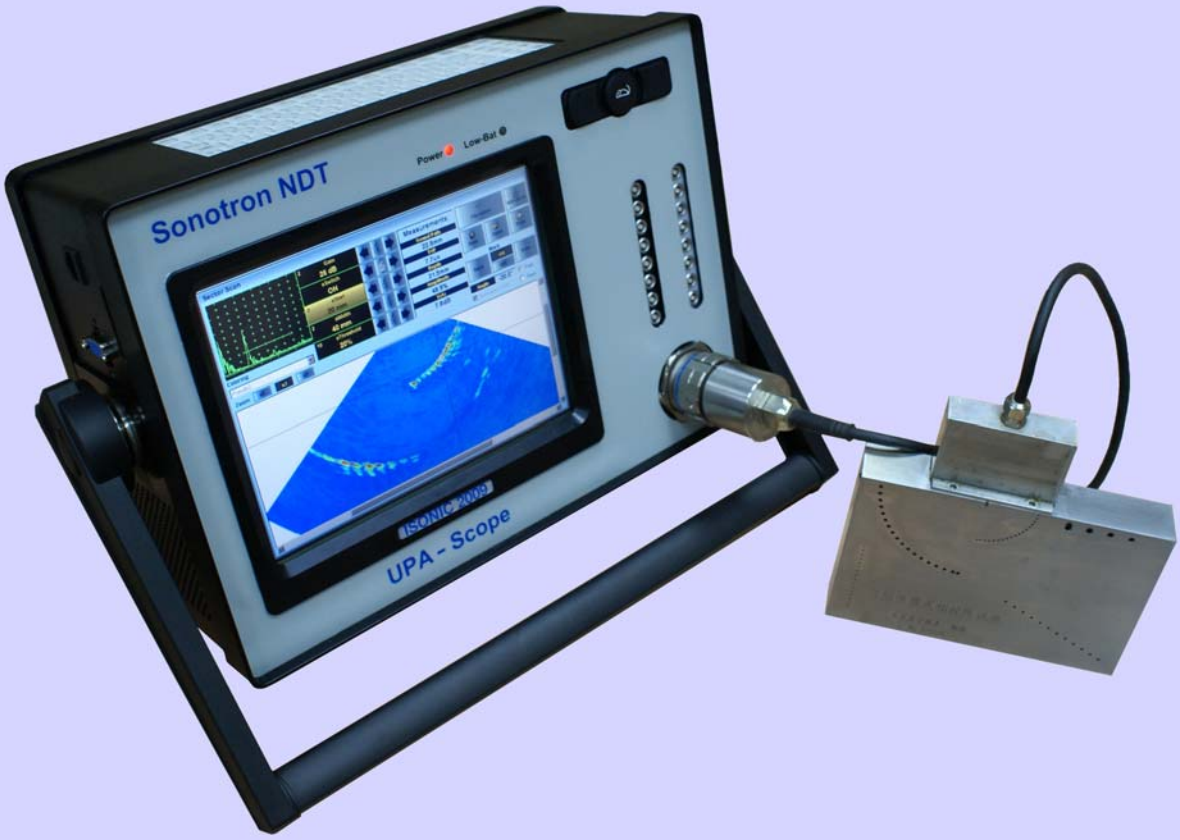
ISONIC 2009 UPA-Scope

Portable Ultrasonic Phased Array Flaw Detector and Recorder



Operating Manual

Revision 1.24

Sonotron NDT

Covered by the United States patents **5524627**, **5952577**, **6545681**; other US & foreign patents pending

Sonotron NDT

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EC Declaration of Conformity

Council Directive 89/336/EEC on Electromagnetic Compatibility, as amended by Council Directive 92/31/EEC & Council Directive 93/68/EEC
Council Directive 73/23/EEC (Low Voltage Directive), as amended by Council Directive 93/68/EEC

We, **Sonotron NDT Ltd.**, 4 Pekeris Street, Rehovot, 76702 Israel, certify that the product described is in conformity with the Directives 73/23/EEC and 89/336/EEC as amended

ISONIC 2009 UPA-Scope

Portable Digital Phased Array Ultrasonic Flaw Detector and Recorder
64 channels phased array electronics and 1 / 8 / 16 independent channels for connection of conventional and TOFD probes

The product identified above complies with the requirements of above EU directives by meeting the following standards:

Safety

EN 61010-1:1993

EMC

EN 61326:1997
EN 61000-3-2:1995 /A1:1998 /A2:1998 /A14:2000
EN 61000-3-3:1995

ISO 9001 REGISTERED
DNV
MGMT. SYS. RvA C024
DNV Certification B.V., The Netherlands

STR-R REGISTERED COMPANY
ISO 9001:2000

UKAS
QUALITY MANAGEMENT
001

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Declaration of Compliance

We, **Sonotron NDT Ltd.**, 4 Pekeris Street, Rehovot, 76702 Israel certify that the product described is in conformity with National and International Codes as amended

ISONIC 2009 UPA-Scope

Portable Digital Phased Array Ultrasonic Flaw Detector and Recorder
64 channels phased array electronics and 1 / 8 / 16 independent channels for connection of conventional and TOFD probes

The product identified above complies with the requirements of following National and International Codes:

- 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
- 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 Per Article 4 Section V
- ASME Code Case 2558 – Use of Manual Phased Array E-Scan Ultrasonic Examination Per Article 4 Section V
- 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 iffraction (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

ISO 9001 REGISTERED
DNV Certification B.V., The Netherlands

FCC Rules

This **ISONIC 2009 UPA-Scope** ultrasonic phased array flaw detector and data recorder (hereinafter called **ISONIC 2009 UPA- Scope**) has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

Safety Regulations

Please read this section carefully and observe the regulations in order to ensure your safety and operate the system as intended

