Acoustic flaw detector TQ-92

Operation manual

Acoustic flaw detector TQ-92

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Preface
This manual introduces the device structure, working principal, technical specifications as well as information necessary for proper operation of the TQ-92 Acoustic flaw detector. Please, read carefully this manual before using of the device.

1. Intended use

1.1. TQ-92 Acoustic flaw detector (hereinafter referred to as “flaw detector”) is designed to detect local delaminations and discontinuities in multilayer adhesive structures and in products made of composite materials used in aircraft construction and other industries.
Flaw detectors use the method of acoustic impedance measurement, which is based on recording changes in the mechanical impedance of the tested product.

1.2. A flaw detector is a portable device designed for manual testing in workshop and laboratory conditions, as well as when climatic conditions of operation do not prevent its use.

1.3. Factors limiting the scope of application of the flaw detector:

- low (less than 1 GPA) elasticity moduli of the tested product outer layer
- oscillations of the tested product
- occurrence of a defect at a depth of more than half of the thickness of the continuous layer
- surface roughness of Rz > 30 μm
- “sticking” of the defect, i.e. complete adhesion of layers in the absence of cohesion between them

1.4. Operating conditions:

- ambient temperature from -10 to +50°C
- relative air humidity up to 98% at a temperature of +20°C
- atmospheric pressure from 84 to 106.7 kPa
- impedance probe oscillators shall not be subjected to shock loads

2. Specifications

2.1. Bedding depth of detected defects:

- from 0.5 mm to 3.0 mm in structures made of aluminum alloys
- from 0.15 mm to 8.0 mm in structures made of composite polymer materials

2.2. The minimum diameter of a detectable defect in aluminum alloy structures at a depth of 0.5 mm is 7 mm.
2.3. The maximum scanning speed for structures with tested surface roughness of Rz < 30 is 10 m/min (0.10 m/s).

2.4. The minimum radius of curvature of convex surfaces is 6 mm. The minimum radius of curvature of concave surfaces is 20 mm.

2.5. For monitoring of the signal amplitude proportional to the mechanical impedance modulus of the product, the flaw detector is equipped with a graphic indicator of the signal level with the visual effect of an analog dial indicator.

2.6. The flaw detector is equipped with the following:

- defect sound alarm
- color graphic display for 240×320 pixels
- keyboard for test modes settings

2.7. Detector has adjustable defect alarm thresholds.

2.8. Powered by: 3 lithium-ion (Li-IO) AA batteries; alternating current main with a voltage of 220 V+22–33 V and a frequency of 50±2 Hz, when using a utility power source (UPS) with a DC output voltage of 9 V and a power of at least 18 W.

2.9. The battery charge level is displayed on the flaw detector screen.

2.11. The current consumption from an external power source when the flaw detector is turned on and the batteries are being charged is no more than 2 A.

2.12. The flaw detector, when fully charged, should operate continuously for at least 5 hours.

2.13. Dimensions:

- 77×160×33 mm for flaw detector electronic unit (EU)
- 82×70×52 mm for utility power source (UPS)
- 100×32×22 mm for double transducer probe
- 67×28×45 mm for single transducer probe

2.14. Weight:

- 0.3 kg for flaw detector electronic unit (EU)
- 0.25 kg for utility power source (UPS)
- 0.22 kg for double transducer probe
- 0.2 kg for single transducer probe

2.15. The minimum expected service life - at least 5 years.

3. Delivery set

3.1. The complete set of delivery of the flaw detector is shown in Table 1.

Name, type	Quantity
Electronic unit with batteries	1 pc.
Single probe	1 pc.*
Double probe	1 pc.*
Probe SP-SCAN-15	1 pc.*
Utility power source	1 pc.
Reference sample SO-91	1 pc.
USB flash drive with factory settings backup copy	1 pc.
USB cable for connecting to a PC	1 pc.
Data sheet. Technical description	1 pc.
Carrying bag	1 pc.

Table 1**.** * The type and number of probes are specified when ordering

4. Design and operating principle

4.1. Operating principle of the flaw detector

The acoustic impedance method uses the dependence of mechanical impedance of the tested section of the product on the presence of a defect in this section or changes in the mechanical parameters of the product (stiffeners, layer thickness, etc.). Mechanical impedance Z is the ratio of disturbance force F to oscillating velocity V caused by it on the tested section of the object.

$$Z = F / V$$

The flaw detector uses two impedance testing methods: pulse and continuous. In the pulse mode, excitation of elastic oscillations in the product occurs with the help of an emitting piezoelectric element.

