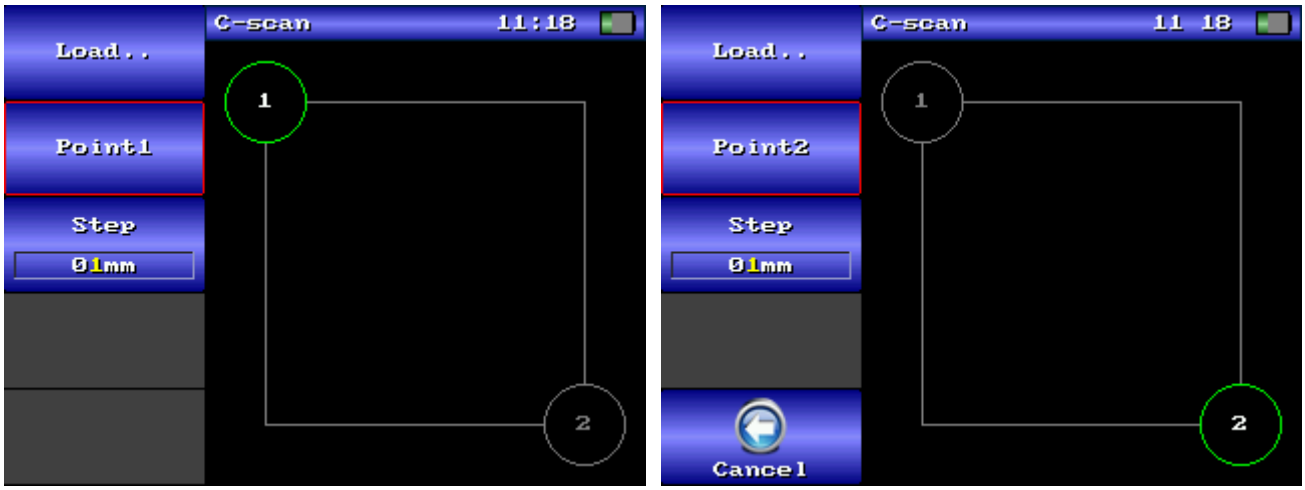

Fig. C. 12 Taking control points.

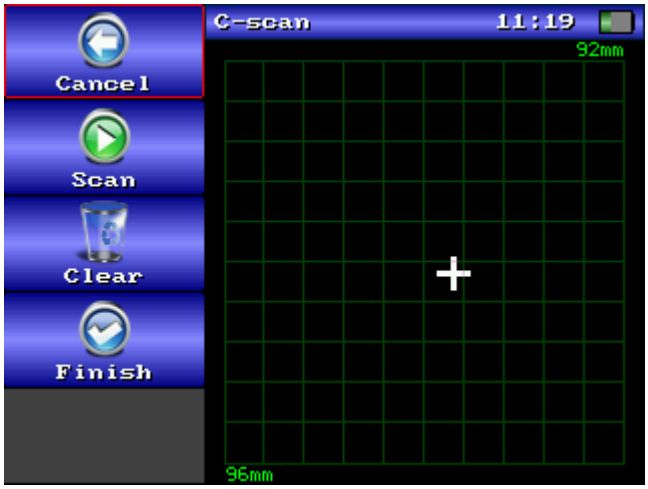

Fig. C. 13 Scan zone.

- To start scanning, press the key “Scan”. Move the transducer on the testing area; passed area will be red-colored if the defect alarm is actuated, if not – it will be green-colored. If necessary, stop scanning, pressing the key “Pause” and then start it again, pressing the key “Scan”. To clear the zone, press the key “Clear”; the whole scanned image will be deleted. If it is necessary to return to taking control points or loading of another setting, press “Cancel”;

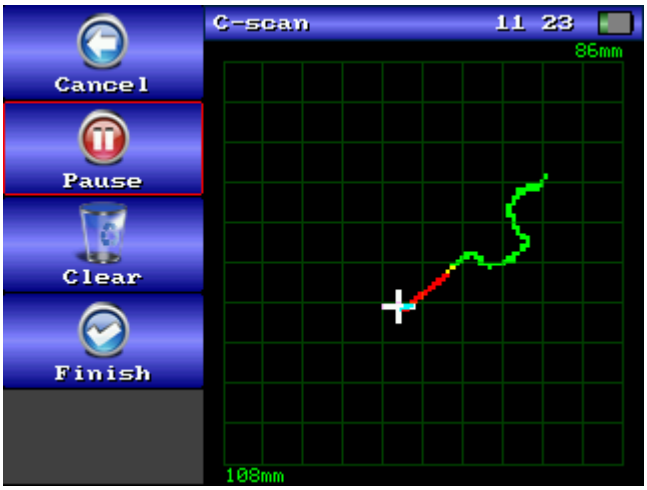

Fig. C. 14 Scanning process.

- After the scan is finished, press menu item key “Finish” and proceed to the defect square measurement mode.

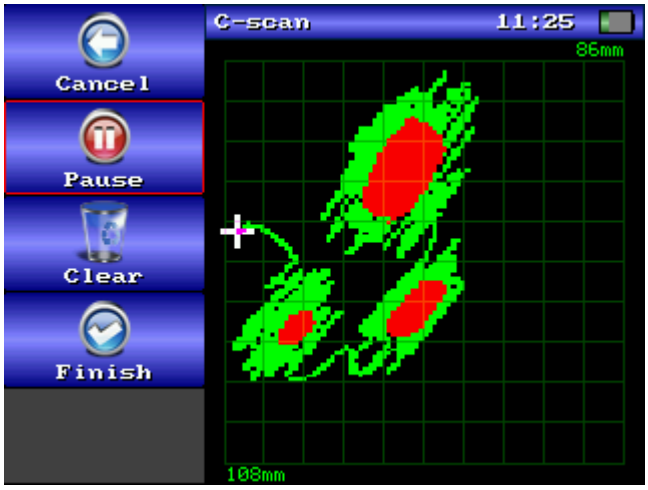

Fig. C. 15 Received scanned image.