Please observe the warnings and notes printed in this manual and on the unit

The **ISONIC 2009 UPA-Scope** has been built and tested according to the regulations specified in EN60950/VDE0805. It was in perfect working condition on leaving the manufacturer's premises

In order to retain this standard and to avoid any risk in operating the equipment, the user must make sure to comply with any hints and warnings included in this manual

Depending on the power supply the **ISONIC 2009 UPA-Scope** complies with protection class I /protective grounding/, protection class II, or protection class III

Exemption from statutory liability for accidents

The manufacturer shall be exempt from statutory liability for accidents in the case of non-observance of the safety regulations by any operating person

Limitation of Liability

The manufacturer shall assume no warranty during the warranty period if the equipment is operated without observing the safety regulations. In any such case, manufacturer shall be exempt from statutory liability for accidents resulting from any operation

Exemption from warranty

The manufacturer shall be exempt from any warranty obligations in case of the non-observance of the safety regulations
The manufacturer will only warrant safety, reliability, and performance of the **ISONIC 2009 UPA-Scope** if the following safety regulations are closely observed:

- Setting up, expansions, re-adjustments, alterations, and repairs must only be carried out by persons who have been authorized by manufacturer
- The electric installations of the room where the equipment is to be set up must be in accordance with IEC requirements
- The equipment must be operated in accordance with the instructions
- Any expansions to the equipment must comply with the legal requirements, as well as with the specifications for the unit concerned
- Confirm the rated voltage of your **ISONIC 2009 UPA-Scope** matches the voltage of your power outlet
- The mains socket must be located close to the system and must be easily accessible
- Use only the power cord furnished with your **ISONIC 2009 UPA-Scope** and a properly grounded outlet /only protection class I/
- Do not connect the **ISONIC 2009 UPA-Scope** to power bar supplying already other devices. Do not use an extension power cord
- Any interruption to the PE conductor, either internally or externally, or removing the earthed conductor will make the system unsafe to use /only protection class I/
- Any required cable connectors must be screwed to or hooked into the casing
- The equipment must be disconnected from mains before opening
- To interrupt power supply, simply disconnect from the mains
- Any balancing, maintenance, or repair may only be carried out by manufacturer authorized specialists who are familiar with the inherent dangers
- Both the version and the rated current of any replacement fuse must comply with specifications laid down
- Using any repaired fuses, or short-circuiting the safety holder is illegal
- If the equipment has suffered visible damage or if it has stopped working, it must be assumed that it can no longer be operated without any danger. In these cases, the system must be switched off and be safeguarded against accidental use
- Only use the cables supplied by manufacturer or shielded data cable with shielded connectors at either end
- Do not drop small objects, such as paper clips, into the **ISONIC 2009 UPA-Scope**
- Do not put the **ISONIC 2009 UPA-Scope** in direct sunlight, near a heater, or near water. Leave space around the **ISONIC 2009 UPA-Scope**
- Disconnect the power cord whenever a thunderstorm is nearby. Leaving the power cord connected may damage the **ISONIC 2009 UPA-Scope** or your property

- When positioning the equipment, external monitor, external keyboard, and external mouse take into account any local or national regulations relating to ergonomic requirements. For example, you should ensure that little or no ambient light is reflected off the external monitor screen as glare, and that the external keyboard is placed in a comfortable position for typing
- Do not allow any cables, particularly power cords, to trail across the floor, where they can be snagged by people walking past
- The voltage of the External DC Power Supply below 11 V is not allowed for the **ISONIC 2009 UPA-Scope** unit
- The voltage of the External DC Power Supply above 16 V is not allowed for the **ISONIC 2009 UPA-Scope** unit
- Charge of the battery for the **ISONIC 2009 UPA-Scope** unit is allowed only with use of the AC/DC converters / chargers supplied along with it or authorized by Sonotron NDT

Remember this before:

- balancing
- carrying out maintenance work
- repairing
- exchanging any parts

Please make sure batteries, rechargeable batteries, or a power supply with SELV output supplies power

Software (SW)

ISONIC 2009 UPA-Scope is a SW controlled inspection device. Based on present state of the art, SW can never be completely free of faults. **ISONIC 2009 UPA-Scope** should therefore be checked before and after use in order to ensure that the necessary functions operate perfectly in the envisaged combination. If you have any questions about solving problems related to use the **ISONIC 2009 UPA-Scope**, please contact your local Sonotron NDT representative

1. Introduction

ISONIC 2009 UPA Scope uniquely combines phased array, single- and multi-channel conventional UT, and TOFD modalities providing 100% raw data recording and imaging. Along with portability, lightweight, and battery operation this makes it suitable for all kinds of every-day ultrasonic inspections

Phased array modality is performed by powerful 64:64 phased array electronics with independently adjustable emitting and receiving aperture, each may consist of 1 through 64 elements. 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

Depending on configuration **ISONIC 2009 UPA Scope** carries 1, 8, or 16 additional independent pulsing-receiving channels with single and dual modes of operation to fulfill conventional UT, and TOFD modalities

High ultrasonic performance is achieved through firing phased array, TOFD, and conventional probes with bipolar square wave initial pulse. Duration and amplitude of the initial pulse are wide-range-tunable. Initial pulse may reach 300 V pp for phased array and 400 V pp for conventional channels. Special circuit provides high stability of the amplitude and shape of the initial pulse, boosting of all it's leading and falling edges, and electronic damping. This significantly improves signal to noise ratio and resolution. The analogue gain for each modality is controllable over 0…100 dB range

Large 800X600 pixels 8.5" bright screen provides fine resolution for all types of data presentation

ISONIC 2009 UPA Scope 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
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- 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

