ISONIC 2010

Portable Ultrasonic Phased Array Flaw Detector and Recorder

SIMPLICITY VERSATILITY RELIABILITY

Phased Array

- 32:32 phased array electronics – independently adjustable emitting and receiving aperture, parallel firing, A/D conversion, and on-the-fly real time digital phasing
- Phased array pulser receiver with image guided ray tracing
- True-to-Geometry / regular B-Scan and Sector Scan (S-Scan) with all-codes-compliant A-Scan evaluation
- Built-in automatic coupling monitor and lamination checker for wedged probes
- Multi-group / dual side scanning and imaging with use of one probe
- Encoded / time-based line scanning with Top (C-Scan), Side, End Mapping and 3D Viewing
- Automatic generating of editable defects list
- Independent gain per focal law adjustment: pure angle gain compensation for S-Scan, etc
- DAC, TCG
- Processing of diffracted and mode converted signals – defects sizing and pattern recognition

Conventional UT and TOFD

- 1 channel
- Single / dual modes of pulsing/receiving
- Regular A-Scan
- Thickness B-Scan
- True-to-Geometry flaw detection B-Scan – straight / angle beam probes
- CB-Scan
- TOFD
- DAC, DGS, TCG
- FFT signal analysis

- *100% raw data capturing*
- *Powerful off-line data analysis toolkit*
- *Intuitive User Interface*
- *Light rugged case*
- *Sealed front panel keypad and mouse*
- *6.5" bright touch screen*
- *Ethernet and 2 X USB Ports*
- *Remote control – UT over IP*
- *Built-in encoder port*

Sonotron NDT

4, Pekeris str., Rabin Science Park, Rehovot, 76702, Israel
Phone:++972-(0)8-9311000 Fax:++972-(0)8-9477712
www.sonotronndt.com

General

ISONIC 2010 uniquely combines phased array, conventional UT, and TOFD modalities providing 100% raw data recording and imaging. Along with superior portability, lightweight, and battery operation this makes it suitable for all kinds of every-day ultrasonic inspections

Phased array modality is performed by powerful 32:32 phased array electronics with independently adjustable emitting and receiving aperture, each may consist of 1 through 32 elements. Groups of phased array probe elements composing emitting and receiving aperture may be fully or partially matching or totally separated allowing flexible managing of incidence angles, focal distances, types of radiated and received waves including directly reflected and diffracted mode converted signals

Each channel is equipped with it's own A/D converter. Parallel firing, A/D conversion, and "on-the-fly" digital phasing are provided for every possible composition and size of the emitting and receiving aperture. Thus implementation of each focal law is completed within single pulsing/receiving cycle providing maximal possible inspection speed

ISONIC 2010 is additionally equipped with independent channel for conventional UT and TOFD inspection and recording capable for both single and dual modes of pulsing/receiving

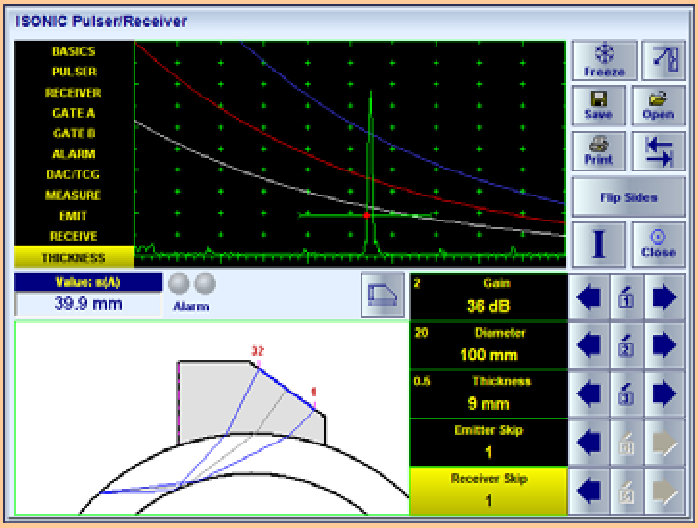
High ultrasonic performance is achieved through firing phased array, TOFD, and conventional probes with bipolar square wave initial pulse with wide-range-tunable duration and amplitude. Maximal amplitude of bipolar square wave initial pulse is 300 V pp for phased array and 400 V pp for conventional channel. High stability of the amplitude and shape of the initial pulse, boosting of all it's leading and falling edges, and electronic damping are provided by the special circuit significantly improving signal to noise ratio and resolution. Thus analogue gain for each modality is controllable over 0…100 dB range

640X480 pixels 6.5" bright touch screen provides optimal resolution / power consumption rate for the outdoor operation

Phased Array Modality

Phased array pulser receiver is controlled through intuitive operating surface comprising user interface of conventional ultrasonic flaw detector and ray-tracing graphics. Type of wave generated in the material is controlled through key in of corresponding ultrasonic velocity. Trace of ultrasonic beam is truly imaged upon entering thickness, outside diameter, and other suitable geometry data characterizing object under test – this extremely simplifies creating of focal laws and calibration of the instrument as well