These oscillations are received by the receiving piezoelectric element, and the presence of a defect in the product is evaluated based on the parameters of the signal received from the receiving piezoelectric element.
For operation in the pulse mode, the flaw detector is equipped with two types of probes: single probe (**SP**) and double transducer probe (**RSP**), which differ in the method of input and reception of oscillations from the test item (TI). In continuous mode, excitation of the emitting piezoelectric element is caused by a sine-wave signal of specific frequency. For operation in the continuous mode, SP-SCAN-15 probe is used.

4.1.1. Operating principle of the single probe
In an oscillator loaded onto the tested product, which is an adhesive structure made of emitting and receiving piezoelectric elements, as well as a contact tip, excitation of the pulse of acoustic oscillations takes place, the parameters of which are determined by the oscillator itself and the mechanical impedance of the section of the tested product onto which the oscillator is loaded. Suitability of the product shall be evaluated by the amplitude and frequency of the received oscillations.

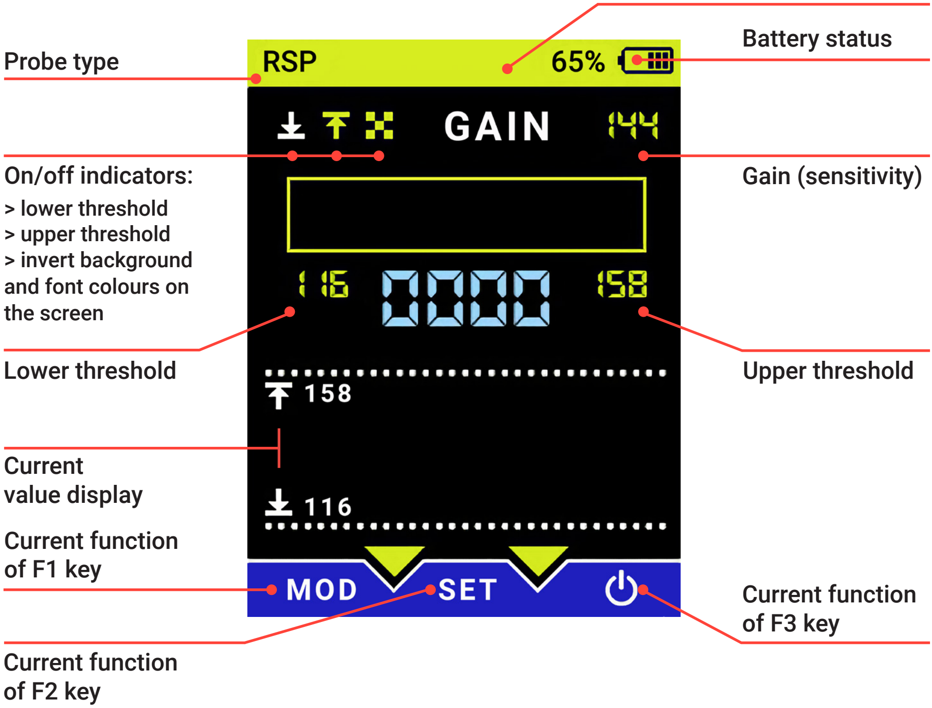
4.1.2. Operating principle of the double probe
In one of the two oscillators loaded on the tested product, excitation of the pulse of acoustic oscillations takes place, which, having passed from the oscillation input point, is received by the receiving oscillator at the reception point. The emitting and receiving oscillators are narrowly-resonance acoustic systems with the same resonating frequencies, so oscillations with the frequency of the emitting oscillator are reliably received by the receiving oscillator. The pulse amplitude of the received oscillations is a function of multiple parameters, such as: quality factor of the oscillators, amplitude of the excitation pulse, force of the oscillators pressing to the product, as well as mechanical impedance of the area where oscillations are entered and received in the product. The amplitude of the received oscillations is used to evaluate whether the product is defective.

4.1.3. Operating principle of SP-SCAN-15 probe
In an oscillator loaded onto the tested product, which is an adhesive structure made of emitting and receiving piezoelectric elements, as well as a contact tip, excitation of the continuous harmonic oscillations takes place, the parameters of which are determined by the oscillator itself and the mechanical impedance of the section of the tested product onto which the oscillator is loaded. Suitability of the product shall be evaluated by the amplitude, frequency and phase of the received oscillations.

4.2. Appearance
4.2.1. Figure 1 shows the appearance of the front panel of Acoustic flaw detector TQ-92. References show the controls and indications of the flaw detector, as well as their names mentioned further in the text of this manual.

