UNIVERSAL ULTRASONIC FLAW DETECTOR UD4-76

TOFD version

ПРОМПРИЛАД®

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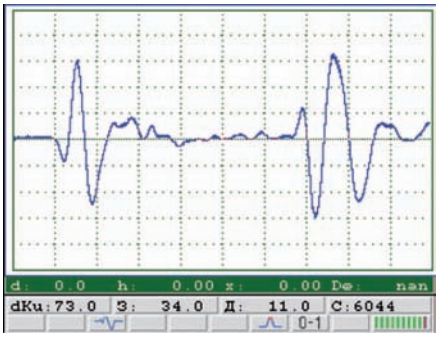
PURSPOSE

UD4-76 universal ultrasonic flaw detector-tomograph with large high-contrast TFT display is intended for products testing for detection of defects, such as discontinuity and inhomogeneity of materials, goods and in-process goods, weld joints, measurements of signals amplitude ratio from defects, of depth and their depth coordinates. Tomograph function allows to display and store testing results in the form of B-scans with affixment to scanning path. Flaw detector also solves the task of items thickness measurement at one-way access. Several operating modes for DGS diagrams are provided too, what makes it possible to define conveniently and quickly equivalent defects dimensions.

UD4-76 universal ultrasonic flaw detector is adapted and totally meets the requirements of regulatory documentation valid in various industrial sectors, such as: nuclear power engineering, metal production, pipe industry, rail transportation etc.



FLAW DETECTOR ADVANTAGES

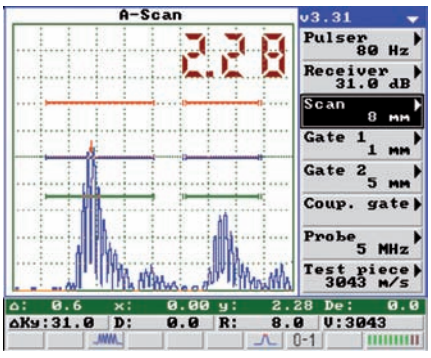
For carrying out the testing of different parts, an individual approach is required for solving each separate task. "Promprylad" scientific production association has great experience in this field and offers the customer:

- Special operating modes performed on the basis of the instrument software package and adapted to the customer's needs (among them there are: "Peak" mode, "Reflections marking" mode, automatic algorithms pf probe calibration, modes of automatic DGS-diagrams and TCG-curves plotting, data storage in the form of RF B-scan, rendering of "corrosion map" ("thicknesses map") and other);
- Flaw detector ergonomics when working with the object (large high-contrast TFT-display, small instrument weight, convenient menu, presence of automatic sound and light alarm of defects at three levels: search, registration, acceptance);
- Individual delivery set which includes the set of ultrasonic probes adapted to the testing of the customer's objects.

FLAW DETECTOR DISTINCTIVE FEATURES

- Large color high-contrast TFT display
- Metal protective case;
- ALARM system: 3 three-color LEDs, sound alarm;
- Convenient menu navigation;
- Various probes types operation;
- Possibility of sound comments creation for all stored data types;
- USB slave;
- Encoder connection;
- Software application for different testing tasks;
- Various A-scan display forms: RF/full wave/+half wave/-half wave;
- Dynamic change of generating path characteristics depending on the switched-on frequency filters;
- Information display forms: A-scan, B-scan, orthogonal views, corrosion map.

INSTRUMENT SERVICE FUNCTIONS



- Availability of two independent measurement gates with the defect alarm system (sound and light) by every gate. With that, every gate has:

THREE GOING-OFF LEVELS:

"ACCEPTANCE";

"REGISTRATION";

"SEARCH";

are marked on flaw detector screen in "RED", "BLUE" and "GREEN" color. The colors of light ALARM by every gate correspond to them.

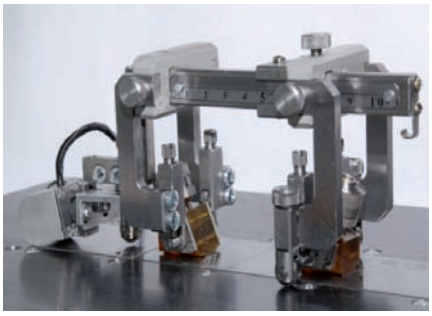
- the sound alarm going-off level is set up by an operator by a specific gate.

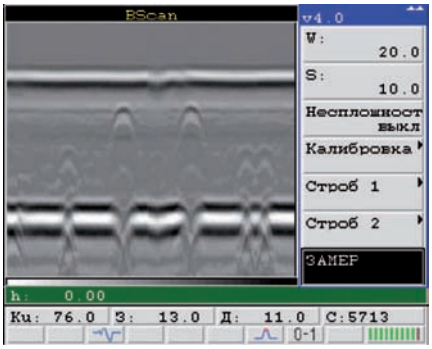
- the mode (when the preset level is transcended or not) is set up by an operator for every gate independently.

Application of three-level gates enables to estimate the risk of detected defects.