2. 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 / Matrix Array**
Emitting aperture:	**1…64**
Phasing (emitting aperture):	**0…100 μs with 5 ns resolution**
Receiving Aperture:	**1…64**
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 – 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** **Tandem-B-Scan – True-To-Geometry (for the detection of planar vertically oriented defects)** **Top (C-Scan), Side, End View imaging formed through encoded / time-based line scanning, 3D-Viewer** **Real time 3D-Scan composed with use of Matrix Array Probes**
Method of data storage:	**100% raw data capturing**

Conventional UT and TOFD

Number of Channels	**1 or 8 or 16**
Pulsing/Receiving Methods (for 8 or 16 conventional channels):	**Parallel - all channels do fire, receive, digitize, and record signals simultaneously** **Sequential – cycles of firing, receiving, digitizing, and recording signals by each channel are separated in time in a sequence loop**
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 / Freeze Peak – signal evaluation, manipulating Gates and Gain is possible for frozen signals as for live**
Scanning and Imaging:	**Single Channel: Thickness Profile B-Scan, Cross-sectional B-Scan, Plane View CB-Scan, TOFD** **Multi-Channel: Strip Charts of 4 types (Amplitude/TOFD P/E, Map, TOFD, Coupling)**
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:	**≥ 512 Megabytes**
Internal Flash Memory - Quasi HDD:	**≥ 4 Gigabytes**
Screen:	**Sun readable 8.5” touch screen 800 × 600**
Controls:	**Sealed keyboard and mouse**
Interface:	**2 × USB, Ethernet**
Operating System:	**Windows™XP Embedded**
Encoder interface:	**Incremental TTL encoder**
Housing:	**IP 53 rugged aluminum case with carrying handle**
Dimensions:	**314×224×124 mm (12.36”×8.82”×4.88”) – without battery** **314×224×152 mm (12.36”×8.82”×5.98”) – with battery**
Weight:	**4.550 kg (10.01 lbs) – without battery** **5.480 kg (12.06 lbs) – with battery**

3. ISONIC 2009 – Scope of Supply

#	Item	Order Code (Part #)	Note
1	**ISONIC 2009 UPA-Scope – Portable Digital Phased Array Ultrasonic Flaw Detector and Recorder: *64 channels PA electronics and 1 independent channel for connection of conventional and TOFD probes*** • **<u>ISONIC 2009 UPA-Scope Electronic unit</u>** – including: > Internal PC (AMD LX 800 500 MHz, RAM-512M, Quazi-HDD Flash Memory Card 4G, Windows XP Embedded, Large 8.5" active TFT sVGA LCD High Color Sun-Readable Touch Screen, Built-In Interfaces: 2XUSB; Ethernet; PS/2; Front Panel Sealed Keyboard and Mouse; sVGA output) > 100 ... 250 VAC AC/DC converter > SE 254064 PA - 64-Channel PA Pulsing Receiving and Processing Card: ❑ Up to 300 Volt Peak to Peak Bipolar Square Wave – Tunable Width / Tunable Firing Level Pulser; Special Probe Protection Circuit to Prevent Probe Damage for Not Properly Adjusted Pulse Width; Freely Adjustable Emitting Aperture - up to 64 elements simultaneous firing ❑ Analogue Gain: 0...100 dB controllable in 0.5 dB resolution; Advanced Low Noise Design: 81µV peak to peak input referred to 80 dB gain / 25 MHz bandwidth; Frequency Band: 0.2 … 25 MHz Wide Band / 32-Taps FIR band pass digital filter with controllable lower and upper frequency limits; Freely Adjustable Receiving Aperture - up to 64 Elements, Parallel Analog to Digital Conversion - No Multiplexing Involved - For Any Size of Receiving Aperture ❑ Built-In Incremental Encoder Interface > SE 254016/1 - 1-Channel UDS 3-6 Pulser Receiver Card ❑ Up to 400 V Peak to Peak Bipolar Square Wave – Tunable Width / Tunable Firing Level Pulser; Single / Dual Modes of Operation; Special Probe Protection Circuit to Prevent Probe Damage for Not Properly Adjusted Pulse Width ❑ Gain: 0...100 dB controllable in 0.5 dB resolution; Advanced Low Noise Design: 81µV peak to peak input referred to 80 dB gain / 25 MHz bandwidth; Frequency Band: 0.2 … 25 MHz Wide Band / 32-Taps FIR band pass digital filter with controllable lower and upper frequency limits ❑ Built-In Incremental Encoder Interface • **<u>SW</u>** ❑ ISONIC 2009 UPA-Scope Multi-Functional Package (SWA 99C09200) ● **PA Modality** ◆ **PA Probes Database** ⇨ Unlimitedly expandable database of PA probes - total aperture size, pitch and offset, wedge geometry and US Velocity / delay geometry and US Velocity, etc ⇨ Manual editing / update of PA probes, wedges and delays parameters or automatic importing of database from a file ⇨ Exporting of PA probes / wedges / delays database into a file ◆ **A-Scan** ⇨ Manual control of emitting/receiving aperture, incidence angle, type of ultrasonic wave, focal distance / focal depth, etc ⇨ A-Scan (Full Wave / Neg Wave / Pos Wave rectification; RF) ⇨ True-To-Geometry Ray Trace (Focal Law) Visualization ⇨ DAC, TCG ⇨ Smart Automatic Measurements of Gated Signals - Flank / Flank First / Top / Top First; Auto-Marking Measuring Points on A-Scan ⇨ Enhanced Signal Evaluation for Live and Frozen A-Scans including Gain Adjustments whilst in Freeze Mode ⇨ Generating Comprehensive Setup and A-Scan report	SA 804900	Standard Configuration # 1