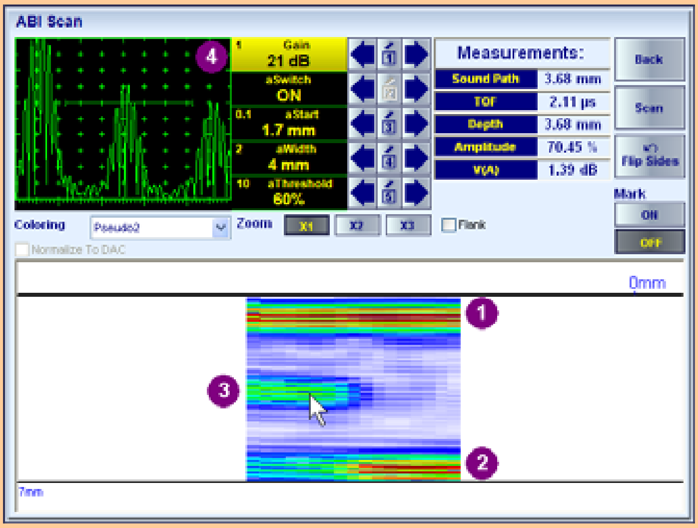
Signal evaluation fully compliant with conventional UT codes and procedures is applicable to A-Scans composed through implementing of various focal laws; DAC and TCG may be created either experimentally (up to 40 points) or theoretically through entering dB/mm (dB/inch) factor



*Typical Phased Array Pulser Receiver screen of **ISONIC 2010***

Cross-sectional insonification and imaging of the material may be provided electronically with use of linear array probes through:

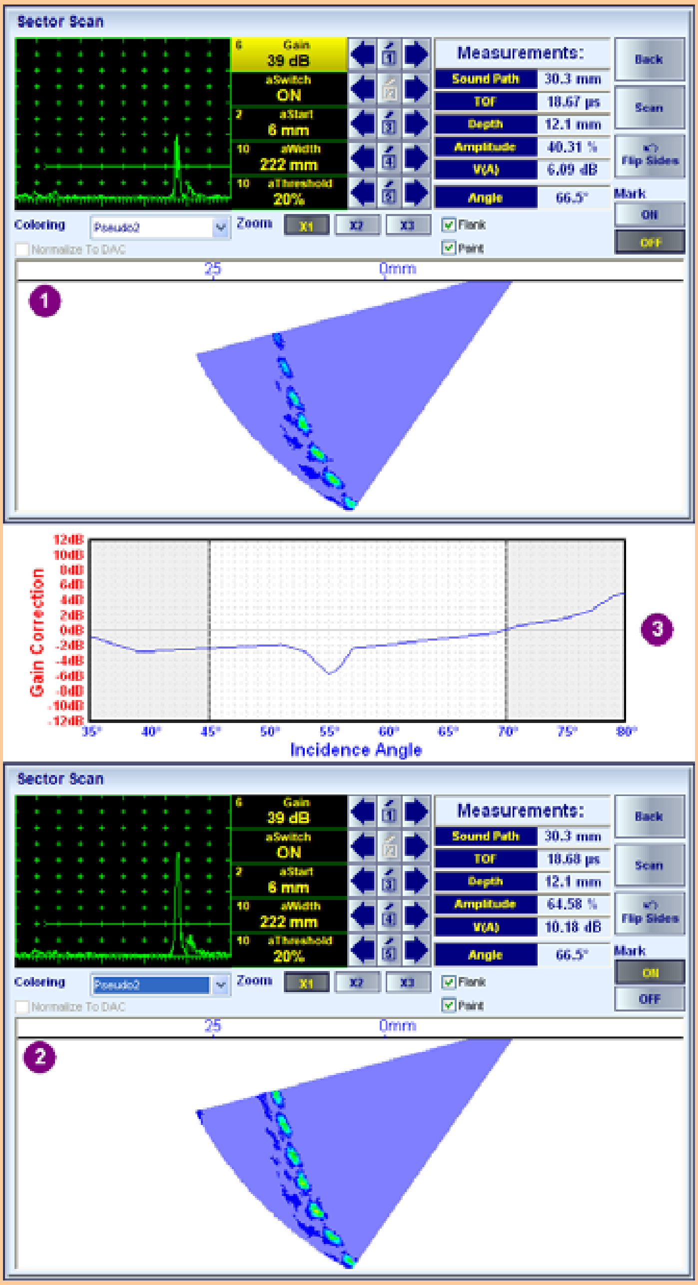
- ♦ *Linear scanning* with ultrasonic beam at predetermined incidence angle through reallocating of fixed size emitting/receiving aperture within entire array and composing of B-Scan image
- ♦ *Sectorial scanning* with ultrasonic beam produced by fixed emitting/receiving aperture through steering of incidence angle in the predetermined range and composing of S-Scan image
- ♦ Combining *linear* and *sectorial scanning*
- ♦ etc