When using three-level gates it is possible to register echo-signals at different levels relative to the acceptance level. It will permit to record echo-signals from developing defects and monitor defects in the program of testing results viewing what is necessary for carrying out ultrasonic testing (UST) of important objects. Three-level gates as well as convenient sound and light defect alarm system allow to assess the detected discontinuity dimensions quickly and qualitatively.

- **MODE OF TOFD TESTING TECHNIQUE (TIME OF FLIGHT DIFFRACTION)**



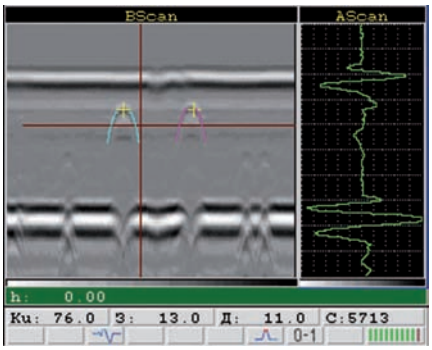


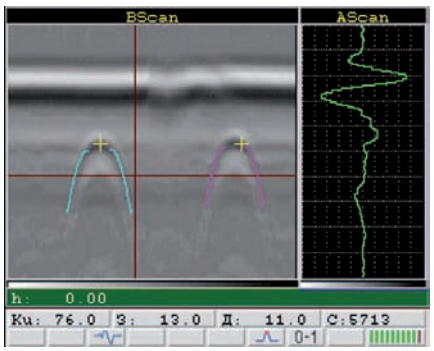
It is based on the measurement of propagation time of waves diffracted from the defect boundaries. TOFD technique is performed by means of two probes, operating in separate mode. It is intended for manual testing of butt-welded joints, plane surfaces and pipes. A manual scanning device is used to provide a constant distance between the probes index points and to orient them relative to each other. There is also the function of information assurance on ultrasonic probes position using encoder.

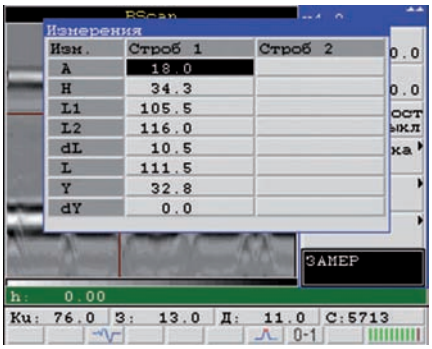
More precise determination of coordinates and dimensions of discontinuities, including cracks, is the main advantage of this technique. Today TOFD technique is applied for the testing of objects quality instead of conventional ones: radiation and ultrasonic echo techniques. Such defects as discontinuities, incomplete fusion, cracks, porosity and slag inclusions can be detected and their characteristics can be determined by means of this technique.

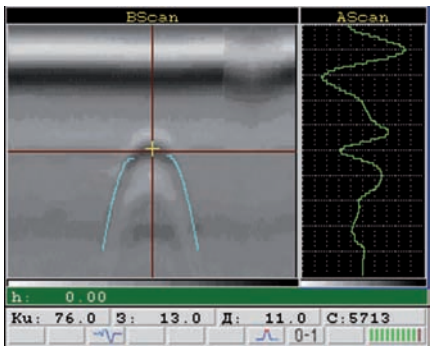
TOFD TECHNIQUE ASSURES:

- testing of the whole volume of weld per one scanning cycle;
- testing of various dimension-types of welded joints;
- determination of defects sizes without taking into account the amplitudes of diffracted signals;
- high sensitivity to all types of defects regardless of their orientation.





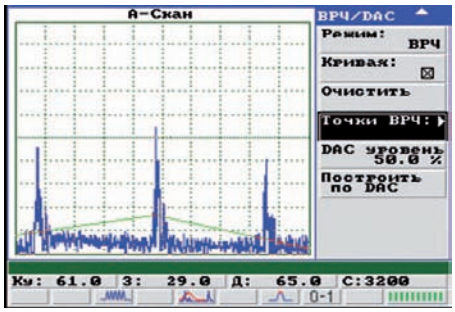




FUNCTIONAL CAPABILITIES:

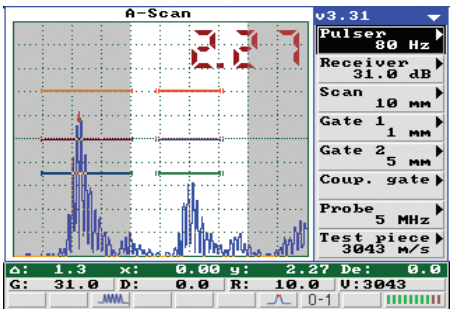
- complete recording of data in the form of A-Scan and RF B-Scan;
- viewing of testing results in the form of A-Scan and RF B-Scan;
- "calibration" mode;
- usage of two standard cursors or two hyperbolic cursors;
- data scaling with reference to the first or second cursor;
- determination of defects types and sizes in vertical plane and scanning plane when using hyperbolic cursors.