Figure 1. Acoustic flaw detector TQ-92

Figure 2. Screen view in pulse operation modes (with single and double probes)



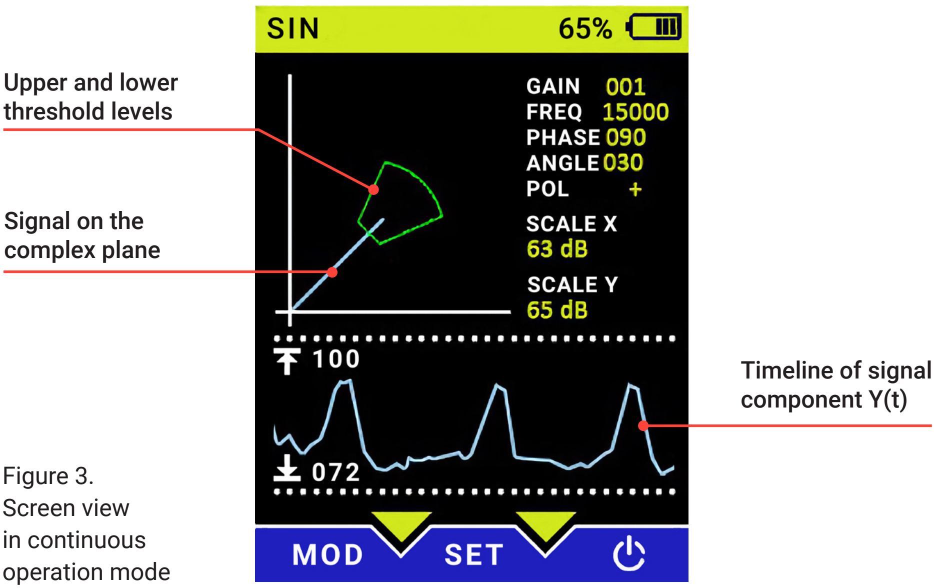


Figure 3.
Screen view
in continuous
operation mode

Dual element probe (RSP)

4.3. Flaw detector control.

4.3.1 The flaw detector is controlled using **F1**, **F2**, **F3**, **UP**, **DOWN** keys.

4.3.2. Parameters available for user adjustment in single and double probe pulse modes:

Parameter	Designation	Description
Gain	**GAIN**	Amplification of the signal received from the probe. Control sensitivity measurement.
Upper threshold alarm	⤓	Enable/disable the defect sound alarm when the signal level is less than the value specified in the Lower threshold field
Lower threshold alarm	⤒	Enable/disable the defect sound alarm when the signal level is greater than the value specified in the Upper threshold field
Palette		Enable/disable black and white color palette displayed on the screen.
Lower threshold	Numerical value, see Fig. 2	Lower threshold value
Upper threshold	Numerical value, see Fig. 2	Upper threshold value

Table 2.

4.3.3. Parameters available for user adjustment in continuous mode:

Parameter	Designation	Description
Gain	**GAIN**	Amplification of the signal received from the probe. Control sensitivity measurement.
Frequency	**Frequency**	Enable/disable the defect sound alarm when the signal level is less than the value specified in the Lower threshold field
Phase	**Phase**	Enable/disable the defect sound alarm when the signal level is greater than the value specified in the Upper threshold field
Upper threshold	⤒	Upper threshold value
Lower threshold	⤓	Lower threshold value
Threshold sector angle	**ANGLE**	The sector opening angle formed on the complex plane by the upper and lower threshold levels (see Fig. 3).
Threshold polarity	**POLARITY**	+ (red outline) – signal on when the vector is inside the threshold sector. - (green outline) - signal on when the vector is beyond the boundaries of the threshold sector
X-axis scale	**SX**	X-axis scale.
Y-axis scale	**SY**	Y-axis scale

Table 3.

4.3.4. Changing flaw detector parameter values in pulse operation modes of single and double probes.

To change a parameter value, it shall be activated first. To do so, press the **F1** key. A cursor will appear in the field displaying the parameter value. To select the next option, press **F1** again. If the parameter is a numeric value, for example, gain, the cursor will highlight one digit of that number. To change the value of the selected digit, use the **UP** and **DOWN** keys.

To move the cursor between digits of the selected parameter, press the **F2** key. To enable/disable the lower and upper threshold alarms or switch the color palette, place the cursor on the corresponding symbol.