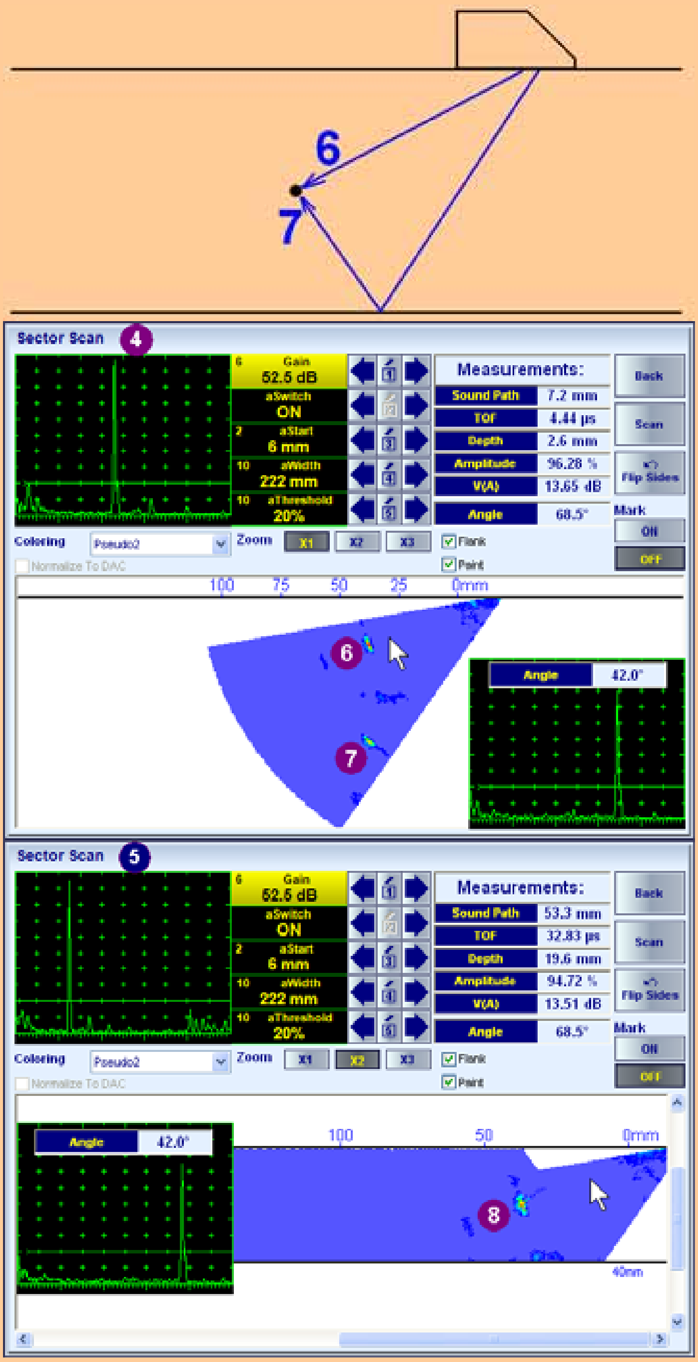
*B-Scan indication of **ISONIC 2010** representing inspection of composites for laminations: 1– scanning surface; 2 – bottom surface; 3 – lamination; 4 – A-Scan corresponding to the position of cursor over image*

The effects of inequality of elements of linear array, varying sound path and loss in the delay line or wedge, dependency of energy of refracted wave and effective size of emitting/receiving aperture on incidence angle should be compensated to equalize the sensitivity over insonified cross-section. The unique feature of **ISONIC 2010** is the ability of managing *independently adjustable focal laws* within the same frame-composing sequence of pulsing/receiving shots so *every focal law may me executed with individually adjusted gain, time base, and other core settings* providing:

- *Gain per Shot Correction* for B-Scan
- *Angle Gain Compensation* for S-Scan
- *True-to-Geometry* imaging either B-Scan or S-Scan representing actual distribution of ultrasonic beams and *true-to-location* indication of defects in the cross-sectional view of the material