#	Item	Order Code (Part #)	Note
	Cross-Sectional Scanning and Imaging: ◆ **ABI-Scan (B-Scan or E-Scan as per ASME Case 2558)** ⇨ Linear electronically controlled scanning using predefined size of pulsing / receiving aperture, incidence angle, and type of ultrasonic wave within entire probe and automatic real time composing of **True-To-Geometry B-Scan** image with 100% raw data capturing ⇨ Unique Individual **Gain per Incidence Point / Gain per Focal Law Adjustment** to compensate: ● inequality of PA probe elements ● variety of wedge losses ◆ **Sector-Scan (S-Scan as per ASME Case 2557)** ⇨ Angular electronically controlled scanning using predefined pulsing / receiving aperture, and type of ultrasonic wave provided through steering of incidence angle and automatic real time composing of **regular Sector Scan (S-Scan)** or **True-To-Geometry Sector-Scan (S-Scan)** image with 100% raw data capturing ⇨ **Angle Gain Compensation:** Unique Individual **Gain per Incidence Angle / Gain per Focal Law Adjustment** compensating incidence angle-steering caused varieties of: ● transparency for probe - material boundary ● wedge losses ● effective size of emitting/receiving aperture ◆ **Tandem B-Scan (Tandem B-Scan) - for 64 elements wedged probes only** ⇨ Unique electronically controlled **Through-Thickness Shear Wave Scanning for Vertically Oriented Defects** with automatically created focal laws and real time composing of **True-To-Geometry Tandem B-Scan** image with 100% raw data capturing ⇨ Unique Individual **Gain per Shot** / **Gain per Focal Law Adjustment** compensating beam steering caused varieties of: ● transparency for probe - material boundary ● wedge losses ● composition and actual/effective size of emitting and receiving apertures All above modes of electronically controlled cross sectional scanning and imaging are featured with: ⇨ Freeze / Unfreeze of live image ⇨ Live A-Scan for the selected beam of live / frozen image, smart signal evaluation using conventional gating of ultrasonic signals ⇨ Versatile user configurable color palette for defects imaging, DAC normalization, reject threshold, noise suppression, etc ⇨ Zoom In / Out ⇨ Storing raw data image along with complete sequence of recorded A-Scans into a file ⇨ Upload raw data image from file ⇨ Off-line image evaluation including: ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Play-back and evaluation of A-Scans sourcing the image ▶ Echo-dynamic pattern analysis ▶ Defects outlining and pattern recognition based on A-Scan sequence analysis ▶ Off-line reconstruction of the images for various Gain / Reject level ▶ DAC normalization ⇨ Generating Comprehensive Setup and Scanning Report **Three-Dimensional Top - Side - End View Imaging Through Linear Scanning with PA Probes:** ◆ **ABI-Scan based C-Scan and 3D Data Presentation** ◆ **Sector-Scan based C-Scan and 3D Data Presentation** ◆ **Tandem B-Scan based C-Scan and 3D Data Presentation** ⇨ Electromechanically encoded or time-based line scanning with PA probe ⇨ **3D presentation - Top, Side, End View** ⇨ Amplitude / Distance mode of C-Scan - Top View image ⇨ Thickness Profiling / Flaw Detection presentation of Side / End View		

#	Item	Order Code (Part #)	Note
	⇨ Storing raw 3D data comprising all raw data B-Scans each accompanied with complete sequence of recorded raw data A-Scans into a file ⇨ Upload 3D data from a file ⇨ Comprehensive off-line analysis / postprocessing of 3D data featured with: ▶ **3D-Viewer** ▶ Off-line Recovery and Play-Back of A-Scans and Raw Data B-Scans ▶ Echo Dynamic Pattern Analysis; ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Gate Manipulation - Rebuild Top, Side, End views for various Gate Settings ▶ Off-line reconstruction of Top, Side, End views for various Gain / Reject level ▶ DAC normalization ▶ Slicing and Filtering Images ▶ Statistical Analysis ⇨ Generating Comprehensive Setup and Scanning Report ● **Conventional UT Modality - Single Channel Operation** ◆ **A-Scan** ⇨ A-Scan (Full Wave / Neg Wave / Pos Wave rectification; RF) ⇨ Selectable A-Scan color scheme ⇨ DAC, DGS, TCG ⇨ Auto Calibration for Straight Beam and Angle Beam Probes ⇨ Curved Surface / Wall Thickness / Skip - Correction for Angle Beam Inspection ⇨ Smart Automatic Measurements of Gated Signals - Flank / Flank First / Top / Top First; Auto-Marking Measuring Points on A-Scan ⇨ FFT (Frequency Domain Signal Presentation) - additional feature for defects evaluation and / or pattern recognition / probes characterization ⇨ Enhanced Signal Evaluation for Live and Frozen A-Scans including Gain Adjustments whilst in Freeze Mode ⇨ Dual Ultrasound Velocity Multi-echo Measurements Mode ⇨ Generating Comprehensive Setup and A-Scan / FFT graph report **Pulse Echo Inspection, Recording, and Imaging Through Linear Scanning with Conventional Probes:** ◆ **Thickness Profile Imaging and Recording (Typical Application: Corrosion characterization)** ⇨ Continuous measuring of thickness value along probe trace and composing of **Thickness Profile B-Scan** with 100% raw data capturing ◆ **B-Scan cross-sectional imaging and recording of defects for longitudinal and shear wave inspection** ⇨ Continuous measuring of echo amplitudes and reflectors coordinates along probe trace and composing of **True-To-Geometry B-Scan** with 100% raw data capturing ◆ **CB-Scan horizontal plane-view imaging and recording of defects for shear, surface, and guided wave inspection** ⇨ Continuous measuring of echo amplitudes and reflectors coordinates along probe trace and composing of **True-To-Geometry CB-Scan** with 100% raw data capturing All above modes of linear scanning and imaging are featured with: ⇨ Electromechanically encoded or time-based data recording ⇨ Recording of complete sequence of A-Scans along scanning line ⇨ Off-line evaluation of images featured with: ▶ Sizing of defects at any location along stored image – coordinates and projection size (plus remaining thickness, thickness loss, and length of damage for Thickness B-Scan); ▶ Play-back and evaluation of A-Scans ▶ Echo dynamic pattern analysis ▶ Off-line reconstruction of image for various Gain / Gate setup ⇨ Generating Comprehensive Setup and Scanning Report **Time of Flight Diffraction Technology - TOFD:** ◆ **TOFD Inspection – RF B-Scan and D-Scan Imaging** ⇨ Electromechanically encoded or time-based data recording ⇨ Averaging recorded A-Scans ⇨ Recording of complete sequence of A-Scans ⇨ Off-line evaluation of TOFD Map featured with: ▶ Improving near to surface resolution through removal of lateral wave and back echo records from TOFD Map		