When the parameter is highlighted by the cursor, use the **UP** key to enable it and the **DOWN** key to disable it.
When the flaw detector is turned on, no parameters are activated.
By successively pressing the **F1** key, the parameters are activated as follows: Gain – lower threshold **ON/OFF** – upper threshold **ON/OFF** – **Palette** – Lower threshold value – Upper threshold value. To ensure that the settings entered by the user are not reset after the power is turned off, they shall be saved in the non-volatile memory of the device. To do so, after the last value (Upper threshold value) has been set, press the **F1** key again. The settings will be saved and the cursor will disappear from the screen.
To finish editing of the parameters and to reset the cursor without saving changes to non-volatile memory, press **F3**.

4.3.5. Parameter adjustment in continuous mode is carried out in a similar way. The order of switching of the parameters using the **F1** key is as follows:
Gain – Frequency – Phase – Upper Threshold – Lower Threshold – Threshold Sector Angle – Threshold Polarity – X Scale – Y Scale.
To switch the strobe polarity, press and hold the **DOWN** key for 2-3 seconds. The color of the strobe sector lines on the screen shall change.

4.3.6. Loading settings. To get to the menu to load previously saved settings, press and hold the **F1** key. A list of names of settings files stored in non-volatile memory will be displayed on the screen. Use the **UP** and **DOWN** keys to select the desired file and press **F1**. To exit the menu, press **F3**.

4.3.7. Creating settings files.
To create a new file with settings, connect the electronic unit to a personal computer (PC) using USB cable. An additional storage device will appear on the PC. Open any file stored on the connected device and save it under a new name. Next time, upon access to the settings menu, this name will also appear in the list. The values in the settings file can be edited in PC using any text editor. The parameter name correspondence table is given in Appendix A hereto. In addition, settings can be changed during operation of the flaw detector. To do this, first download the required file (section **4.3.6**), change the settings as necessary, and then save them by scrolling through all the parameters with the **F1** key (section **4.3.4**).

4.3.8. The package includes a USB flash drive with a backup copy of the factory settings. If the files stored in the non-volatile memory of the flaw detector are lost or damaged for any reason, they can be copied again from a backup USB drive.

5. Safety precautions

5.1. When working with a flaw detector, it is necessary to comply with the requirements of the “Rules for Technical Operation of Electrical Installations by Consumers” and “Safety Rules for Operation of Electrical Installations by Consumers”.

6. Preparation for operation

6.1. Switching the flaw detector to battery operation.
6.1.1. The electronic unit of the flaw detector contains 3 removable lithium-ion batteries of AA size. The battery is shipped from the factory fully discharged. It shall be pre-charged before starting operation. To charge the battery, connect the power adapter, the **CHARGE** indicator will light up. Once charging is complete, the **CHARGE** indicator will turn off. Batteries that fail after long-term use can be replaced with similar ones.

6.1.2. Connect a probe to the electronic unit of the flaw detector (the type of the probe shall be determined depending on the type of product being tested in accordance with Section 8).

6.1.3. To turn on the flaw detector, press and hold the **F3** key until the beep (2...3 s).
6.1.4. Upon completion of the initialization procedure, the flaw detector will boot into the operating mode set in the settings menu item called “default”.
6.1.5. To switch the probe type, press and hold the **F2** key for 2-3 seconds.

6.2. Performance check of the flaw detector on a reference sample SO-91 (see Appendix A).
6.2.1. Performance check of the flaw detector with the double probe (**RSP**).
6.2.2. Load settings SO91_RSP (item **4.3.6**).
6.2.3. Place the probe with the contact zone on a defect-free area of the sample. In this case, no alarm should be triggered.

6.2.4. Place the probe with the contact zone in the center of the artificial defect and make sure that the sound and light alarms are triggered: the flaw detector shall positively detect defects 1-7.

6.2.5. Performance check of the flaw detector with the single probe (**SP**).

6.2.6. Load settings SO91_SP (item **4.3.6**).

6.2.7.. When using the probe supplied with the flaw detector, skip this item. If this single probe is used for the first time, it shall be pre-balanced. To balance the probe, place it in a way so that its contact plate is in the air without touching any objects. Then, press and hold the **UP** key for 2-3 seconds.

BALANCE will appear on the screen. After the procedure is completed (up to 60 seconds), the inscription will disappear. The balancing parameters will be saved into the non-volatile memory of the flaw detector. Rebalancing is not required for operation of this probe. The single probe supplied with the device is balanced during the production process and does not require re-balancing.

6.2.8. Place the probe with the contact zone on a defect-free area of the sample. In this case, no alarm should be triggered.

6.2.9. Place the probe with the contact zone in the center of the artificial defect and make sure that the sound and light alarms are triggered: the flaw detector shall positively detect defects 1-3.