- **TIME CONTROL GAIN (TCG) MODE**



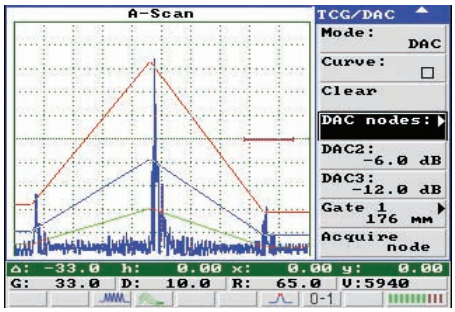
TCG level is set up in the point grid connected by linear sections, i.e. it is possible to set sundry TCG curve forms - piecewise-linear, step etc. TCG level corresponds to the signal attenuation in the given point relative to the set gain value. This option allows to test long-length items and items made from materials with great attenuation, it is also used for sensitivity setup when testing weld joints with wall thickness of more than 12 mm.

- **DAC AMPLITUDE CURVES MODE**



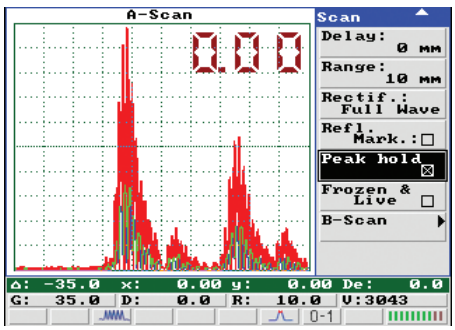
It helps to imagine the detected defect location in the testing item in the same direction as ultrasonic beams (straight, once- and multiple-reflected beam).

- **REFLECTIONS MARKING" MODE**



DAC mode is an alternative to TCG mode and enables to plot the curve which connects points (corresponding to signals peaks) on the screen, and also to plot up to 2 additional curves which is the preset value dB distant from the base one. DAC mode also allows quick and convenient TCG curve plotting.

- **"PEAK" MODE**



It is indispensable during small defects search, operation in unstable acoustic coupling conditions. Upon that, the current signal value is displayed on the screen concurrently with the max. signal envelope of all observable echo-signals (displayed in red color). This mode is applied for max. echo-signal amplitude determination and conditional length estimation. It can be used for testing results registration both for rejected and in-order items, what will confirm the presence or absence of defects throughout the whole scanning perimeter.

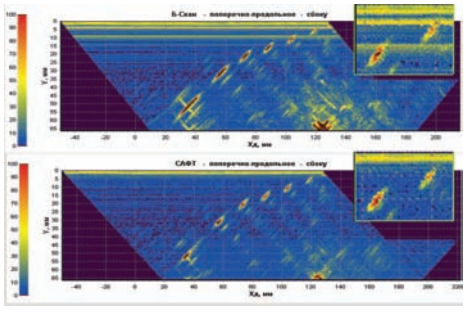
Thus, "Peak" mode application increases results reliability and reduces testing time.

- **MEASUREMENT OF EQUIVALENT DEFECTS DIMENSIONS (DGS DIAGRAMS)**

Using DGS diagrams UD4-76 flaw detector enables to measure equivalent defects dimensions in the range from 0,8 to 20,0 mm (equivalent defect diameter) with relevant error which does not exceed 15 %.

Availability of the algorithm (built in flaw detector software) of automatic plotting of DGS diagrams for various probes types makes it possible to analyze the received data quickly and qualitatively and determine equivalent dimensions of the detected discontinuities with their further registration. To save the time which is used for the instruments setup, UD4-76 instrument software contains the function of automatic TCG curve plotting by DGS diagram plotted for a specific probe.

- **SAFT MODE**

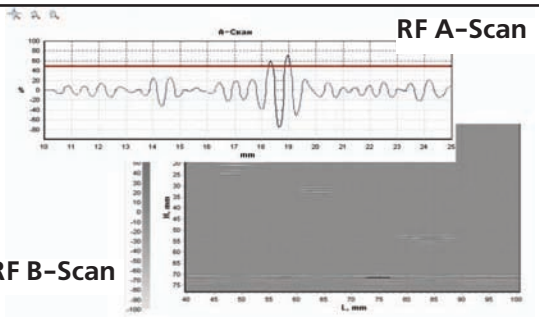


To receive more accurate testing results, a special program application which performs SAFT algorithm for the usage of weld joints and steel workpieces in flaw detection is developed. This algorithm permits to get higher value of "signal/noise" ratio (even during testing of objects made from coarse materials) during data processing and reproduce an approximate defect form.

- **RENDERING OF "CORROSION MAP" - "THICKNESSES MAP"**

To carry out thickness measurement as well as flaw detection of weld joints heat-affected zones, special modes are developed. These modes allow to perform flaw detection and thickness measurement of the testing area by means of the trolley where the probe is fixed. At the same time, the scanning path coordinates are fixed with the help of encoder and the received data are processed, whereby it is possible to get the profile of surface containing all possible discrepancies by metal thickness, delaminations and pitting damages.

- **RF SIGNAL DISPLAY**



To measure precisely the item thickness and defects coordinates, the undetected RF (radiofrequency) signal is used what enables to assure the measurement resolution of 0,01 mm. Two modes of the point selection on the signal oscillogram by which the measurements are taken (automatic and manual) are provided in the instrument.