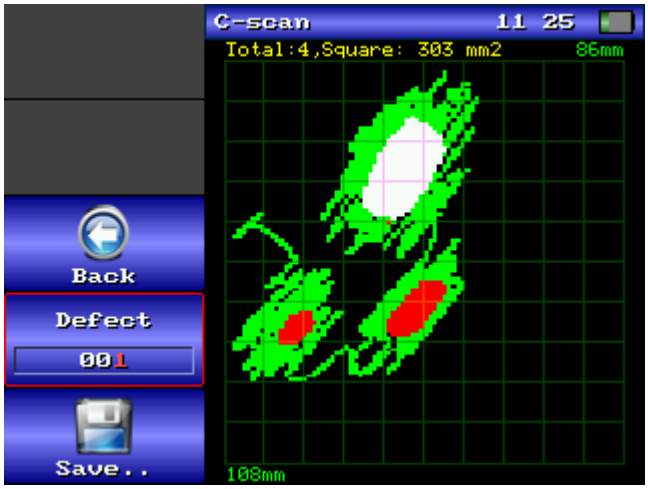

Fig. C. 16 Defect square measurement mode.

In the defect square measurement mode, total number of detected defects as well as the square of the current selected defect will be displayed in the upper part of the scan zone. A selected defect will be white-colored on the screen. Use the key “Defect” to navigate through the list of defects, the listed defects will be sorted by decrease of their square, i.e. the first defect is the biggest, the second is smaller, etc.

To save a received scanned image of the defects, press the key “Save”; then input a name in the appeared window. Received scanned images can be later viewed in the archive of results.

If scanning must be continued or any other object is to be scanned, press the key “Back” to return to the scanning mode.

C.2.7 Intellectual transducers and the “Transducers” mode

DAMI-C09 supports operating of the intellectual transducers. When connecting an intellectual transducers, the device automatically determines its data (name, serial number, etc.). The status line will display the intellectual transducer’s indicator 

. The received data are further used for saving the settings and testing results; it makes the manual data input unnecessary.

The data of the currently connected intellectual transducer can be viewed in the “Program” mode, menu item “Transducers”.

In order to facilitate operating of the non-intellectual transducers, the “Transducers” mode can be used. This mode provides an alternative to the manual data input that is effected by saving the settings or testing results.

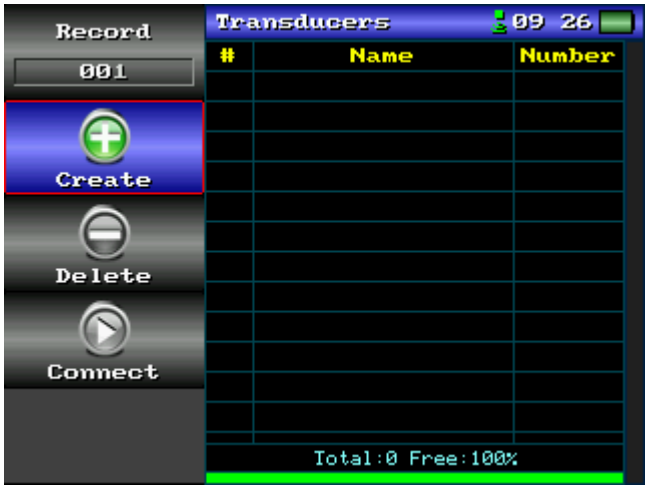

Fig. C. 17 “Transducers” mode.

The “Transducers” mode is the list of all non-intellectual transducers connected to the device. One of the listed non-intellectual transducers can be currently connected. The list of non-intellectual transducers is originally created by the operator and can be then added. While replacing the non-intellectual transducer, the operator just needs to enter the “Transducers” mode and connect the needed -intellectual transducer.

- **Creating** of the non-intellectual transducer. In order to create the non-intellectual transducer, press the key “Create”. The screen will display the window, having the input fields for the transducer’s data. The data of the window are edited in the same way as it is done to save settings or testing results.
- **Deletion** of the non-intellectual transducer. If necessary, the non-intellectual transducer can be removed from the list by pressing the key “Delete”.
- **Connection** of non-intellectual transducer. In order to connect the non-intellectual transducer, select the needed list item by pressing the key “Record” and connect the non-intellectual transducer by pressing the key “Connect”. The selected list item will be green-colored. The status line will display the non-intellectual transducer’s connection indicator 

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C.2.8 Archive of settings and testing results.

The archive of settings allows to view and load earlier saved settings.

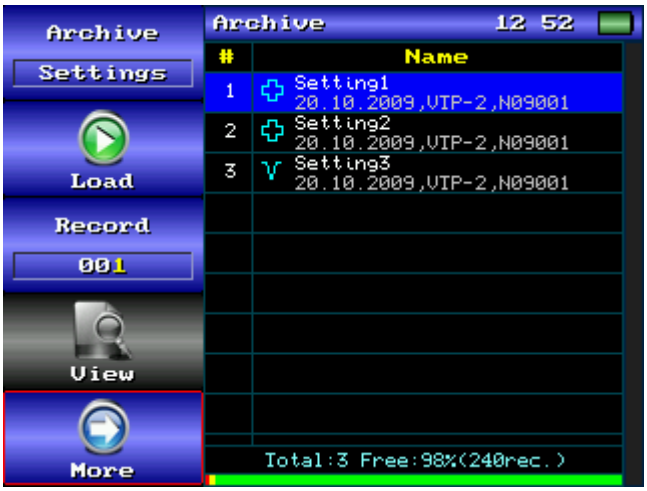

Fig. C. 18 Archive of settings – main parameters.

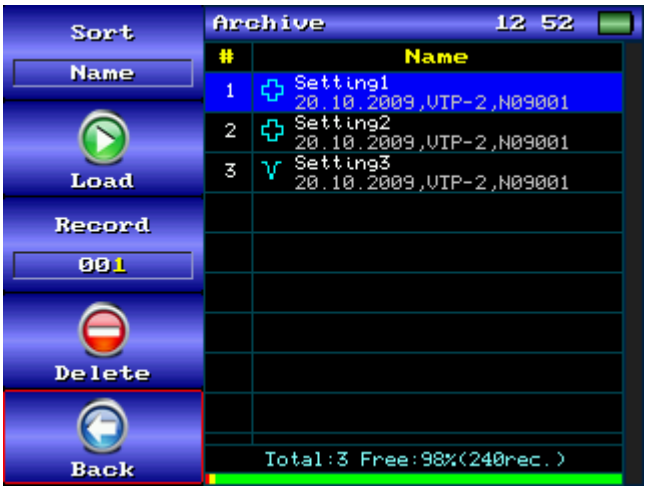

Fig. C. 19 Archive of settings – additional parameters.