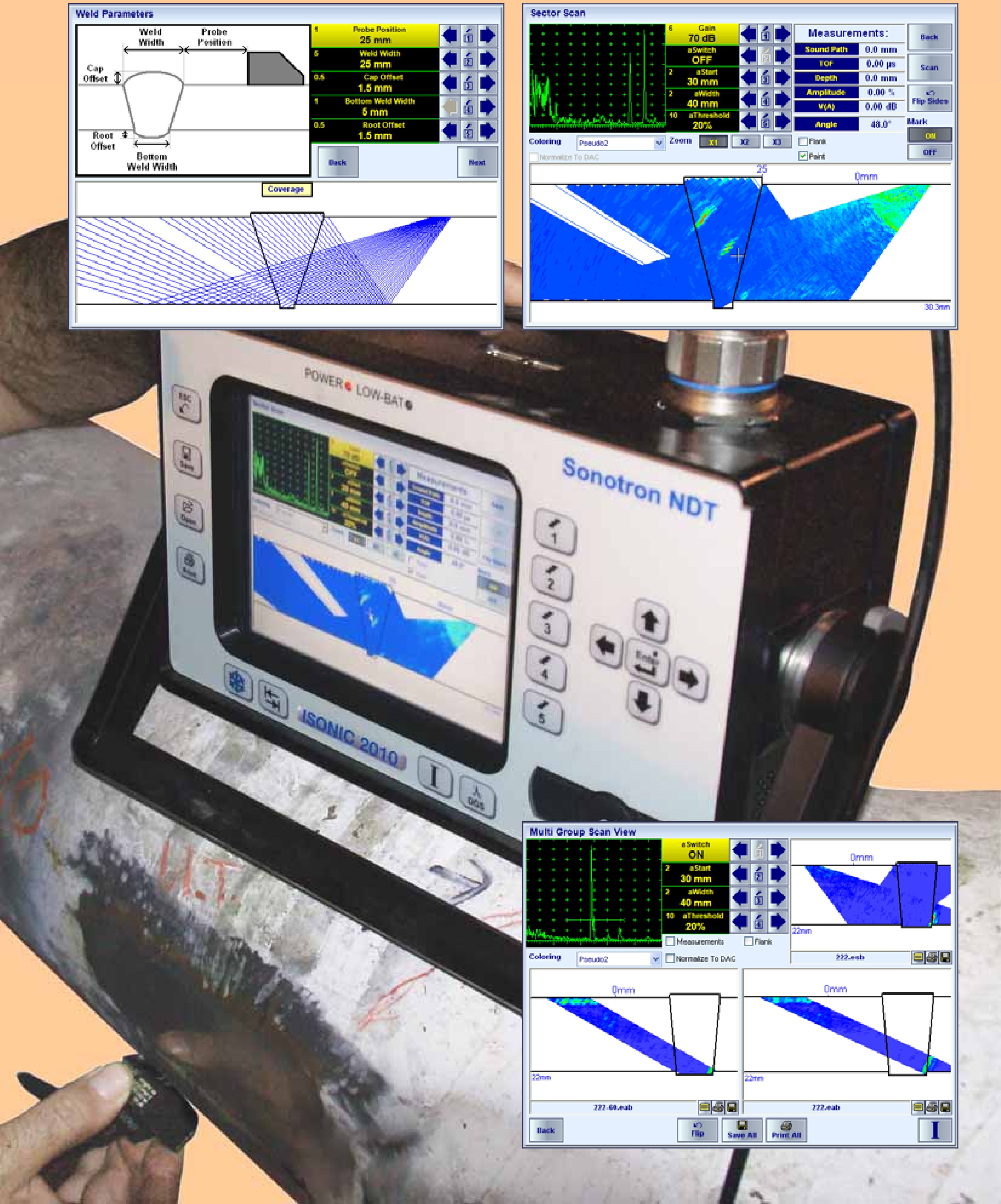


*S-Scan produced by **ISONIC 2010** for several equal reflectors in the material with use of wedged linear array probe: 1 – angle gain compensation (AGC) is inactive; 2 – AGC is active; 3 – typical AGC graph*

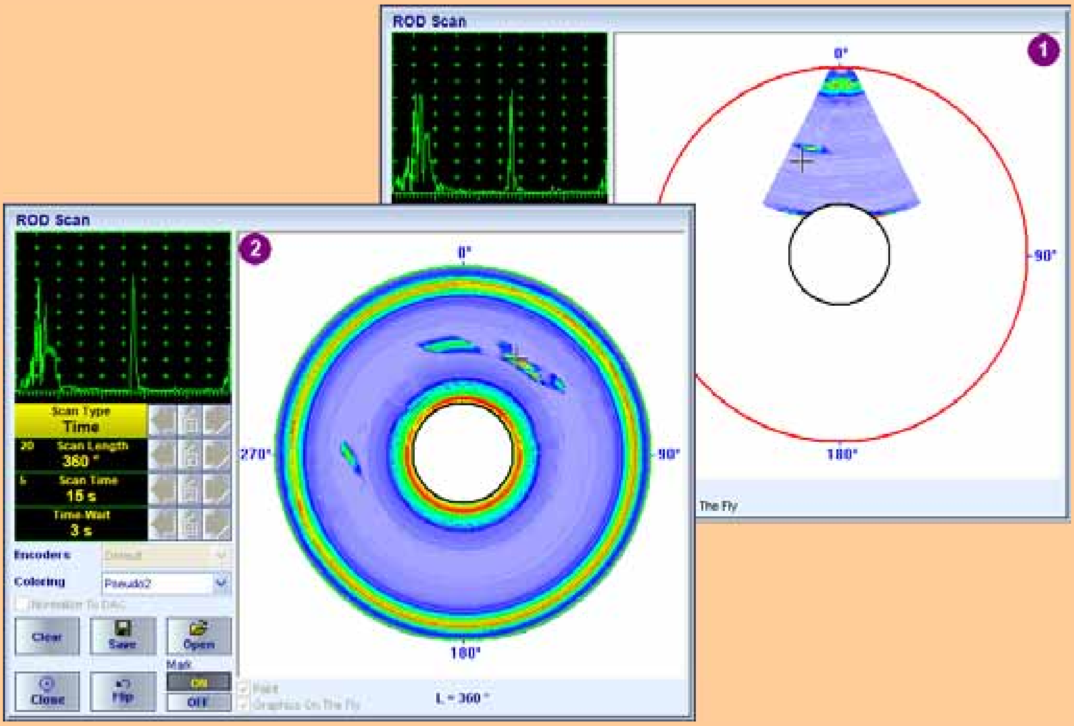


*Regular (4) and true-to-geometry (5) S-Scan produced by **ISONIC 2010** for compact reflector located at 20 mm depth of 40 mm thick plate. On the regular S-Scan single compact reflector is indicated twice for half (6) and full (7) skip detection while on the true-to-geometry S-Scan single reflector is shown in the real position for both ways of detection (8)*