- **SPECIAL PROGRAM INTERFACE MODE**

This mode is applied for solving special-purpose tasks. For example, when testing various single-type parts or when the part has many testing area. For solving this task "Special program interface" system is used in UD4-76. The necessary standard setups and program interface of "Special program interface" enter flaw detector from PC. The input setups are protected from illegal change by NDT inspector (operator).

- **MODE OF CONNECTION TO PC**

Mode of connection to PC is essential for data transmission from the flaw detector memory to the computer memory and vice-versa. It is used for transmitting "A-scans" and "B-scans" to PC for reports creation on the basis of testing results or databases.

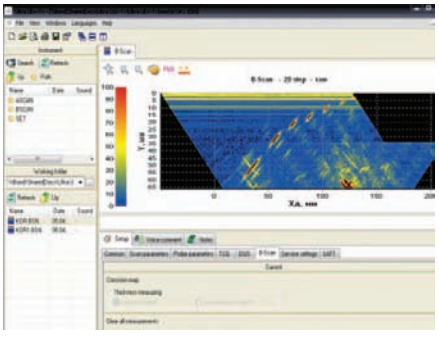
If required, the user can input setups for specific testing types in flaw detector from PC via in-built USB port what considerably reduces the time of flaw detector preparation for testing execution.

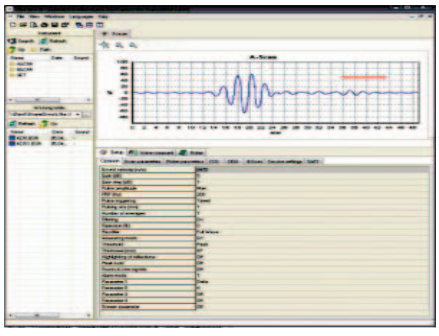
ADDITIONAL SOFTWARE

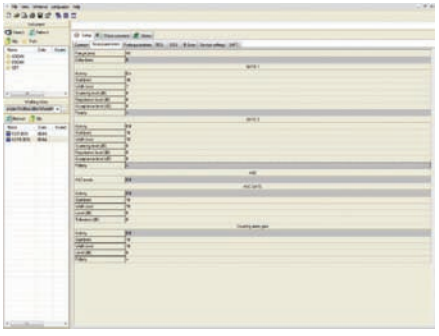
Ultra UDx-7x - the program intended for processing testing results of UD4-76 ultrasonic flaw detector and serves for functionality extension and increase of instrument operation comfort. The present program assures operation with the data stored on PC.

Memory elements operation enables to perform the following functions:

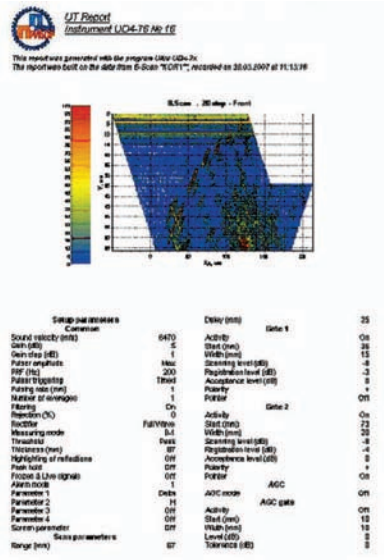
- VIEW: setups, A- Scans and B- Scans
- PROCESSING AND MEASUREMENTS: B-Scans
- CREATION AND EDITING: Setups