#	Item	Order Code (Part #)	Note
	▶ Linearization and straightening of TOFD Map ▶ Increasing contrast of TOFD images through varying Gain and rectification ▶ A-Scan sequence analysis ▶ Defects pattern recognition and sizing with use of interactive parabolic cursors ⇨ Generating Comprehensive Setup and Scanning Report • **<u>Connectivity to Any Type of Windows Printer Through USB or LAN</u>** • **<u>USB Flash Drive for External Data Storage</u>** • **<u>12 months warranty period for the instrument</u>** • **<u>Lifetime free SW update</u>**		
2	**ISONIC 2009 UPA-Scope – Portable Digital Phased Array Ultrasonic Flaw Detector and Recorder: *64 channels PA electronics and 8 independent channels for connection of conventional and TOFD probes*** • **<u>ISONIC 2009 UPA-Scope Electronic unit</u>** – including: > Internal PC (AMD LX 800 500 MHz, RAM-512M, Quazi-HDD Flash Memory Card 4G, Windows XP Embedded, Large 8.5" active TFT sVGA LCD High Color Sun-Readable Touch Screen, Built-In Interfaces: 2XUSB; Ethernet; PS/2; Front Panel Sealed Keyboard and Mouse; sVGA output) > 100 ... 250 VAC AC/DC converter > SE 254064 PA - 64-Channel PA Pulsing Receiving and Processing Card: ❑ Up to 300 Volt Peak to Peak Bipolar Square Wave – Tunable Width / Tunable Firing Level Pulser; Special Probe Protection Circuit to Prevent Probe Damage for Not Properly Adjusted Pulse Width; Freely Adjustable Emitting Aperture - up to 64 elements simultaneous firing ❑ Analogue Gain: 0...100 dB controllable in 0.5 dB resolution; Advanced Low Noise Design: 81μV peak to peak input referred to 80 dB gain / 25 MHz bandwidth; Frequency Band: 0.2 … 25 MHz Wide Band / 32-Taps FIR band pass digital filter with controllable lower and upper frequency limits; Freely Adjustable Receiving Aperture - up to 64 Elements, Parallel Analog to Digital Conversion - No Multiplexing Involved - For Any Size of Receiving Aperture ❑ Built-In Incremental Encoder Interface > SE 254016/1 - 1-Channel UDS 3-6 Pulser Receiver Card ❑ Up to 400 V Peak to Peak Bipolar Square Wave – Tunable Width / Tunable Firing Level Pulser; Single / Dual Modes of Operation; Special Probe Protection Circuit to Prevent Probe Damage for Not Properly Adjusted Pulse Width ❑ Gain: 0...100 dB controllable in 0.5 dB resolution; Advanced Low Noise Design: 81μV peak to peak input referred to 80 dB gain / 25 MHz bandwidth; Frequency Band: 0.2 … 25 MHz Wide Band / 32-Taps FIR band pass digital filter with controllable lower and upper frequency limits ❑ Built-In Incremental Encoder Interface • **<u>SW</u>** ❑ ISONIC 2009 UPA-Scope Multi-Functional Package (SWA 99C09200) ● **PA Modality** ◆ **PA Probes Database** ⇨ Unlimitedly expandable database of PA probes - total aperture size, pitch and offset, wedge geometry and US Velocity / delay geometry and US Velocity, etc ⇨ Manual editing / update of PA probes, wedges and delays parameters or automatic importing of database from a file ⇨ Exporting of PA probes / wedges / delays database into a file ◆ **A-Scan** ⇨ Manual control of emitting/receiving aperture, incidence angle, type of ultrasonic wave, focal distance / focal depth, etc ⇨ A-Scan (Full Wave / Neg Wave / Pos Wave rectification; RF) ⇨ True-To-Geometry Ray Trace (Focal Law) Visualization ⇨ DAC, TCG ⇨ Smart Automatic Measurements of Gated Signals - Flank / Flank First / Top / Top First; Auto-Marking Measuring Points on A-Scan ⇨ Enhanced Signal Evaluation for Live and Frozen A-Scans including Gain Adjustments whilst in Freeze Mode ⇨ Generating Comprehensive Setup and A-Scan report	SA 804902	Standard Configuration # 2