The archive mode has two sets of parameters – main and additional. To switch between them, press the keys “More” and “Back”.

In the archive mode workspace, there is a numbered table with a list of records. Date of saving in the archive, name and probe number are provided for each record. To the right from the table, there is a scroll bar; below there is a status line with the information about the archive state:

- Total number of saved records;
- Free space in percent from the total capacity of the archive as well as approximate number of records, for which this free space is sufficient;
- Additional graphic band with information about filling of the archive. Green color means free space of the archive, red color – busy space, yellow color – free space, which will be available after defragmentation of the archive.

While displaying the list of the settings archive records, every record has a corresponding icon, meaning a type of settings, by which it was created. “Cross” means manual setting, “sector” – phase setting.

Main capabilities of the archive:

“Archive” – switching between the archives of settings and results, different data will be displayed in the same table;

“Load” – is active only in the settings archive mode – loading of a setting with proceeding to the corresponding testing mode (manual or phase);

“Record” – record selection from the list;

“View” – view a setting or scanned images.

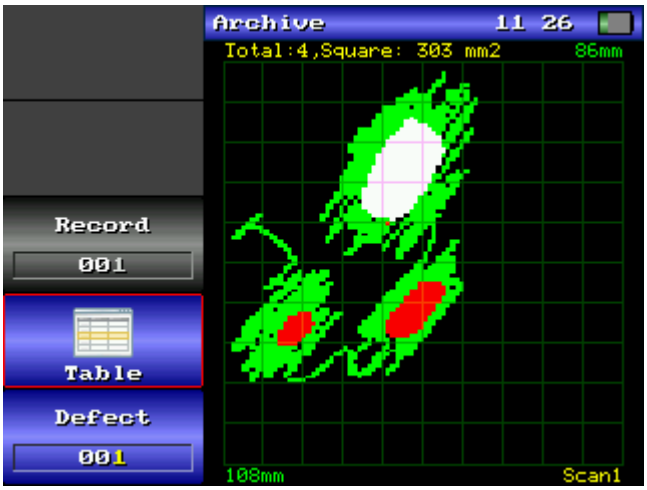

Fig. C. 20 Viewing an image.

“Delete” – record deletion from the list;

“Sort” – sort records in the table by selected criterion (name, date, type of setting)

C.2.9 Program

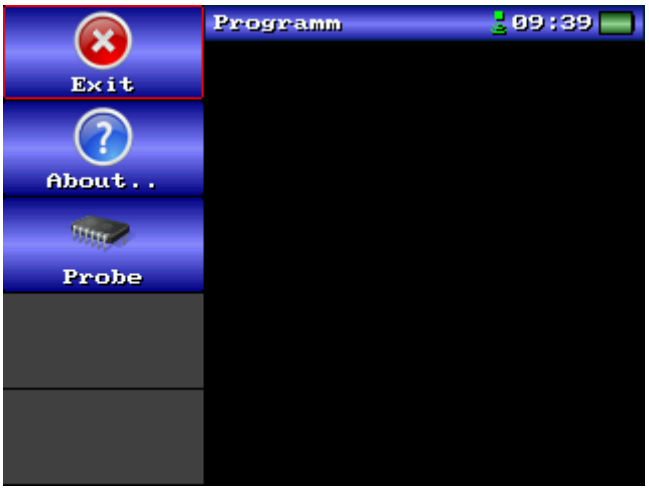

Fig. C. 21 Menu item “Program”.

- “**Exit**” - exit from the program into the splash screen menu;
- “**About** ..” - displaying of the program information;
- “**Probe**” – info about the currently connected intellectual probe. If the connected probe is not intellectual, this item will be inactive.

Fig. C. 22 Program information.

C.3 STANDARD TESTING PROCEDURE WITH THE USE OF DAMI-C09 EDDY CURRENT DEFECTOSCOPE

Typical sequence of testing steps required for the DAMI-C09 eddy current testing:

- *Turn DAMI-C09 on and make sure that the built-in clock and calendar data are right set.* These data are used by the processor to keep the archives of settings and testing results parameters.
- *Choose the eddy current transducer according to the testing technology and connect it to DAMI-C.*
- *Perform DAMI-C09 setting on the testing object in accordance with* **p. C.2.2** *and save it in the device archive.* Performed setting will be used in the current testing session. Saved setting can be invoked and repeatedly used for the testing of identical workpieces. If an appropriate setting is already available in the archive, enter the settings archive and load it according to **p. C.2.8** of instead of creating a new setting.

- *Perform testing without a scanner device.* This mode allows detecting defects without building of their image.
- *Test an object with building of defect images according to* **p.C.2.5** *of.* The transducer's movement on the object's surface is displayed on the device screen in this mode. The points, in which the signal level exceeds the threshold value determined during the setting, are red-colored; the points, in which the signal level is lower than the threshold value, are green-colored. So, the images of detected defects are red-colored; the transducer's movement trajectory is green-colored on the DAMI-C09 screen.
- *Working with the archive.* The archive is intended for operative saving and accumulation of testing results during the testing process, uploading of accumulated testing results into PC as well as for saving and quick invoking of settings during the testing of different objects. Selective removal of settings and testing results is provided as well.
- *Uploading of testing results into PC.* With a lapse of time, the archive of results is filled with the defects data. Every time when it is necessary, all archived data can be uploaded into the PC carrier for further saving, visualization and/or printing as a document. For uploading, use the "Operator's workbench" software.