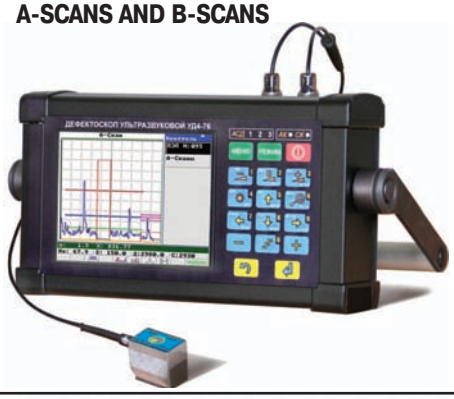


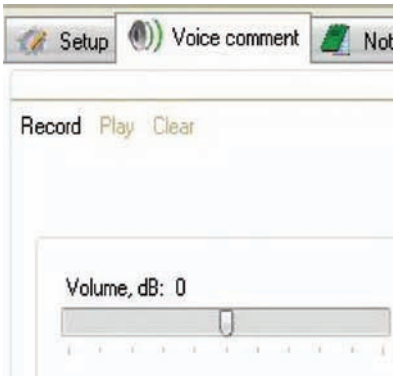


- **REPORTS PRINTING BY: A-SCANS AND B-SCANS**



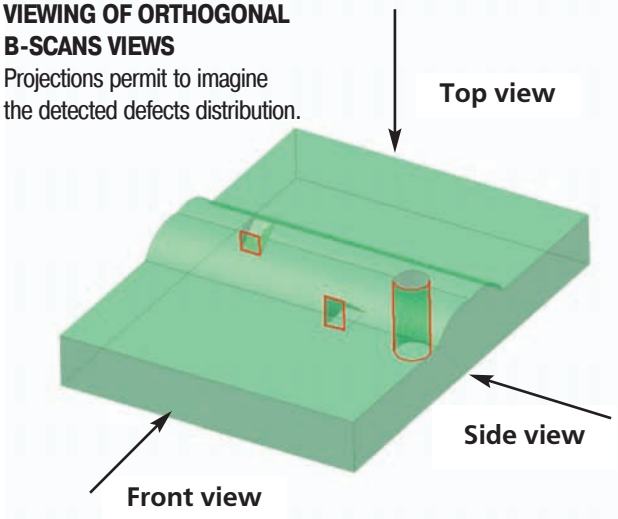
- **RECORDING AND LISTENING TO SOUND COMMENTS FOR: SETUPS, A-SCANS AND B-SCANS**

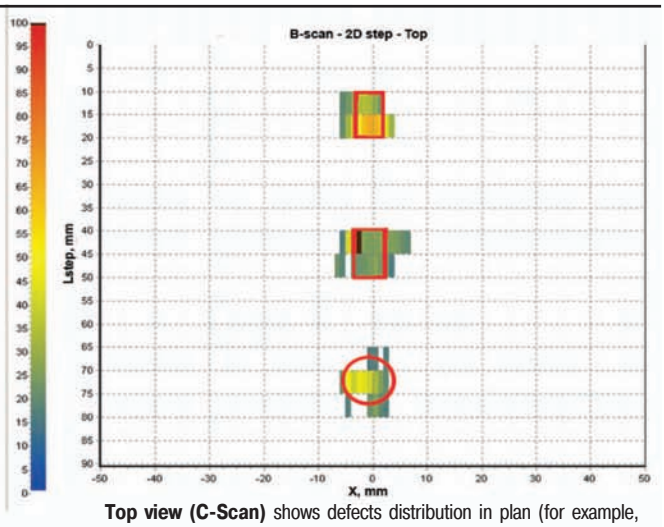




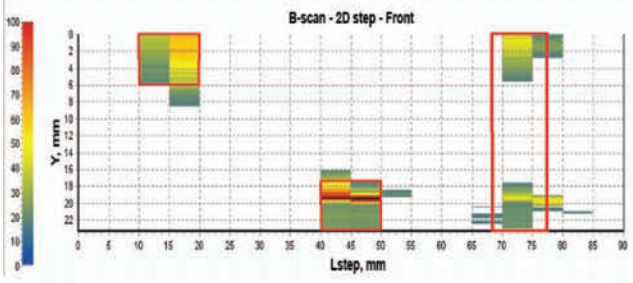
- **VIEWING OF ORTHOGONAL B-SCANS VIEWS**

Projections permit to imagine the detected defects distribution.

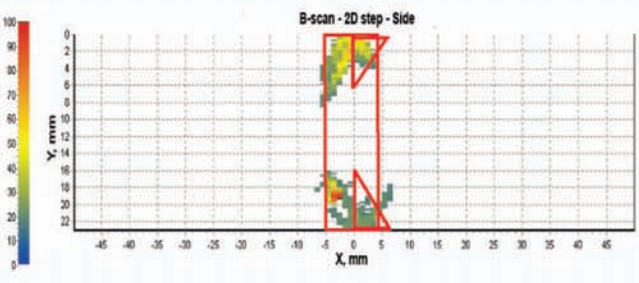




Top view (C-Scan) shows defects distribution in plan (for example, along the joint, and permits to differentiate the joint defects from the heat-affected zone defects etc.).



Front view allows to see the defect pattern in the joint section.



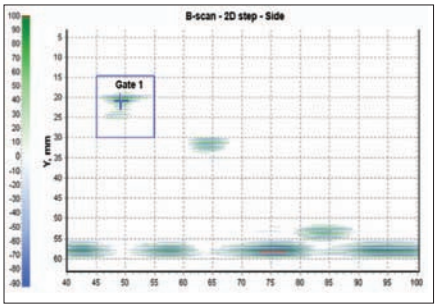
Side view is the view of defects along the joint.

Besides signal amplitudes and distance along the beam, flaw detector also saves the probe position coordinates in the moment of defect detection. Software calculates 3-dimensional coordinates of every indication basing of the stored data and setups of flaw detector. As a result, it becomes possible to build 3-D scan or, what is more informative, its orthogonal views.

Orthogonal B-Scan views can be used both for studying the detected defects distribution and for measuring their parameters and printing testing reports.