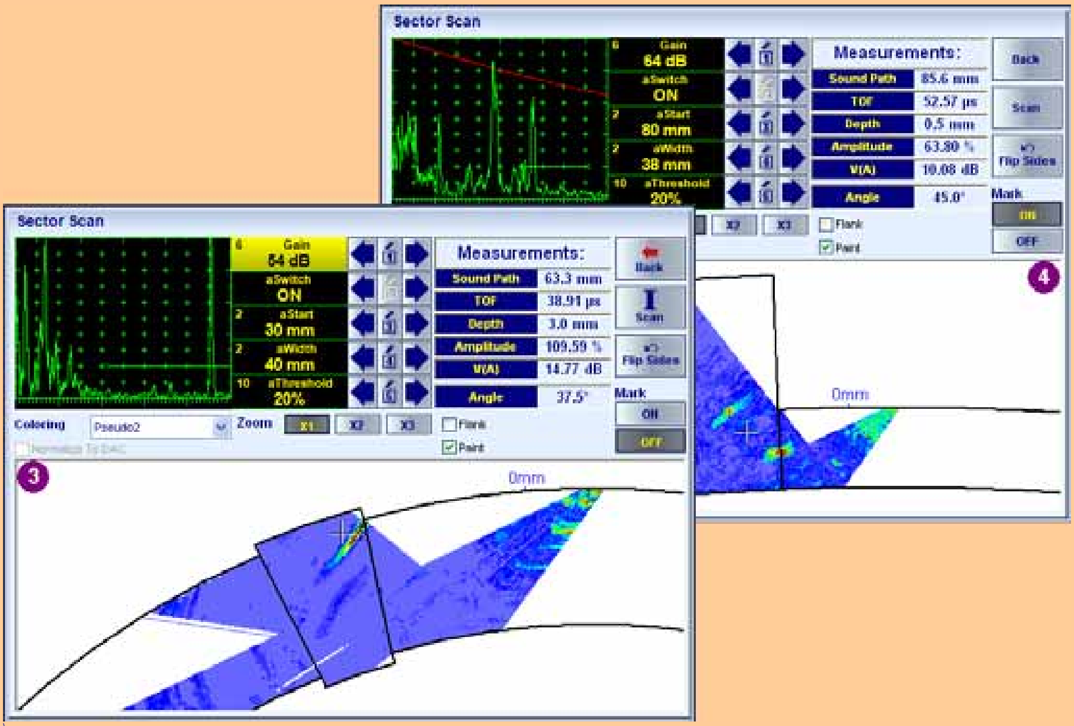
Weld inspection is the typical application benefited through use of *True-to-Geometry* imaging: upon defining geometry and entering dimensions operator is provided with intuitive ray tracing dialogue indicating actual coverage of the weld for the desired probe position and incidence angle steering range followed by live cross-sectional view either S-Scan or B-Scan *with true-to-location defects indication*. To ensure detection of variously oriented defects several S-Scan and B-Scan insonifications may be performed simultaneously with use of the same probe providing multi-group cross-sectional viewing and recording along whole inspected length. In addition to simple geometry butt joints *True-to-Geometry* imaging technology is applicable to longitudinal, nozzle, fillet, TKY, corner, elbow welds, and the like



Testing of solid and hollow shafts, axles, rods, billets, etc are among other applications improved significantly thanks to the easy-to-interpret advantage of *True-to-Geometry* imaging vs regular S-Scan and B-Scan

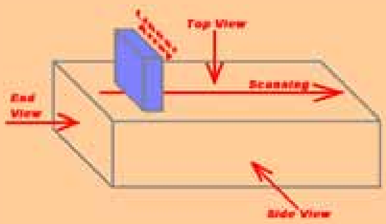


True-to-Geometry S-Scan for single location (1) and complete cross sectional image of the hollow shaft with defects obtained after full circumference scanning (2) with linear array probe

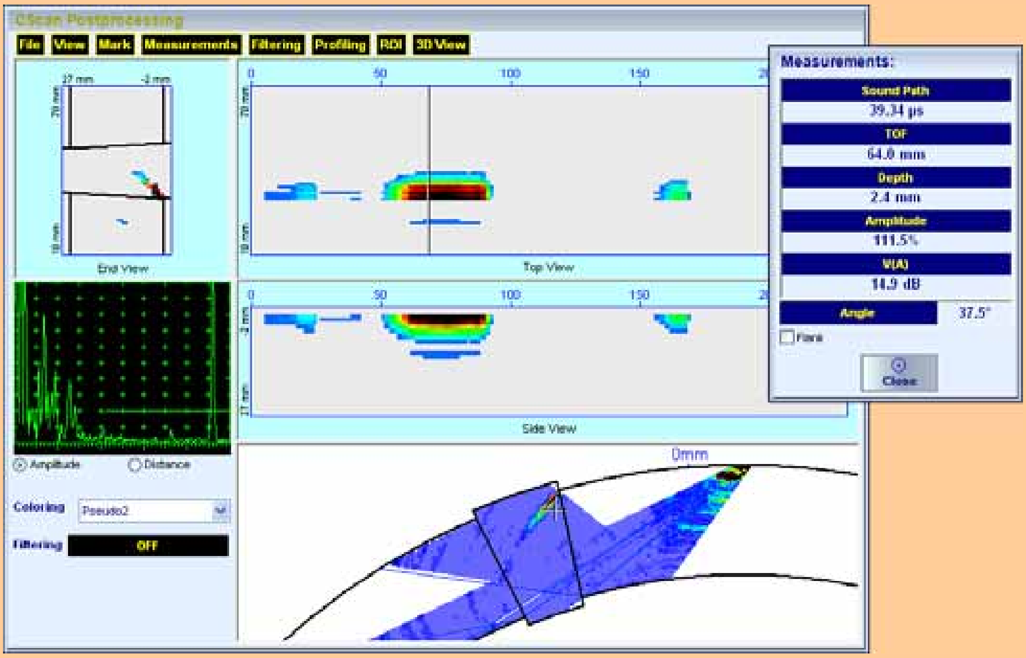


True-to-Geometry S-Scan for longitudinal weld (3) and nozzle (4)