#	Item	Order Code (Part #)	Note
	Cross-Sectional Scanning and Imaging: ◆ **ABI-Scan (B-Scan or E-Scan as per ASME Case 2558)** ⇨ Linear electronically controlled scanning using predefined size of pulsing / receiving aperture, incidence angle, and type of ultrasonic wave within entire probe and automatic real time composing of **True-To-Geometry B-Scan** image with 100% raw data capturing ⇨ Unique Individual **Gain per Incidence Point / Gain per Focal Law Adjustment** to compensate: ● inequality of PA probe elements ● variety of wedge losses ◆ **Sector-Scan (S-Scan as per ASME Case 2557)** ⇨ Angular electronically controlled scanning using predefined pulsing / receiving aperture, and type of ultrasonic wave provided through steering of incidence angle and automatic real time composing of **regular Sector Scan (S-Scan)** or **True-To-Geometry Sector-Scan (S-Scan)** image with 100% raw data capturing ⇨ **Angle Gain Compensation:** Unique Individual **Gain per Incidence Angle / Gain per Focal Law Adjustment** compensating incidence angle-steering caused varieties of: ● transparency for probe - material boundary ● wedge losses ● effective size of emitting/receiving aperture ◆ **Tandem B-Scan (Tandem B-Scan) - for 64 elements wedged probes only** ⇨ Unique electronically controlled **Through-Thickness Shear Wave Scanning for Vertically Oriented Defects** with automatically created focal laws and real time composing of **True-To-Geometry Tandem B-Scan** image with 100% raw data capturing ⇨ Unique Individual **Gain per Shot** / **Gain per Focal Law Adjustment** compensating beam steering caused varieties of: ● transparency for probe - material boundary ● wedge losses ● composition and actual/effective size of emitting and receiving apertures All above modes of electronically controlled cross sectional scanning and imaging are featured with: ⇨ Freeze / Unfreeze of live image ⇨ Live A-Scan for the selected beam of live / frozen image, smart signal evaluation using conventional gating of ultrasonic signals ⇨ Versatile user configurable color palette for defects imaging, DAC normalization, reject threshold, noise suppression, etc ⇨ Zoom In / Out ⇨ Storing raw data image along with complete sequence of recorded A-Scans into a file ⇨ Upload raw data image from file ⇨ Off-line image evaluation including: ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Play-back and evaluation of A-Scans sourcing the image ▶ Echo-dynamic pattern analysis ▶ Defects outlining and pattern recognition based on A-Scan sequence analysis ▶ Off-line reconstruction of the images for various Gain / Reject level ▶ DAC normalization ⇨ Generating Comprehensive Setup and Scanning Report **Three-Dimensional Top - Side - End View Imaging Through Linear Scanning with PA Probes:** ◆ **ABI-Scan based C-Scan and 3D Data Presentation** ◆ **Sector-Scan based C-Scan and 3D Data Presentation** ◆ **Tandem B-Scan based C-Scan and 3D Data Presentation** ⇨ Electromechanically encoded or time-based line scanning with PA probe ⇨ **3D presentation - Top, Side, End View** ⇨ Amplitude / Distance mode of C-Scan - Top View image ⇨ Thickness Profiling / Flaw Detection presentation of Side / End View ⇨ Storing raw 3D data comprising all raw data B-Scans each accompanied with complete sequence of recorded raw data A-Scans into a file ⇨ Upload 3D data from a file		

#	Item	Order Code (Part #)	Note
	⇨ Comprehensive off-line analysis / postprocessing of 3D data featured with: ▶ **3D-Viewer** ▶ Off-line Recovery and Play-Back of A-Scans and Raw Data B-Scans ▶ Echo Dynamic Pattern Analysis; ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Gate Manipulation - Rebuild Top, Side, End views for various Gate Settings ▶ Off-line reconstruction of Top, Side, End views for various Gain / Reject level ▶ DAC normalization ▶ Slicing and Filtering Images ▶ Statistical Analysis ⇨ Generating Comprehensive Setup and Scanning Report ● **Conventional UT Modality - Single and Multi Channel Operation** ◆ **A-Scan** ⇨ A-Scan (Full Wave / Neg Wave / Pos Wave rectification; RF) ⇨ Selectable A-Scan color scheme ⇨ DAC, DGS, TCG ⇨ Auto Calibration for Straight Beam and Angle Beam Probes ⇨ Curved Surface / Wall Thickness / Skip - Correction for Angle Beam Inspection ⇨ Smart Automatic Measurements of Gated Signals - Flank / Flank First / Top / Top First; Auto-Marking Measuring Points on A-Scan ⇨ FFT (Frequency Domain Signal Presentation) - additional feature for defects evaluation and / or pattern recognition / probes characterization ⇨ Enhanced Signal Evaluation for Live and Frozen A-Scans including Gain Adjustments whilst in Freeze Mode ⇨ Dual Ultrasound Velocity Multi-echo Measurements Mode ⇨ Generating Comprehensive Setup and A-Scan / FFT graph report **<u>Pulse Echo Inspection, Recording, and Imaging Through Linear Scanning with Conventional Probes – Single Channel Operation:</u>** ◆ **Thickness Profile Imaging and Recording (Typical Application: Corrosion characterization)** ⇨ Continuous measuring of thickness value along probe trace and composing of **Thickness Profile B-Scan** with 100% raw data capturing ◆ **B-Scan cross-sectional imaging and recording of defects for longitudinal and shear wave inspection** ⇨ Continuous measuring of echo amplitudes and reflectors coordinates along probe trace and composing of **True-To-Geometry B-Scan** with 100% raw data capturing ◆ **CB-Scan horizontal plane Top-View imaging and recording of defects for shear, surface, and guided wave inspection** ⇨ Continuous measuring of echo amplitudes and reflectors coordinates along probe trace and composing of **True-To-Geometry CB-Scan** with 100% raw data capturing All above modes of linear scanning and imaging are featured with: ⇨ Electromechanically encoded or time-based data recording ⇨ Recording of complete sequence of A-Scans along scanning line ⇨ Off-line evaluation of images featured with: ▶ Sizing of defects at any location along stored image – coordinates and projection size (plus remaining thickness, thickness loss, and length of damage for Thickness B-Scan); ▶ Play-back and evaluation of A-Scans ▶ Echo dynamic pattern analysis ▶ Off-line reconstruction of image for various Gain / Gate setup ⇨ Generating Comprehensive Setup and Scanning Reporting **<u>Time of Flight Diffraction Technology – TOFD – Single Channel Operation:</u>** ◆ **TOFD Inspection – RF B-Scan and D-Scan Imaging** ⇨ Electromechanically encoded or time-based data recording ⇨ Averaging recorded A-Scans ⇨ Recording of complete sequence of A-Scans ⇨ Off-line evaluation of TOFD Map featured with: ▶ Improving near to surface resolution through removal of lateral wave and back echo records from TOFD Map ▶ Linearization and straightening of TOFD Map		