APPENDIX D “IMPACT FLAW DETECTOR”. OPERATOR’S MANUAL

D.1 INTENTION OF THE “IMPACT FLAW DETECTOR” PROGRAM

The “Impact flaw detector” program is intended for:

- Impact testing of composite and honeycomb materials, bonded, soldered connections from different materials to detect such defects as delaminations, disbonds, discontinuities, etc.;
- working with the impact transducers UDP-10-02P (is designed as a hammer, the operator manually strikes on the testing object) and UDP-10-02 (electromagnetic impact mechanism, makes impacts with the certain frequency);
- creating settings of the testing object with the possibility to save them in the archive for further usage;
- receiving the two-dimensional defect images (C-scan) with the possibility to save them in the archive and upload into PC to save and represent as reports.

D.2 WORK ORDER

D.2.1 Program control

Read **p. 6.5** “Graphical user interface” of the DAMI-C09 Multifunctional bond testing & eddy current Operation’s manual to learn the general principles of the DAMI-C09 program operation.

The main program features are available through the main menu (**Fig.D. 1**).

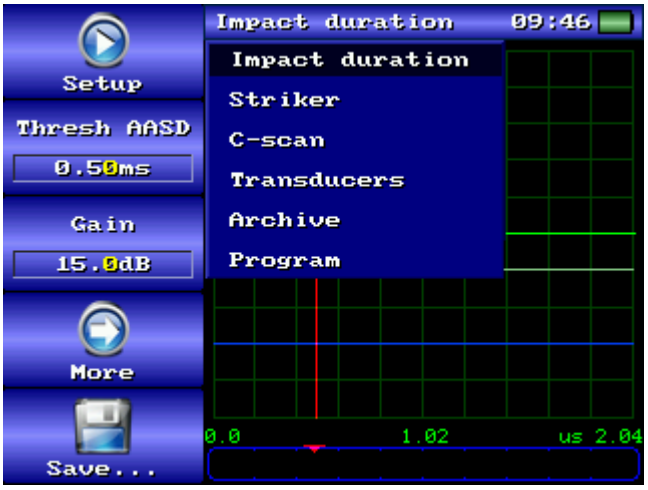

Fig.D. 1 Program main menu

Main menu items:

- **“Impact duration”** – the impact setting\testing mode, in which the impact duration is measured;
- **“Striker”** – setting mode of the electromagnetic impact transducer UDP-10-02E;
- **“C-scan”** - building of the two-dimensional defect images
- “**Transducers**” – the archive of non-intellectual transducers
- **“Archive”** – the archive of saved settings and testing results;
- **“Program”** –data about the “Impact flaw detector” program and exit from the program into the splash screen

D.2.2 “Impact duration” mode

During the impact testing on the specimen's surface, impacts are made by striking with the transducer's striker. The impact oscillations are read off the striker and displayed in the "Impact duration" mode chart (see **Fig.D. 2**).

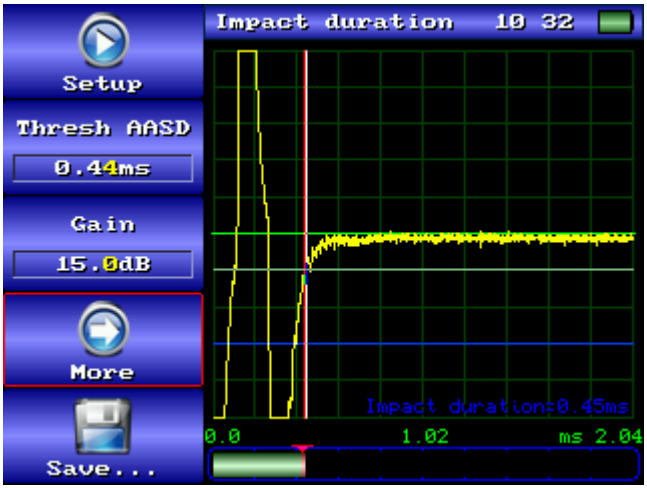

Fig.D. 2 Impact vibrations chart.

Impact duration is measured according to the received signal of impact vibrations. This duration is indicated on the graph as a vertical white line, its numeric value is displayed in the right lower corner of the graph. For better visualization, this duration is also displayed on the level band, which is placed under the graph.

Impact vibrations on the defect site have greater duration; therefore, it is just necessary to set the alarm activation time threshold for the defect-free area. If this threshold is exceeded, the testing object is defected.

The "Impact duration" mode consists of the set of main and additional parameters, which are switched by pressing the keys "More" and "Back".

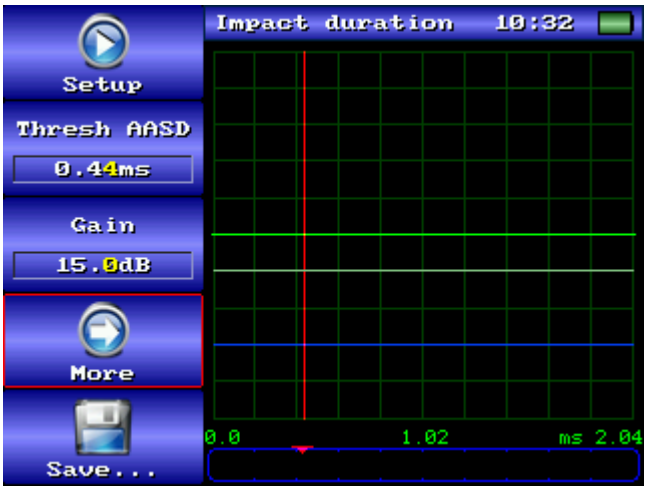

Fig.D. 3 Main parameters of the "Impact duration" mode.