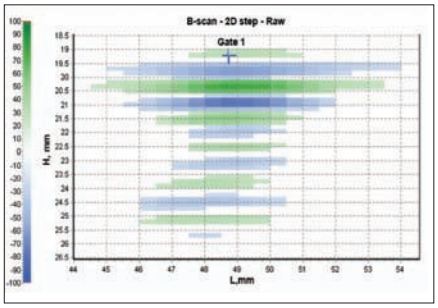
• MEASUREMENTS ON B-SCANS

Absolute



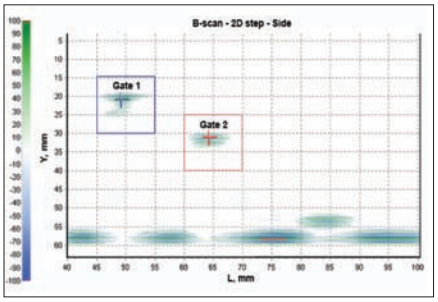
Abs1: L=49.43 mm, Y=20.92 mm, A=27.95 dB, Δ=4.01 dB, dL=9.00 mm, dY=6.65 mm

By selected half-wave



Abs1: L=48.93 mm, H=19.14 mm, A=35.31 dB, Δ= –3.73 dB

Relative



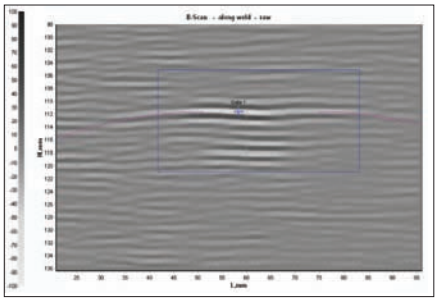
Abs1: L=49.43 mm, Y=20.92 mm, A=27.95 dB,, Δ=4.01 dB,, dL=9.00 mm, dY=6.65 mm

Abs2: L=64.43 mm, Y=31.14 mm, A=31.73 dB,, Δ=2.39 dB,, dL=7.00 mm, dY=3.89 mm

RelMax: L_{12}=15.00 mm, Y_{12}=10.22 mm, A_{12}=3.79 dB,, Δ_{12}=1.62 dB,

RelBorder: L_{12}=6.50 mm, Y_{12}=4.38 mm

Determination of the real defect length by hyperbolic cursors



Abs1: L = 58.40 mm, H = 111.64 mm, A = 48.49 dB, Δ = 1.51 dB, dL = 41.25 mm, dH = 15.71 mm

HypCurs: L_1 = 51.25 mm, L_2 = 74.75 mm, L_0 = 63.00 mm, L_{12} = 23.50 mm

Absolute measurements allow to receive information about the next indication parameters:

- coordinates:
  L - coordinate along the joint (Lstep - in case of step scanning), mm;
  X - horizontal coordinate across the joint, mm;
  Y - defect depth, mm;
  H - distance to the defect along the acoustic probe beam, mm.
- Amplitude characteristics:
  A - defect amplitude (gain at which the signal amplitude would correspond to 50% of the screen height), dB;
  Δ - exceeding of level 50% of the screen height by the signal amplitude, dB.
- conditional dimensions:
  dL - conditional length;
  dX - conditional width;
  dY - conditional height.

During Relative measurements, in addition to the parameters described above, the following values are displayed:

- conditional distances between the defects measured by the points of max. amplitude (RelMax) and relative to indications edges (RelBorder):
  L_{12} - conditional distance along the joint, mm;
  X_{12} - conditional distance across the joint, mm;
  Y_{12} - conditional distance by the depth, mm.
- amplitudes difference:
  A_{12} - absolute amplitudes difference (taking into account TCG influence), dB;
  Δ_{12} - on-screen amplitudes difference (without taking into account TCG influence), dB.

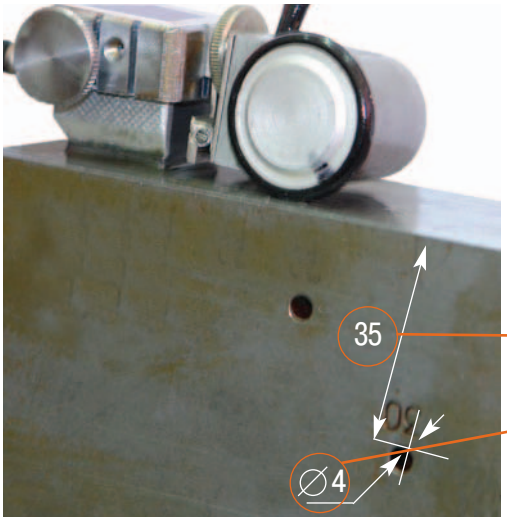
Measurements by the selected half-wave

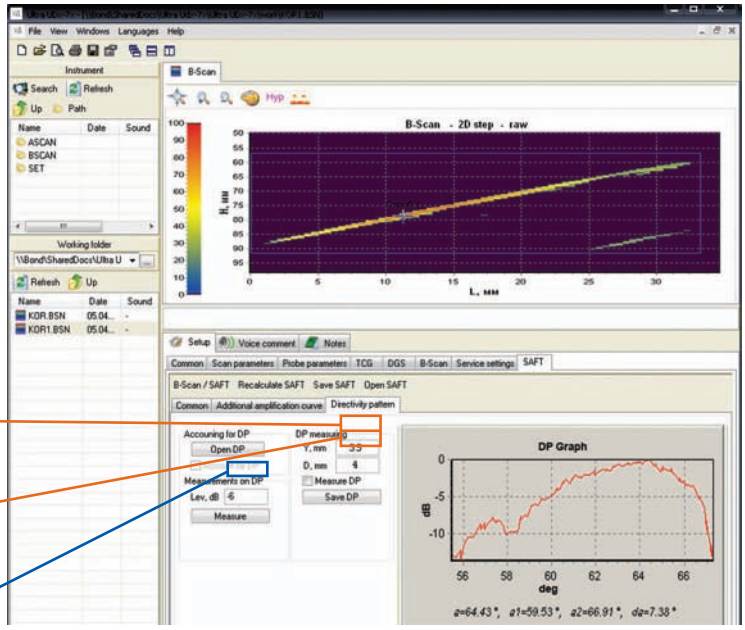
(both absolute and relative) enable to increase considerably the accuracy of measurement of testing objects thickness and detected defects coordinates. They also add to the measurements accuracy using TOFD technique.