#	Item	Order Code (Part #)	Note
	▶ Increasing contrast of TOFD images through varying Gain and rectification ▶ A-Scan sequence analysis ▶ Defects pattern recognition and sizing with use of interactive parabolic cursors ⇨ Generating Comprehensive Setup and Scanning Report **<u>Multi-Channel Operation – up to 8 channels for Conventional and TOFD Probes</u>** ◆ **Multiple A-Scan** ◆ **Strip Chart** ⇨ Continuous capturing and recording of up to 8 channel complete sequence A-Scans along probe trace and real time creating of up to 8 channel strip chart ⇨ Time-based (real time clock) and true-to-location (built-in incremental encoder interface) modes of data recording ⇨ 4 types of strip chart selectable by operator: ▽ TOFD ▽ Map ▽ PE Amplitude / TOF ▽ Coupling ⇨ Comprehensive Off-line evaluation of recorded strip chart: ▶ Play-back and evaluation of A-Scans ▶ Marking Defects and Creating Defect List ▶ Varying layout of strip chart ▶ Conversion of Map Strips into PE Amplitude TOF strips and reverse conversion of PE Amplitude TOF strips into Map Strips ▶ Varying ROI and rebuild of PE Amplitude/TOF Strips ▶ Stripped C-Scan Creation ▶ Echo dynamic pattern analysis ▶ Individual Postprocessing of Each strip based on strip type: ▽ TOFD ▽ Map ▽ PE Amplitude / TOF ⇨ Generating Comprehensive Setup and Scanning Report • **<u>Connectivity to Any Type of Windows Printer Through USB or LAN</u>** • **<u>USB Flash Drive for External Data Storage</u>** • **<u>12 months warranty period for the instrument</u>** • **<u>Lifetime free SW update</u>**		
3	**ISONIC 2009 UPA-Scope – Portable Digital Phased Array Ultrasonic Flaw Detector and Recorder: *64 channels PA electronics and 16 independent channels for connection of conventional and TOFD probes***	SA 804906	Customized Configuration – to be agreed on order
4	Rechargeable Battery Ni MH 9 AH / 12V	SK 2005102	Optional
5	Battery Charger	SK 2005103	Optional Required for battery charge
6	Silicon Rubber Jacket  	SK 2009111	Optional
7	Travel Hard Case	SK 2009104	Optional Allows safe cargo transportation

#	Item	Order Code (Part #)	Note
8	<u>Postprocessing SW Package for Office PC</u>: **ISONIC 2009 PP** ⇨ comprehensive postprocessing of inspection results PA Modality files captured by ISONIC 2009 UPA-Scope using Inspection SW Packages of any type ⇨ automatic creating of ISONIC 2009 UPA-Scope - PA Modality inspection reports for printing hard copy	SWA 909844	Included into scope of supply of each ISONIC 2009 UPA Scope instrument
9	**Wheels-Free** Compact One-Axis Mechanical Encoder for manual line scanning with **PA probes** and for TOFD / CHIME/ CB-Scan / Thickness Profile / Straight Beam B-Scan imaging with conventional probes	SK 2001108 PA	Optional
10	<u>Inspection SW Utility for ISONIC 2009 UPA-Scope - PA Modality:</u> **Kls - Delta Technique** ⇨ Single probe insonification of defects with receiving and evaluation of direct and mode converted echoes for the distinguishing between volumetric and sharp defects ⇨ Generating Comprehensive Setup and Evaluation Report	SWA 909801	Optional
11	<u>Inspection SW Utility for ISONIC 2009 UPA-Scope - PA Modality:</u> **CDM - Crack Depth Measurements** ⇨ Single probe sizing of cracks and remaining wall thickness ⇨ Generating Comprehensive Setup and Evaluation Report	SWA 909802	Optional
12	<u>Inspection SW Package for ISONIC 2009 UPA-Scope - PA Modality:</u> **Horizontal Plane Top View CB-Scan - Lateral Scanning** **<u>Scanning Technique # 1</u>** ⇨ Electronically controlled scanning using predefined pulsing / receiving aperture and type of ultrasonic wave provided through **swiveling of ultrasonic beam** with predefined incidence angle and automatic real time composing of **Top View CB-Scan** image with 100% raw data capturing ⇨ **Swiveling Angle Gain Compensation:** Unique Individual **Gain per Swiveling Angle / Gain per Focal Law Adjustment** compensating swiveling angle-steering caused varieties of: ● wedge losses ● effective size of emitting/receiving aperture **<u>Scanning Technique # 2</u>** ⇨ Electronically controlled scanning using predefined size of pulsing / receiving aperture, incidence and swiveling angle, and type of ultrasonic wave through **linear motion of ultrasonic beam** within entire probe and automatic real time composing of **Top View CB-Scan** image with 100% raw data capturing ⇨ Unique Individual **Gain per Incidence Point / Gain per Focal Law Adjustment** to compensate: ● inequality of PA probe elements Both electronically controlled scanning techniques are featured with: ⇨ Freeze / Unfreeze of live image ⇨ Live A-Scan for the selected beam of live / frozen image, smart signal evaluation using conventional gating of ultrasonic signals ⇨ Versatile user configurable color palette for defects imaging, DAC normalization, reject threshold, noise suppression, etc ⇨ Zoom In / Out ⇨ Storing raw data image along with complete sequence of recorded A-Scans into a file ⇨ Upload raw data image from file ⇨ Off-line image evaluation including: ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Play-back and evaluation of A-Scans sourcing the image ▶ Echo-dynamic pattern analysis ▶ Defects outlining and pattern recognition based on A-Scan sequence analysis ▶ Off-line reconstruction of the images for various Gain / Reject level ▶ DAC normalization ⇨ Generating Comprehensive Setup and Scanning Report	SWA 909803	Optional
13	<u>Inspection SW Package for ISONIC 2009 UPA-Scope - PA Modality:</u> **EXPERT - Weld Inspection (planar and circumferential butt welds, nozzle welds, fillet welds)** **<u>Cross-Sectional Scanning and Imaging Uniquely Representing Real Distribution Of Ultrasonic Beams In the Weld and Parent Material with True-To-Location Visualization of Defects and Weld Geometry:</u>** ◆ **ABI-Scan (B-Scan or E-Scan as per ASME Case 2558)** ⇨ Linear electronically controlled scanning using predefined size of pulsing / receiving aperture, incidence angle, and type of ultrasonic wave within entire probe and automatic real time composing of **True-To-Geometry B-Scan** image with 100% raw data capturing ⇨ Unique Individual **Gain per Incidence Point / Gain per Focal Law Adjustment** to compensate: ● inequality of PA probe elements ● variety of wedge losses	SWA 909804	Optional