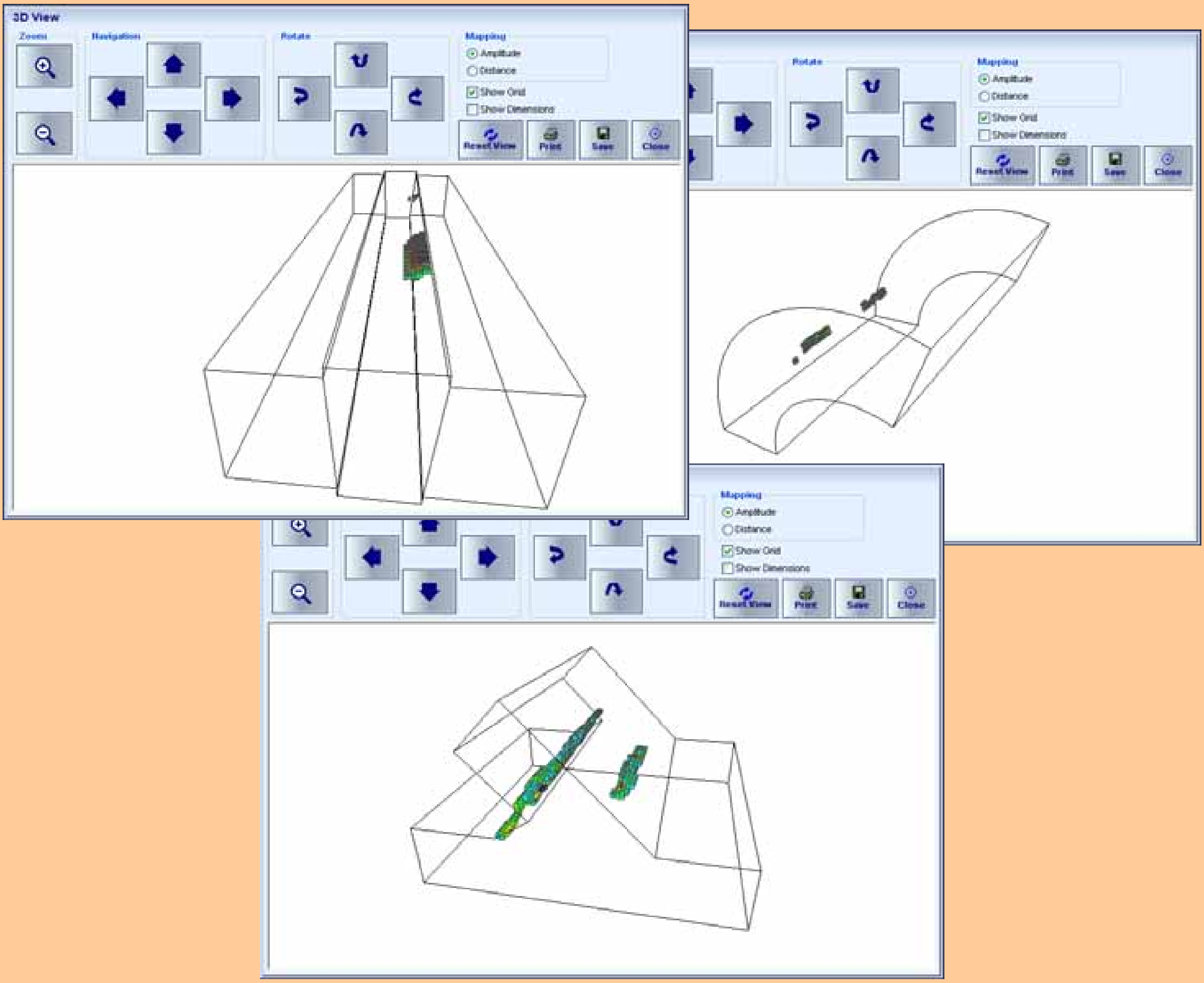
3D Data Presentation – Top (C-Scan), Side, and End Projection Views is performed through line scanning with linear array probe either encoded or time-based at rectangle to the elements count direction. It is applicable for all types of cross-sectional insonification



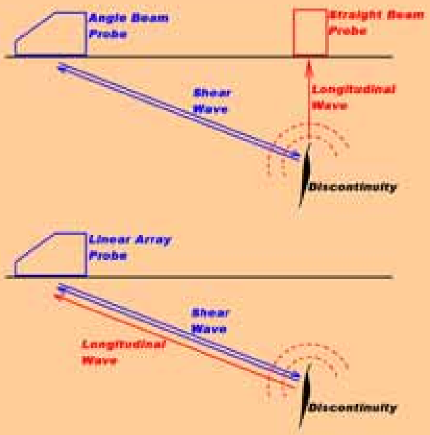
For line scanning every cross sectional view is recorded along with complete sequence of raw data A-Scans it is composed of. C-Scan image is switcheable between distance (thickness or defects depth) and amplitude map