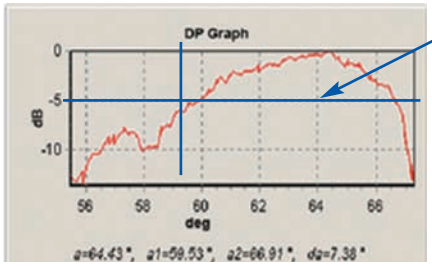
Measurements of the real defect length by hyperbolic cursors:

- are performed **automatically** - it is enough only to select the indication in frame or (for accuracy increase) to indicate the pulse
- enable to clip "wings" of indication which are generated by the probe field and, thereby, to get coordinates of extreme defect points (L1 and L2) and its real length L_{12}.

- **PROBE DIRECTION PATTERN MEASUREMENT ***







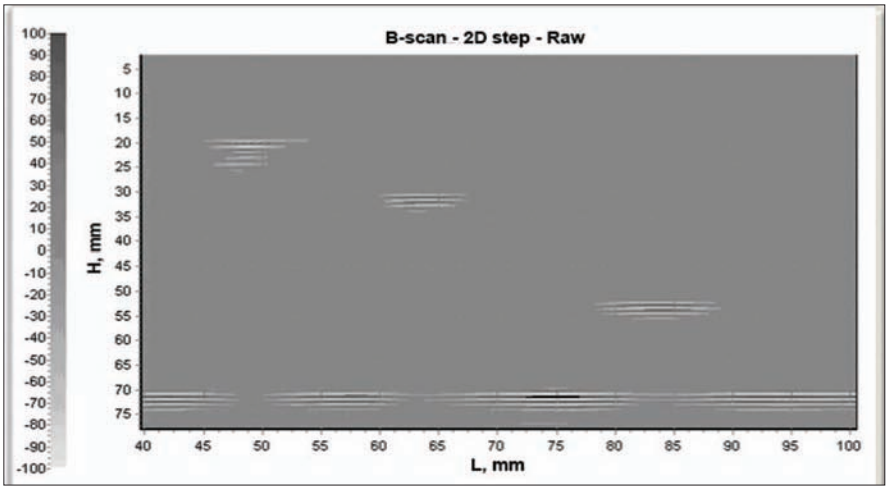
$\alpha=64,4^0$ $d\alpha=7,4^0$ $\alpha_1=59,5^0$ $\alpha_2=66,9^0$

Testing results interpretation based only on the refracted angle can lead to an error, as the influence of the width of main and the presence of side directional lobes of the probe are not taken into account. Ultra UDx-7x enables to take the probe direction pattern and measure its main parameters. For this purpose, one can use any B-Scan acquired by this probe and containing indication from the side drilling. Knowing the probe direction pattern form and its parameters it is possible to treat testing results with greater certainty.

* **Functions are available to a separate order.**

- **TOFD-scan**

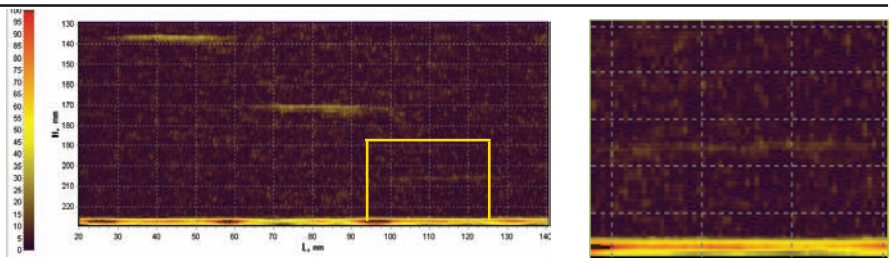
TOFD (Time Of Flight Diffraction) technique allows to define the real defect dimensions. For instance, the crack height and coordinates of its tips. In spite of the fact that the technique can be carried out in A-Scan mode, it is much more convenient to perform testing applying TOFD-scan.