6.2.10. Performance check of the flaw detector with probe SP-SCAN-15.
6.2.11. Load settings SO91_SP15 (item **4.3.6**).
6.2.12. Place the probe with the contact zone on a defect-free area of the sample. In this case, no alarm should be triggered.
6.2.13. Place the probe with the contact zone in the center of the artificial defect and make sure that the sound and light alarms are triggered: the flaw detector shall positively detect defects 1-2.

7. Reference-free tuning

7.1. Reference-free tuning mode.
7.1.1. The presence of a reference-free tuning mode allows to adjust the impedance flaw detector directly on the tested product without the use of a tuning sample with artificial defect simulators. Thus, it is possible to significantly reduce the costs of non-destructive testing, by saving time and material resources required in the manufacture of samples.

7.1.2. Reference-free tuning of the TQ-92 Acoustic flaw detector is carried out on a small area of the tested product with of approximately 100x100 mm, by smoothly moving the probe within the selected area.
Then, using statistical data analysis methods, the flaw detector automatically selects the optimal gain value so that most of the local stiffness values of the defect-free part of the sample will be displayed in the middle of the instrument scale, and the upper and lower thresholds are set so that even a slight drop in local stiffness in tested point (which indicates the presence of a defect), relative to the value of local stiffness in the defect-free section of the sample, will trigger the defect alarm.

While the probe is moving, the flaw detector collects data on the local stiffness of the product in the selected area.

Then, using statistical data analysis methods, the flaw detector automatically selects the optimal gain value so that most of the local stiffness values of the defect-free part of the sample will be displayed in the middle of the instrument scale, and the upper and lower thresholds are set so that even a slight drop in local stiffness in tested point (which indicates the presence of a defect), relative to the value of local stiffness in the defect-free section of the sample, will trigger the defect alarm.

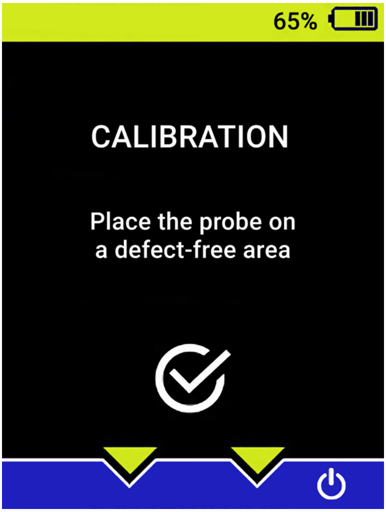


Figure 4. Screen view when switching to reference-free tuning.

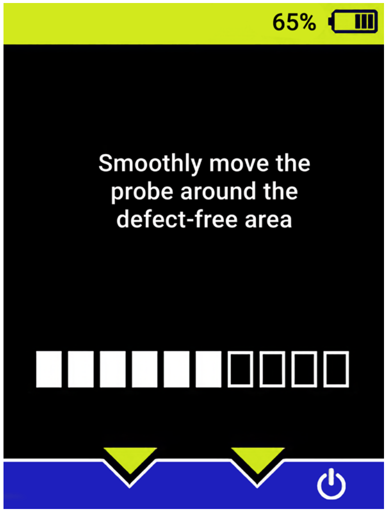


Figure 5. Screen view when performing reference-free tuning.

Figure 6. Screen view with reference-free tuning completed.

Single element probe (SP)

8. Inspection guidelines

8.1. These guidelines establish methods and means for inspection of TQ-92 Acoustic flaw detector during operation and storage.
8.2. The frequency of inspection shall be at least once a year.
8.3. When conducting an inspection, operations shall be performed and verification tools applied as given in Table 4.

Operation	Item number	Means and methods of inspections
Visual inspection	**7.6.1.**	Visually
Testing	**7.6.2.**	SO-91

Table 4.

8.4. Inspection conditions
The inspections shall be carried out under normal conditions.

Ambient temperature, °C	20 + 10
Atmospheric pressure, kPa	100 + 4
Relative air humidity, %	60 + 20
Supply voltage, V	220 + 10
Supply frequency, Hz	50 + 2

Table 5.

8.5. Preparation for inspection
Prior to the inspection, perform operations described in items 6.1. – 6.3 of the data sheet.

8.6. Inspection
8.6.1. Visual inspection:

- establish the compliance of the flaw detector with the following requirements: the complete set of the flaw detector shall comply with Section 3 hereof
- the flaw detector and the probes shall not have mechanical damage

8.6.2. Testing.
During testing, check the performance of the flaw detector on a reference sample as described in items 6.2.1 - 6.2.12.