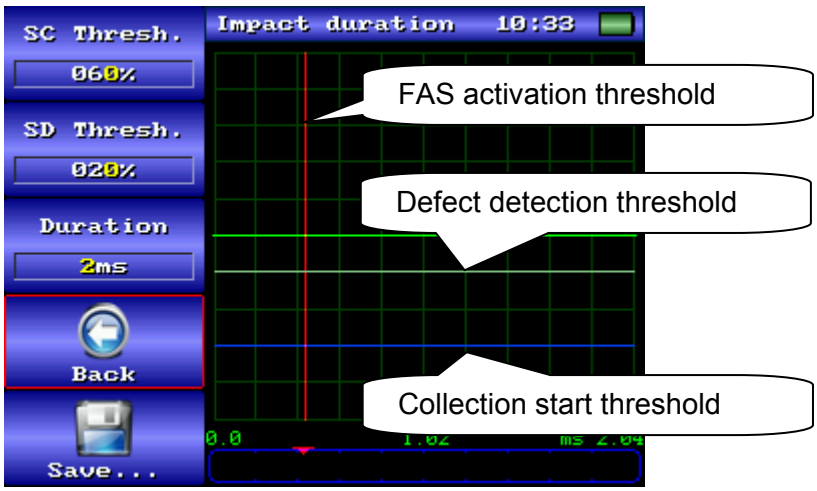

Fig.D. 4 Additional parameters of the “Impact duration” mode.

The “Impact duration” mode parameters:

“SC Thresh.” – collection start threshold. The data collection is started if the signal exceeds the pre-set threshold level (is marked with a blue horizontal line on the chart). Is set in percent of the scale half-height (100% - five cells of the scale);

“SD Thresh.” - defect detection threshold. The impact duration is the first exceeding of the defect search threshold on the timescale backside (is marked with the grey-colored horizontal line on the chart). Is set in percent of the scale half-height (100% - five cells of the scale);

“Duration” - data collection duration. The data collection length is set up in such a way that the defect that has the maximal length for the tested material is settled within the selected length. The collection length is set in the range from 1 to 5μs.

D.2.3 Setting of the UDP-10-02P transducer on the TS-2 testing specimen

D.2.3.1 Connect the UDP-10-02 transducer, load the “Impact flaw detector” program, connect the UDP-10-02P transducer.

D.2.3.2 Select the “Striker” mode in the main menu (see **Fig.D. 5**). Set the “Mode” parameter to “Manual”.

D.2.3.3 Go into the “Strike duration” mode; for this purpose, press “Back” or select the main menu mode “Strike duration”;

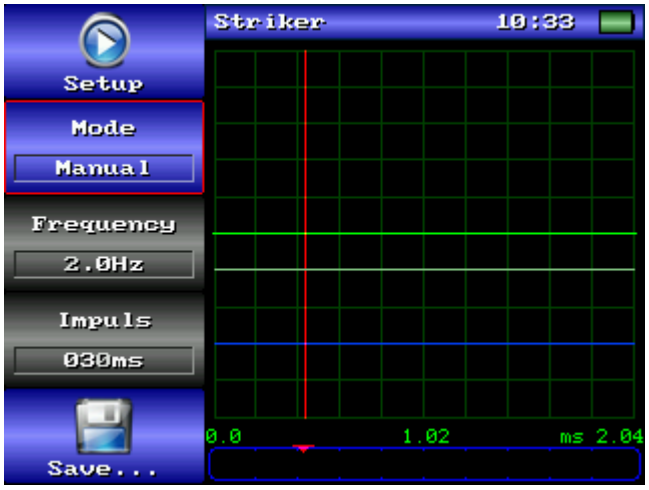

Fig.D. 5 “Striker” mode.

D.2.3.4 Set the “Gain” parameter value to 15 dB.

D.2.3.5 Set the the “SC Thresh”parameter to 60%;

D.2.3.6 Set the the “SD Thresh”parameter to 20%;

D.2.3.7 Set the “Duration” parameter to 2 ms.

D.2.3.8 Impact the defect-free area of the TS-2 testing specimen with the transducer. The graph of vibrations must be displayed (see **Fig.D. 2**);

Note: the found duration of impact vibrations is indicated with the vertical white line on the graph (see **Fig.D. 2**). This duration is determined by exceeding of the amplitude threshold (set in the “SC Thresh.” parameter) on the timescale backside (see **Fig.D. 6**). The amplitude of received vibrations depends on two values: the impact strength and set gain length. **Fig.D. 7** represents the graphs of received signals. The amplitude of received vibrations represented in the **Fig.D. 7**, a) is sufficient for correct determination of the vibration duration. The amplitude represented in the **Fig.D. 7**, b) does not exceed the threshold of one scale cell along the Y axis; it is necessary to increase the gain value. Therefore, it is necessary to make special impacts (they must be experimentally determined) and set the right gain level. By default, the gain is set to 15 dB; it will be optimal for the most cases.

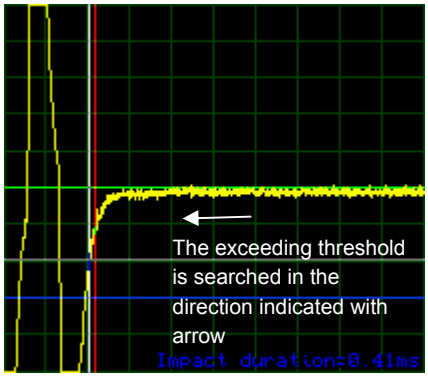

Fig.D. 6 Determination of the impact vibrations length

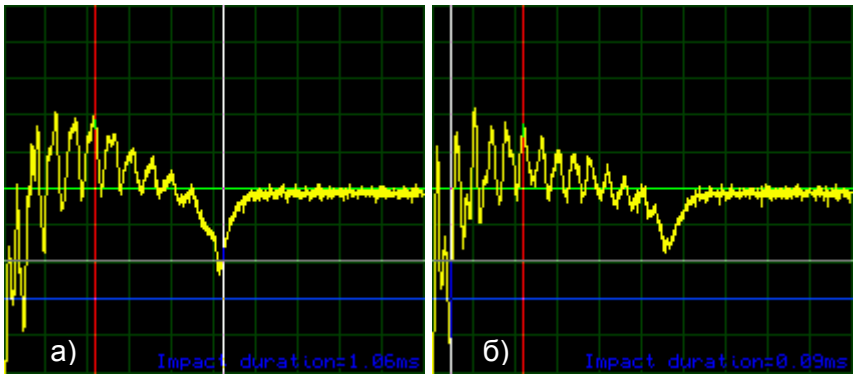

Fig.D. 7 Right gain setting.

a) the amplitude of impact vibrations is sufficient to correctly determine the duration;

b) the amplitude of impact vibrations is not sufficient (the vibrations duration is wrong determined) – it is necessary to increase the gain;

D.2.3.9 Press the key “Setup” and make several impacts on defect-free sites of the TS-2 testing specimen. The maximal impact duration value will be automatically saved and set as the defect alarm activation threshold in the “Thresh AASD” parameter. Finish setting by pressing the key “Finish”. If striking the defected specimen`s area now, the FAS threshold is exceeded and the light\audible defect alarm is activated The setting is completed by pressing the key “Finish”. If the specimen’s defect area is now impacted, the threshold is exceeded and the light (LED light on the transducer and the device front panel) and sound alarm is activated. At the level band, the threshold exceeding is indicated by red color of the band.