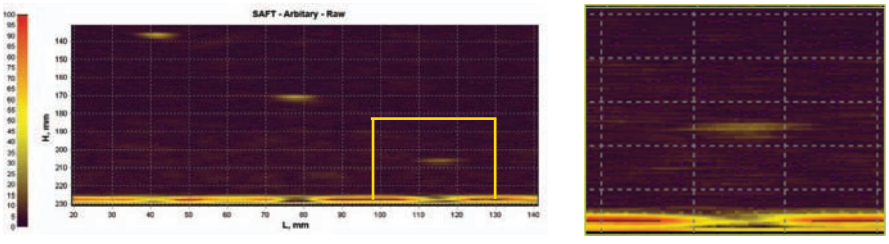
- **SAFT - TECHNIQUE OF COHERENT SIGNAL PROCESSING ***

Control of various noise types

B-Scan



SAFT

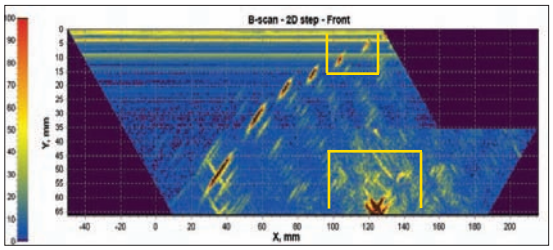


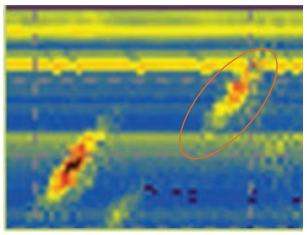
* **Functions are available to a separate order.**

- **SAFT - TECHNIQUE OF COHERENT SIGNAL PROCESSING ***

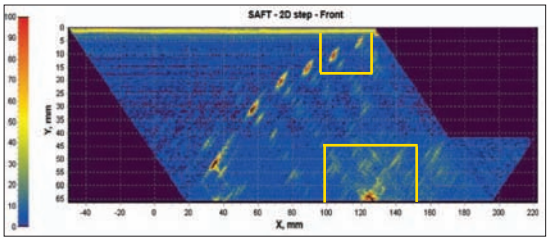
  Control of various noise types

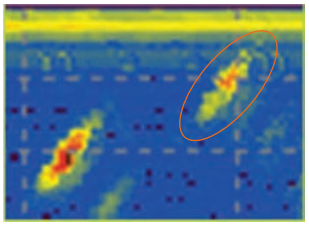
B-Scan





SAFT



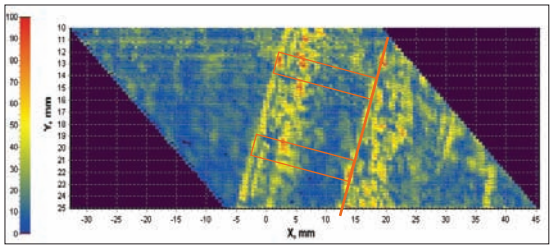


* **Functions are available to a separate order.**

- **Digital control of the probe angle**

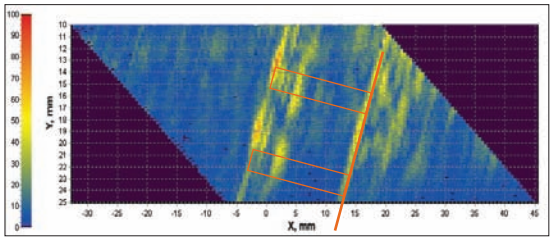
That what Phase Array do is now available be means of UD4-76! (In postprocessing)

B-Scan



Detection of flat-bottomed reflectors (FBH) directed at an angle of 60º by an ordinary probe 50 º

SAFT



TECHNICAL SPECIFICATIONS

parameters	units	values
Max. scan range	inch	236,22
	mm	6000
Min. scan range	inch	0,039
	mm	1
Velocity in the material	inch/mcs	from 0,0025 to 0,0375
	m/s	from 1000 to 15000
Scan delay	inch	472,44
	mm	12000
Delay (in the wedge)	mcs	from 0 to 100 .
Frequency	MHz	from 0,4 to 20
Initial pulse frequency	Hz	from 30 to 1000
Operating modes		A-scan, B-scan
Gain	dB	from 0 to 100
Signal detection		radio signal (without detection),
		double half-wave,
		positive half-wave,
		negative half-waves
Noises cutoff	%	from 0 to 80
Gates		Two independent three-level
		measuring gates;
		Two additional special gates;
Measurement modes		Peak, Front
Reconfigurable readings in A-scan		distance by the beam,
		amplitude in gates,
		defects depth coordinates,
		equivalent defect dimensions

parameters	units	values
Measurement resolution	inch	0,00039
	mm	0,1
Defect alarm		sound, light, visual
Setups quantity		100
Languages and interfaces		English, Russian, Chinese
		(additional languages
		are possible to the customer's order)
Units		SI system units
Connection to PC		USB port
Battery		Storage battery Hi-MH
		12V/2500 mA h
Operation time from the battery	hour.	at least 8
Power supply from AC network		single-phase network
		230 V, 50 Hz.
Screen		Color TFT
Screen size, W x H	inch	4,33 x 3,346
	mm	110 x 85
Screen resolution, W x H	pixel	320 x 240
A-scan size, W x H x D	pixel	320 x 200
Overall dimensions	inch	9,72 x 5,79 x 3,15
	mm	247 x 147 x 80
Weight	lb	7,717
	kg	3,5
Operating temperature	ºF	from +14 to +122
	ºC	from minus 10 to +50
Protection from environmental impacts		IP 65 according to GOST 14254

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