9. Operation procedure

9.1. Probe type selection

9.1.1. Single probe (**SP**) is designed to detect defects such as "glueline defect (gap)" and "delamination" at relatively shallow depths:

- 0.50-1.50 mm for metals
- 0.15-3.00 mm for composite materials and for monitoring of curved surfaces with a small radius of curvature:
- > 6.00 mm for convex surfaces
- > 20.00 mm for concave surfaces

9.1.2. Double transducer probe (**RSP**) is designed to detect defects such as "glueline defect (gap)" and "delamination" at the following depths of occurrence:

- 0.50 – 2.00 mm in metal structures
- 0.15 – 8.00 mm in structures made of PMC

Moreover, defects with a relatively shallow depth (up to 1.00 mm) can be detected in a negative mode (decreasing the signal at the defect), as well as to detect such defects as "destruction of cell core at a depth of up to 2.00 mm".

9.1.3. After connecting the selected type of the probe, press and hold the **F2** key to set the appropriate operating mode of the flaw detector. Previously saved settings can also be loaded with the parameters for a given test object.

9.2. Operation mode selection

9.2.1. The selection of the optimal operation mode shall be carried out on tuning samples with artificial defects corresponding to real structures.

9.1.2. When adjusting the value of the Gain parameter (Fig. 2, Fig. 3), start with smaller values (less than 10), gradually moving upwards. The maximum gain value is **255**.

9.2.3. A defect sound alarm is triggered when the current value is outside the interval set by the lower and upper thresholds. i.e. if the current value is less than the lower threshold or greater than the upper threshold. The lower threshold alarm can be enabled or disabled. The alarm for exceeding the upper threshold can also be enabled or disabled (item **4.3.4**).

9.2.4. Upon availability of a specific testing method, it is possible to select the operation mode on the tested structure.

9.3. Setting of a flaw detector with a double probe (**RSP**) on a sample with an embedded defect.

9.3.1. By switching between the modes by long pressing the **F2** key, switch the flaw detector to the **RSP** (double probe) mode.

9.3.2. Enable digital display.

9.3.3. Turn on the upper threshold alarm.

9.3.4. For testing of products with defect depths of up to 1 mm, turn on the lower threshold alarm.
9.3.5. By moving the probe along the sample surface, set the gain so that the digital readings on the screen differ significantly in the area of the defect and in the defect-free area against the background of interference caused by the roughness of the test object.
9.3.6. Set the values of the upper and lower thresholds so that a sound alarm is triggered when the probe passes the defect area and the analog scale readings are easy to read.
9.3.7. Upon completion of the setup, the digital display can be turned off. The spacing frequency of probing pulses will increase and the test speed may increase.

9.4. Setting of a flaw detector with a single probe (**SP**) on a sample with an embedded defect.
9.4.1. By switching between the modes by long pressing the **F2** key, switch the flaw detector to the **SP** (single probe) mode.
9.4.2. Enable digital display.
9.4.3. Turn on the lower threshold alarm.
9.4.4. By moving the probe along the sample surface, set the gain so that the digital readings on the screen differ significantly in the area of the defect and in the defect-free area against the background of interference caused by the roughness of the test object.
9.4.5. Set the values of the upper and lower thresholds so that a sound alarm is triggered when the probe passes the defect area, and the analog scale readings are easy to read.
9.4.6. Upon completion of the setup, the digital display can be turned off. The spacing frequency of probing pulses will increase and the test speed may increase.

9.5. Setting of a flaw detector with SP-SCAN-15 probe on a sample with an embedded defect.
9.5.1. By switching between the modes by long pressing the **F2** key, switch the flaw detector to the (excitation) mode.
9.5.2. Set the value of the **Frequency** parameter to **15000**.
9.5.3. Place the probe in the defect-free area of the sample and start the balancing operation by pressing and holding the **UP** key for 2–3 seconds. **BALANCE** will appear on the screen. Upon completion of the process, the message will disappear. The length of the complex vector shall be now close to **0**.
9.5.4. Place the probe over the defect, and the length of the complex vector shall increase. Set the **Gain** parameter so that the end of the vector is in the visible area of the screen.
9.5.5. Using the **Phase** parameter, rotate the complex vector so that when the probe is above the defect, in vertical position.