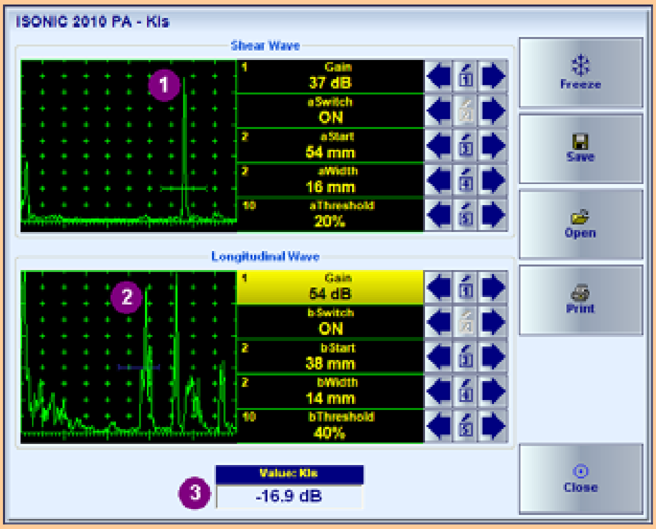


Powerful off-line data analysis toolkit includes playing back cross sectional views and A-Scans, gain manipulation in ±6dB range for all recorded A-Scans followed by corresponding image update, all-standards-compliant gate-based evaluation of echoes, geometry and amplitude filtering, image slicing and profiling, determining projection dimensions and area size of defects, 3D-viewing, etc



Defects pattern analysis may be carried with use of well-known *Delta Technique* allowing distinguishing between low risk compact volumetric defects and cracks. Shear wave insonification of the evaluated discontinuity is performed with receiving of both *direct* shear wave and *diffracted* longitudinal wave echoes using the same linear array probe. Both echoes have been evaluated automatically providing digital readout of so called K_{LS} value, based on which defect pattern is determined





*Implementation of Delta Technique is extremely simplified as only one linear array probe placed into position of receiving maximized echo from evaluated discontinuity is used instead of pair of conventional shear wave and longitudinal wave probes. Corresponding screen of **ISONIC 2010** indicates 2 individually adjustable A-Scans comprising direct shear wave echo (1) with A_S amplitude, diffracted longitudinal wave echo (2) with A_L amplitude, and digital readout of K_{LS} value (3) rating A_S/A_L*

Conventional UT and TOFD modalities

For single conventional channel operation **ISONIC 2010** provides fully featured A-Scan inspection as well as line scanning recording and imaging of the following types: thickness B-Scan; flaw detection B-Scan for angle beam and straight beam probes; CB-Scan for guided, surface, and shear wave probes inspections; TOFD. This fully covers scope of functions implemented by very well known **ISONIC 2005** / **ISONIC STAR** / **ISONIC 2020** portable ultrasonic flaw detector and recorder of Sonotron NDT – **www.sonotronndt.com/i2005.htm**

Comprehensive off-line analysis and data reporting toolkit for all kinds of data captured using conventional UT and TOFD modalities is built-in

Remote Control – UT over IP

Remote control of **ISONIC 2010** is implemented through Ethernet port. The instrument is fully compatible with new ***UT over IP*** technology from Sonotron NDT allowing full control of the instrument, imaging, recording, and storage inspection data in the remote control computer

Compliancy with international and national codes

ISONIC 2010 is fully compliant with the following codes

- ASME Code Case 2541 – Use of Manual Phased Array Ultrasonic Examination Section V
- ASME Code Case 2557 – Use of Manual Phased Array S-Scan Ultrasonic Examination Section V per Article 4 Section V
- ASME Code Case 2558 – Use of Manual Phased Array E-Scan Ultrasonic Examination Section V per Article 4 Section V
- ASTM 1961– 06 – Standard Practice for Mechanized Ultrasonic Testing of Girth Welds Using Zonal Discrimination with Focused Search Units
- ASME Section I – Rules for Construction of Power Boilers
- ASME Section VIII, Division 1 – Rules for Construction of Pressure Vessels
- ASME Section VIII, Division 2 – Rules for Construction of Pressure Vessels. Alternative Rules
- ASME Section VIII Article KE-3 – Examination of Welds and Acceptance Criteria
- ASME Code Case 2235 Rev 9 – Use of Ultrasonic Examination in Lieu of Radiography
- Non-Destructive Examination of Welded Joints – Ultrasonic Examination of Welded Joints. – British and European Standard BS EN 1714:1998
- Non-Destructive Examination of Welds – Ultrasonic Examination – Characterization of Indications in Welds. – British and European Standard BS EN 1713:1998
- Calibration and Setting-Up of the Ultrasonic Time of Flight Diffraction (TOFD) Technique for the Detection, Location and Sizing of Flaws. – British Standard BS 7706:1993
- WI 00121377, Welding – Use Of Time-Of-Flight Diffraction Technique (TOFD) For Testing Of Welds. – European Committee for Standardization – Document # CEN/TC 121/SC 5/WG 2 N 146, issued Feb, 12, 2003
- ASTM E 2373 – 04 – Standard Practice for Use of the Ultrasonic Time of Flight Diffraction (TOFD) Technique
- Non-Destructive Testing – Ultrasonic Examination – Part 5: Characterization and Sizing of Discontinuities. – British and European Standard BS EN 583-5:2001
- Non-Destructive Testing – Ultrasonic Examination – Part 2: Sensitivity and Range Setting. – British and European Standard BS EN 583-2:2001
- Manufacture and Testing of Pressure Vessels. Non-Destructive Testing of Welded Joints. Minimum Requirement for Non-Destructive Testing Methods – Appendix 1 to AD-Merkblatt HP5/3 (Germany).– Edition July 1989