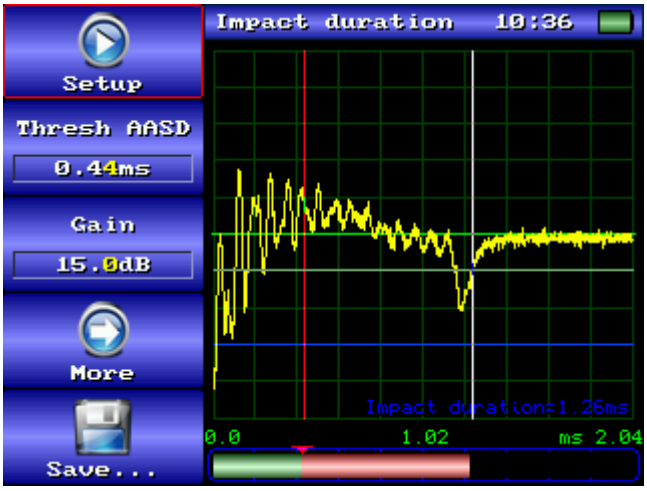

Fig.D. 8 Impact vibrations on defected area of the TS-2 specimen.

D.2.3.10 Check the setting quality, making several impacts on defect-free sites of the TS-2 testing specimen. If the false alarm activation occurs, desensitize (increase) the alarm activation threshold by changing the “Thresh AASD” parameter. After that, the setting is completed and the device is ready for testing.

D.2.4 Setting of the UDP-10-02 transducer on the TS-2 testing specimen

D.2.4.1 Turn on the device, load the “Impact flaw detector” program, connect the UDP-10-02 transducer (that is equipped with the electromagnetic striker and enables to strike on the tested object surface with the frequency of 1 - 5 Hz), place the transducer on the TS-2.

D.2.4.2 In the main menu, select the “Striker” mode. In the “Frequency” parameter, set the necessary value of the transducer frequency strikes (is methodically determined, by default this value is equal to 2Hz).

D.2.4.3 Set the the “SC Thresh”parameter to 60%.

D.2.4.4 Set the the “SD Thresh”parameter to 20%.

D.2.4.5 Set the “Duration” parameter to 2 ms

D.2.4.6 Set the “Impuls” parameter to 20 ms.

D.2.4.7 Set the “Mode” parameter to “Auto”. The UDP-10-02 transducer will start striking on the testing object.

D.2.4.8 Go into the “Strike duration” mode. For this purpose, press “Back” or select the main menu item “Strike duration”.

D.2.4.9 Further setting is performed like the setting of UDP-10-02 transducer (see p.**D.2.3.4 - D.2.3.10)**

D.2.4.10 How to save setting in the archive

In order to repeatedly use the setting, save it in the archive of settings. To save, activate the item “Save”.

D.2.5 “C-scan” mode

C-scan mode is intended to build two-dimensional images of defects, using such scanning devices as “Slider” (further - scanner).

Work order:

- Connect the scanner to DAMI-C, fix the scanner on the testing object, using a suction cap or magnet; the X axis of the scanner must be parallel to one of the scan area sides. Fix the transducer in the scanner;

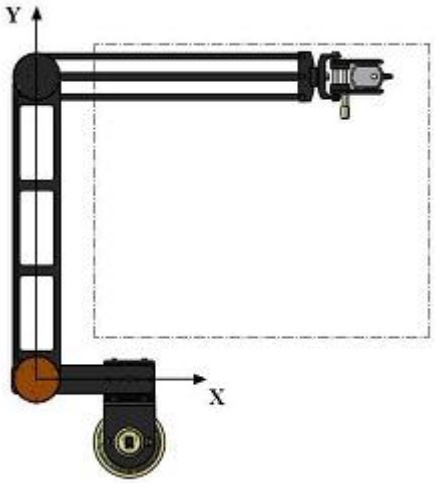

Fig.D. 9 Positioning of the “Slider” relative to the testing zone.

- Select the main menu item “C-scan”;
- Load the setting created earlier in one of the testing methods; press the key “Load…”. If a scanning device is not connected, the key “Load…” will be inactive;

Fig.D. 10 C-scan mode.

- Choose the scanning step in the menu item “Step”. While scanning, the workspace is divided into square cells; a cell side is equal to a scanning step. If a defect is found even in one point within the cell, the whole cell will be marked as defected.
- “Take” two control points - place the transducer sequentially in the upper left corner of the tested area and press “Point1”, place the transducer in the lower right corner and press “Point 2”. After that, the screen will display the scan zone as a grid. Actual sizes of the received area are highlighted on the grid (minimal size -10x10 mm). The current scanner position will be shown with a white marker (cross);

Fig.D. 11 Taking the control points.

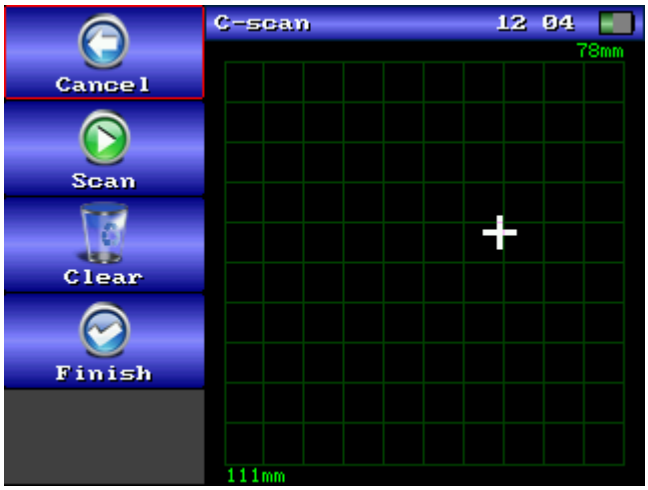

Fig.D. 12 Scan zone.