9.5.6. Depending on the polarity of the threshold, the sound alarm of the defect is triggered either when the end of the complex vector enters the threshold sector area (**red**), or when it goes outside of the threshold sector (**green**). By moving the probe over the defect, set the threshold sector configuration to ensure reliable detection of defects.
To do this, use the following parameters: – upper threshold,   – lower threshold, **Angle** – sector opening angle, **Polarity** – threshold polarity.
9.5.7. By moving the probe along the sample surface, adjust the scale along **X** and **Y** axes so that friction noise has the minimum possible effect on the test results. At the same time, the defect shall be reliably detected. The X-axis scale is set by **X SCALE** parameter, and the Y-axis scale is set by **Y SCALE** parameter.

9.6. Product testing
9.6.1. Products testing shall be carried out by scanning the surface of the product with a probe.
9.6.2. The scanning step shall be 60-70% of the width of the permissible defect.
9.6.3. The scanning speed shall depend on the roughness of the scanned surface and shall be determined methodically, but it shall not exceed 0.10 m/s.
9.6.4. Boundaries of defects shall be determined by activation of an alarm (light, sound) by means of scanning from four sides to the center of the defect and shall be marked on the front and side surfaces of the probe at the intersection point.

9.7. Saving settings
9.7.1. The flaw detector is equipped with non-volatile memory for storing settings for various modes of operation. Settings are stored as text files of a specific format (see below). To display a list of saved settings files, press and hold the **F1** key for 2–3 seconds. To move through the list, use the **UP** and **DOWN** keys. Having placed the cursor over the desired line, press **F3**. To return to the test mode without loading the settings, press the **F1** key.

If the user downloads a file with settings, changes the parameters, and then saves the changes made (item **4.3.6**), they will be recorded in the file from which it was downloaded. Immediately after turning the device on, the settings are loaded from a file named “default”. In order to create a new file or edit an existing one, the electronic unit of the flaw detector can be connected to a personal computer (PC) using USB cable. A new storage device shall appear on the PC. Settings files are stored in the root directory and can be opened in any text editor. After making changes, the file can be saved under the same or a new name. It is allowed to use only Latin characters for file names.

IMPORTANT!!!
Files shall have idc extension (for example: Plate.idc), otherwise they will not appear in the settings menu.

9.7.2. Settings file format

the parameter name begins with “#” symbol;
the parameter name is followed by “=” symbol, after which the parameter value is indicated (example: #GAIN_SP=14);
each line can contain only one parameter;
a file can contain any number of lines of parameters; if the same parameter occurs more than once, the last one will be loaded into the flaw detector;

Settings of TQ-92 for ABCD.123456.123

Table 6. Testing parameters

Gain	**#GAIN_SP=14**
Lower threshold enabled	**#ONOFF_THRESHOLD_LOW_SP=1**
Upper threshold disabled	**#ONOFF_THRESHOLD_HIGH_SP=0**
Threshold values – lower and upper thresholds:	**#THRESHOLD_LOW_SP=150** **#THRESHOLD_HIGH_SP=300**
Testing is performed with single probe	**#PROBE=SP**

Mode	Parameter	Designation in the settings file	Message on the screen
SP	Gain	**GAIN_SP**	**GAIN**
	Enable/disable lower threshold alarm	**ONOFF_THRESHOLD_LOW_SP**	**L**
	Enable/disable upper threshold alarm	**ONOFF_THRESHOLD_HIGH_SP**	**H**
	Lower threshold	**THRESHOLD_LOW_SP**	**123**
	Upper threshold	**THRESHOLD_HIGH_SP**	**123**
RSP	Gain	**GAIN_RSP**	**GAIN**
	Enable/disable lower threshold alarm	**ONOFF_THRESHOLD_LOW_RSP**	**L**
	Enable/disable upper threshold alarm	**ONOFF_THRESHOLD_HIGH_RSP**	**H**
	Lower threshold	**THRESHOLD_LOW_RSP**	**123**
	Upper threshold	**THRESHOLD_HIGH_RSP**	**123**
SP-15	Gain	**GAIN_SIN**	**GAIN**
	Excitation frequency	**FREQ_SIN**	**FREQUENCY**
	Phase	**PHASE_SIN**	**PHASE**
	Lower limit of the threshold sector	**THRESHOLD_LOW_SIN**	**RL**
	Upper limit of the threshold sector	**THRESHOLD_HIGH_SIN**	**RH**
	Threshold sector opening angle	**THRESHOLD_ANGLE_SIN**	**ANGLE**
	X-axis scale	**SCALE_RE_SIN**	**SX**
	Y-axis scale	**SCALE_IM_SIN**	**SY**
All	Probe type	**PROBE**	**SP RSP SIN**