ISONIC 2010 –Technical Data

Phased Array

Pulse Type:	**Bipolar Square Wave with electronically controlled damping**
Initial Transition:	**≤7.5 ns (10-90% for rising edges / 90-10% for falling edges)**
Pulse Amplitude:	**Smoothly tunable (12 levels) 50V … 300 V pp into 50 Ω**
Half Wave Pulse Duration:	**50…600 ns controllable in 10 ns step**
Probe Types:	**Linear / Ring Array**
Emitting aperture:	**1…32**
Phasing (emitting aperture):	**0…100 μs with 5 ns resolution**
Receiving Aperture:	**1…32**
Gain:	**0...100 dB controllable in 0.5 dB resolution**
Advanced Low Noise Design:	**85 μV peak to peak input referred to 80 dB gain / 25 MHz bandwidth**
Frequency Band:	**0.2 … 25 MHz Wide Band**
A/D Conversion:	**100 MHz 16 bit**
Superimposing of receiving aperture signals:	**On-the-fly, no multiplexing involved**
Phasing (receiving aperture):	**On-the-fly 0…100 μs with 5 ns resolution**
A-Scan Display Modes:	**RF, Rectified (Full Wave / Negative or Positive Half Wave)**
DAC / TCG per focal law – for rectified and RF display:	**Theoretical – dB/mm (dB/")** **Experimental – through recording echoes from several reflectors** **46 dB Dynamic Range, Slope ≤ 20 dB/μs, Capacity ≤ 40 points**
Gates per focal law:	**2 Independent Gates / unlimitedly expandable**
Gate Start and Width:	**Controllable over whole variety of A-Scan Display Delay and A-Scan Range in 0.1 mm /// 0.001" resolution**
Gate Threshold:	**5…95 % of A-Scan height controllable in 1 % resolution**
Number of focal laws:	**8192**
Scanning and Imaging:	**B-Scan (E-Scan) – regular and True-To-Geometry** **Sector Scan (S-Scan) – regular and True-To-Geometry** **One-probe multi-group image composed from several B- and S-Scans** **Top (C-Scan), Side, End View imaging formed through encoded / time-based line scanning, 3D-Viewer**
Method of data storage:	**100% raw data capturing**

Conventional UT and TOFD

Number of Channels:	**1**
Pulse Type:	**Bipolar Square Wave with electronically controlled damping**
Initial Transition:	**≤7.5 ns (10-90% for rising edges / 90-10% for falling edges)**
Pulse Amplitude:	**Smoothly tunable (12 levels) 50V … 400 V pp into 50 Ω**
Half Wave Pulse Duration:	**50…600 ns independently controllable in 10 ns step**
Modes:	**Single / Dual**
Gain:	**0...100 dB controllable in 0.5 dB resolution**
Advanced Low Noise Design:	**85 μV peak to peak input referred to 80 dB gain / 25 MHz bandwidth**
Frequency Band:	**0.2 … 25 MHz Wide Band**
A/D Conversion:	**100 MHz 16 bit**
Digital Filter:	**32-Taps FIR band pass with controllable lower and upper frequency limits**
A-Scan Display Modes:	**RF, Rectified (Full Wave / Negative or Positive Half Wave), Signal's Spectrum (FFT Graph)**
DAC / TCG – for rectified and RF display:	**Theoretical – dB/mm (dB/")** **Experimental – through recording echoes from several reflectors** **46 dB Dynamic Range, Slope ≤ 20 dB/μs, Capacity ≤ 40 points**
DGS:	**Standard Library for 18 probes / unlimitedly expandable**
Gates:	**2 Independent Gates / unlimitedly expandable**
Gate Start and Width:	**Controllable over whole variety of A-Scan Display Delay and A-Scan Range in 0.1 mm /// 0.001" resolution**
Gate Threshold:	**5…95 % of A-Scan height controllable in 1 % resolution**
Measuring Functions – Digital Display Readout:	**27 automatic functions / expandable; Dual Ultrasound Velocity Measurement Mode for Multi-Layer Structures; Curved Surface / Thickness / Skip correction for angle beam probes; Ultrasound velocity and Probe Delay Auto-Calibration for all types of probes**
Freeze (A-Scans and Spectrum Graphs):	**Freeze All – A-Scans and Spectrum Graphs / Freeze Peak – A-Scans / All measurements functions, manipulating Gates, and ±6dB Gain varying are available for frozen signals**
Scanning and Imaging:	**Thickness Profile B-Scan, Cross-sectional B-Scan, Plane View CB-Scan, TOFD**
Standard Length of one Line Scanning record:	**50…20000 mm (2"…800"), automatic scrolling**
Method of data storage:	**100% raw data capturing**

General

PRF:	**10...5000 Hz controllable in 1 Hz resolution**
On-Board Computer CPU:	**AMD LX 800 - 500MHz**
RAM:	**1 Gigabyte**
Internal Flash Memory - Quasi HDD:	**4 Gigabytes**
Screen:	**Sun readable 6.5" touch screen 640 × 480**
Controls:	**Sealed keyboard and mouse**
Interface:	**2 × USB, Ethernet**
Operating System:	**Windows™XP Embedded**
Encoder interface:	**Incremental TTL encoder**
Standard Length of one Line Scanning record:	**50…20000 mm (2"…800"), automatic scrolling**
Housing:	**IP 53 rugged aluminum case with carrying handle**
Dimensions:	**265×156×101 mm (10.43"×6.14"×3.98") - without battery** **265×156×139 mm (10.43"×6.14"×5.47") - with battery**
Weight:	**2.500 kg (5.50 lbs) - without battery** **3.430 kg (7.55 lbs) - with battery**

Updated March 6, 2011