– Press the key “Scan” to start scanning. Move the transducer on the testing area. Passed area will be red-colored if the defect alarm has been actuated; if not – it will be green-colored. If necessary, stop scanning, pressing the key “Pause” and then start scanning again, pressing the key “Scan”. To clear the zone, press the key “Clear” – the whole scanned image will be deleted. If it is necessary to return to taking control points or loading of the other setting, press “Cancel”;

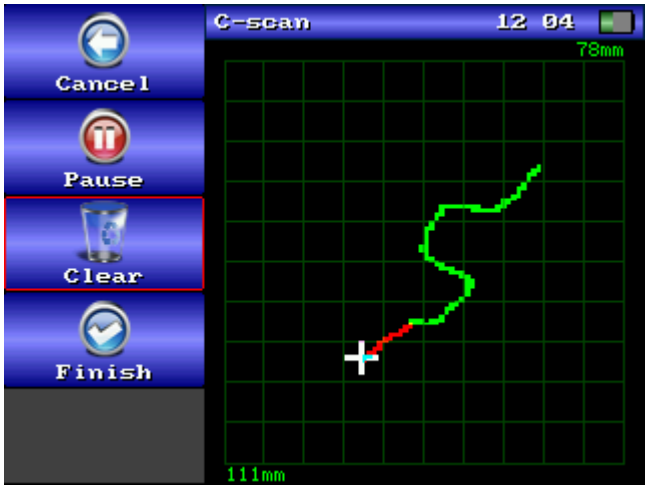

Fig.D. 13 Scanning process.

– After the scan is completed, press the key “Finish..” and proceed to the defects square measurement mode.

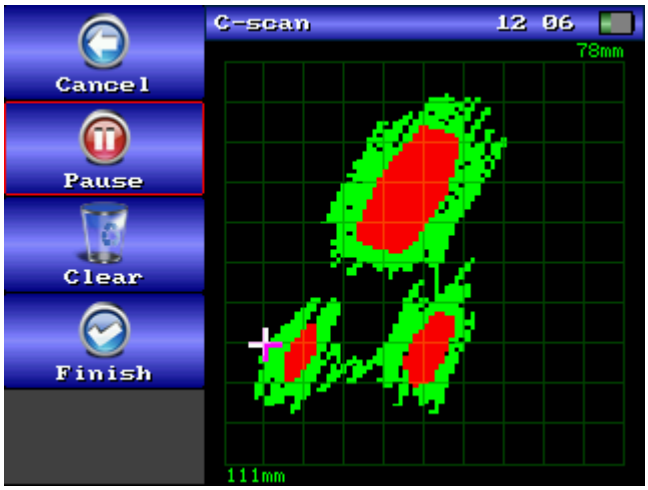

Fig.D. 14 Received scanned image.

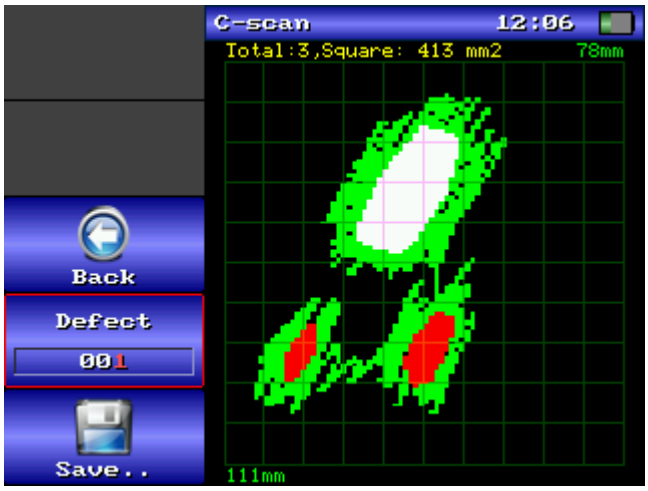

Fig.D. 15 Defects square measurement mode.

In the defects square measurement mode, the total number of detected defects as well as the square of the current selected defect will be displayed in the upper part of the scan zone. A selected defect will be white-colored on the screen. To navigate through the list of defects, use the key “Defect”. Defects will be listed by decrease of their square, i.e. the first defect is the biggest, the second is smaller, etc.

To save a received scanned defect image, press the key “Save..”; then input a name in the appeared saving window. Received scanned images can be further seen in the archive of results.

If it is necessary to continue scanning or scan any other object, return to the scanning mode, pressing the key “Back”.

D.2.6 Intellectual transducers and the “Transducers” mode

DAMI-C09 supports operating of the intellectual transducers. When connecting the intellectual transducer, the device automatically determines its data (name, serial number, etc.). The status line displays the intellectual transducer’s indicator 

. The intellectual transducer data are further used to save settings and testing results and makes their manual input unnecessary.

The connected intellectual transducer’s data can be viewed in the “Program” mode, menu item “Transducers”.

In order to facilitate the operating of non-intellectual transducers, the “Transducers” mode can be used. This mode is alternative to the manual data input by saving the settings or testing results.

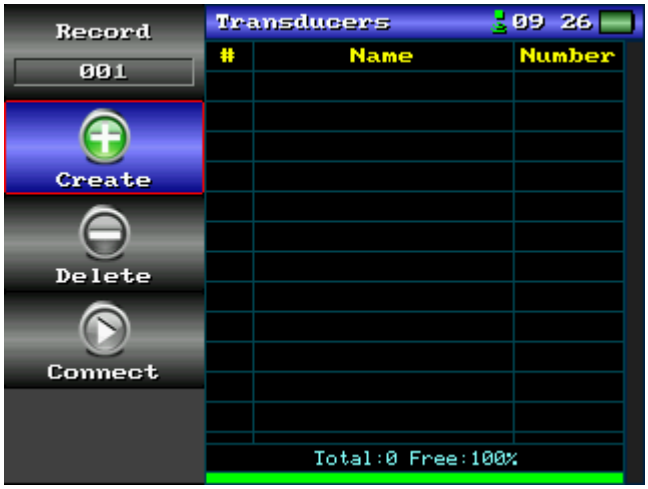

Fig.D. 16 “Transducers” mode.