10. Maintanance

10.1. Maintenance shall be carried out in order to ensure normal operation of the flaw detector during its service life.
10.2. Recommended types and terms of maintenance:

- immediately prior to non-destructive testing for visual inspection of the flaw detector case and connecting cables of the transducers
- at least once a month for cleaning of support pads (fluoroplastic) of the transducers from contamination and metal shavings
- at least once a year for wiping of the contacts of microswitches in transducers upon wear for spherification of wear-resistant tips of the transducers using a diamond-tipped finishing stone

11. Storage and transportation regulations

11.1. Packaged flaw detectors shall be stored in a dry facility in accordance with storage conditions 1. The storage facility shall be free of conductive dust, vapors, acids and alkali, as well as gases that cause corrosion and destroy insulation.
11.2. Transportation of a flaw detector without packaging shall be allowed only in passenger carriages, vessel cabins, vehicle passenger compartments and airplanes at temperatures from -10 to +50°C and relative humidity of up to 98% at +20°C.

12. Acceptance certificate

Flaw detector TQ-92 Acoustic number ____

Single element transducer (SP) ____

Dual element transducer (RSP) ____

Reference sample SO-91____

Complies with technical documentation and has been accepted by the manufacturer.

Date of manufacture ____

Date of issue ______________________ Shipping date ______________________

L.S. Stamp

Quality Inspector ____

13. Manufacurer’s warranty

13.1. The guaranteed shelf life of the flaw detector and transducers is 18 months from the date of sale (shipment).

13.2. The warranty period for operation of the flaw detector and converters is 18 months from the date of shipment.

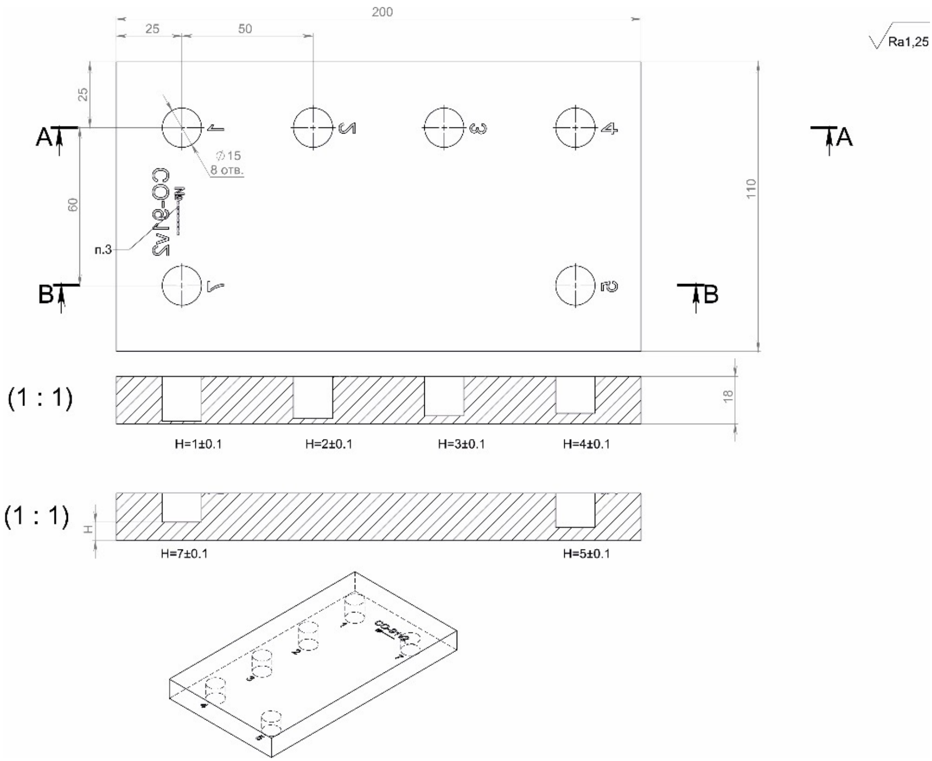
13.3. The manufacturer’s warranty does not apply to cables and consumables.

13.4. The shelf life of the reference sample SO-91 is unlimited.

13.5. The manufacturer undertakes to repair the flaw detector free of charge during the warranty period (up to replacement thereof as a whole) in case of a failure of the flaw detector within this period or its characteristics falling below the standard values established in item 2 of this data sheet.
Free repair or replacement of the flaw detector shall be provided subject to the consumer’s compliance with the instructions on operation, transportation and storage.

Problem	Analysis	Solution

14. Appendix A



For notes

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