The “Transducers” mode is the list of all non-intellectual transducers connected to the device. One of the listed non-intellectual transducers can be currently connected. The list of non-intellectual transducers is originally created by the operator and can be added if necessary. By changing the non-intellectual transducers, the operator just needs to enter the “Transducers” mode and connect the needed non-intellectual transducer.

– Creating of non-intellectual transducers. In order to create a non-intellectual transducer, press the key “Create”. The screen will display the window, having the fields for input of the transducer’s data. To edit data in the window, do the same actions as for saving of the settings or testing results.

– Deletion of non-intellectual transducers. A non-intellectual transducer can be removed from the list by pressing the key “Delete”.

– Connecting of non-intellectual transducers. In order to connect a non-intellectual transducer, select the necessary item from the list by pressing the key “Record” and activate the non-intellectual transducer by pressing the key “Connect”. The selected list item will be green-colored. The status line will display the non-intellectual transducer’s connection indicator 

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D.2.7 Archive of settings and results.

The archive of settings enables to view and download the saved settings.

Fig.D. 17 Archive of settings – main parameters

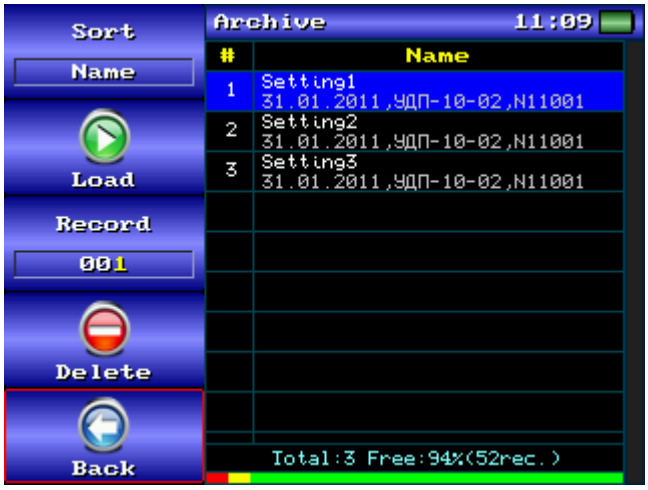

Fig.D. 18 Archive of settings – additional parameters

The archive mode supports both main and additional parameters. To switch between them, press the keys “More” and “Back”.

The numbered table with the list of records is located in the working area of the archive. The date of saving, description and transducer no. are displayed for each record. On the right from the table, there is the scroll bar

On the down, there is the status line containing:

– Total number of saved records;

– Free space in percent from the total archive capacity as well as the approximate number of records, for which this free space is sufficient;

– Additional data line with the graphical information about the archive filling. The green color means the free space of the archive, the red color means the busy space. The yellow color means the space, which will be free after defragmentation of the archive.

Main capabilities of the archive:

“**Archive**” – switching between the archives of settings and results whereas the different data are displayed in the same table;

"**Load**" – it is active only in the settings archive mode; the setting is loaded with further going to the respective (manual or phase) testing mode;

"**Record**" – selection of the record from the list;

"**View**" – viewing the scanned image.

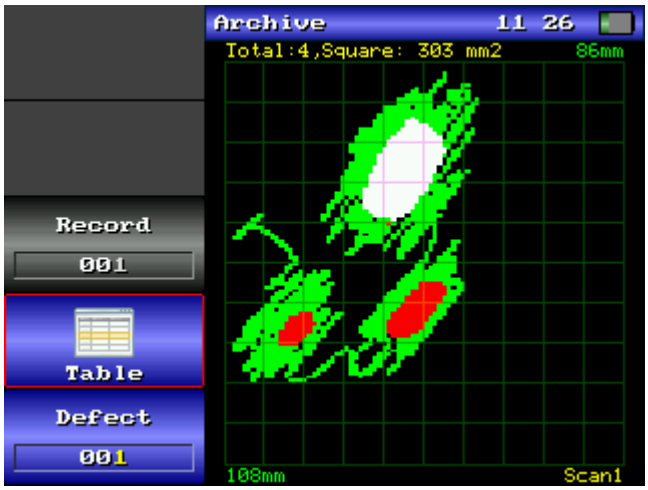

Fig.D. 19 Viewing the image

"**Delete**" – deletion of the record from the archive.

"**Sort**" – sorting records in the table by selected criteria (description, date, setting type).

D.2.8 Program

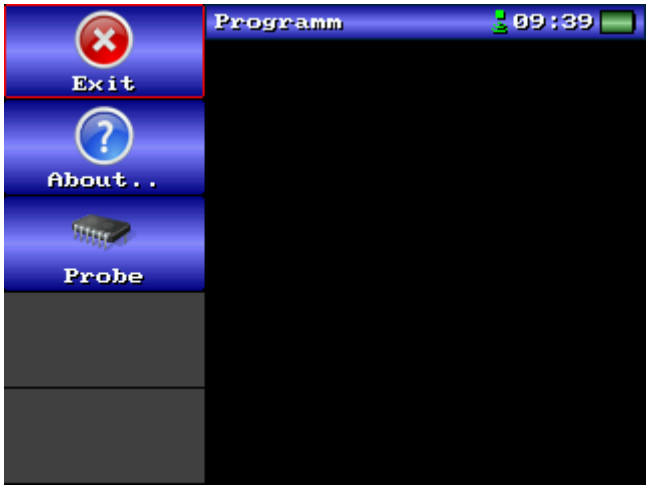

Fig.D. 20 Menu item "Program".

- "**Exit**" – exit from the program into the splash screen menu;
- "**About**" – receiving of the program data;
- "**Probe**" – info about the currently connected intellectual probe. If the connected probe is not intellectual, this item will be inactive.