#	Item	Order Code (Part #)	Note
	◆ **Sector-Scan (S-Scan as per ASME Case 2557)** ⇨ Angular electronically controlled scanning using predefined pulsing / receiving aperture, and type of ultrasonic wave provided through steering of incidence angle and automatic real time composing of **regular Sector Scan (S-Scan)** or **True-To-Geometry Sector-Scan (S-Scan)** image with 100% raw data capturing ⇨ **Angle Gain Compensation:** Unique Individual **Gain per Incidence Angle / Gain per Focal Law Adjustment** compensating incidence angle-steering caused varieties of: ● transparency for probe - material boundary ● wedge losses ● effective size of emitting/receiving aperture Both modes of electronically controlled cross sectional scanning are featured with: ⇨ Freeze / Unfreeze of live image ⇨ Live A-Scan for the selected beam of live / frozen image, smart signal evaluation using conventional gating of ultrasonic signals ⇨ Versatile user configurable color palette for defects imaging, DAC normalization, reject threshold, noise suppression, etc ⇨ Zoom In / Out ⇨ Storing raw data image along with complete sequence of recorded A-Scans into a file ⇨ Upload raw data image from file ⇨ Off-line image evaluation including: ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Play-back and evaluation of A-Scans sourcing the image ▶ Echo-dynamic pattern analysis ▶ Defects outlining and pattern recognition based on A-Scan sequence analysis ▶ Off-line reconstruction of the images for various Gain / Reject level ▶ DAC normalization ⇨ Generating Comprehensive Setup and Scanning Report **<u>Three-Dimensional Top - Side - End View Imaging of Weld and Heat Affected Zone Through Linear Scanning with PA Probes:</u>** ◆ **ABI-Scan based C-Scan and 3D Data Presentation** ◆ **Sector-Scan based C-Scan and 3D Data Presentation** ⇨ Electromechanically encoded or time-based line scanning with PA probe ⇨ **3D presentation - Top, Side, End View** ⇨ Amplitude / Distance mode of C-Scan - Top View image ⇨ Thickness Profiling / Flaw Detection presentation of Side / End View ⇨ Storing raw 3D data comprising all raw data B-Scans each accompanied with complete sequence of recorded raw data A-Scans into a file ⇨ Upload 3D data from a file ⇨ Comprehensive off-line analysis / postprocessing of 3D data featured with: ▶ **3D-Viewer** ▶ Off-line Recovery and Play-Back of A-Scans and Raw Data B-Scans ▶ Echo Dynamic Pattern Analysis; ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Gate Manipulation - Rebuild Top, Side, End views for various Gate Settings ▶ Off-line reconstruction of Top, Side, End views for various Gain / Reject level ▶ DAC normalization ▶ Slicing and Filtering Images ▶ Statistical Analysis ⇨ Generating Comprehensive Setup and Scanning Reporting		
14	<u>Inspection SW Package for ISONIC 2009 UPA-Scope - PA Modality:</u> **EXPERT CU - Weld Inspection (longitudinal welds in tubes; nozzle, fillet, TKY, etc welds for curved components)** **<u>Cross-Sectional Scanning and Imaging Uniquely Representing Real Distribution Of Ultrasonic Beams In the Weld and Parent Material with True-To-Location Visualization of Defects and Weld Geometry:</u>** ◆ **Sector-Scan (S-Scan as per ASME Case 2557)** ⇨ Angular electronically controlled scanning using predefined pulsing / receiving aperture, and type of ultrasonic wave provided through steering of incidence angle and automatic real time composing of **regular Sector Scan (S-Scan)** or **True-To-Geometry Sector-Scan (S-Scan)** image with 100% raw data capturing ⇨ **Angle Gain Compensation:** Unique Individual **Gain per Incidence Angle / Gain per Focal Law Adjustment** compensating incidence angle-steering caused varieties of: ● transparency for probe - material boundary ● wedge losses ● effective size of emitting/receiving aperture ⇨ Freeze / Unfreeze of live image ⇨ Live A-Scan for the selected beam of live / frozen image, smart signal evaluation using conventional gating of ultrasonic signals ⇨ Versatile user configurable color palette for defects imaging, DAC normalization, reject threshold, noise suppression, etc ⇨ Zoom In / Out ⇨ Storing raw data image along with complete sequence of recorded A-Scans into a file ⇨ Upload raw data image from file	SWA 909805	Optional

#	Item	Order Code (Part #)	Note
	⇨ Off-line image evaluation including: ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Play-back and evaluation of A-Scans sourcing the image ▶ Echo-dynamic pattern analysis ▶ Defects outlining and pattern recognition based on A-Scan sequence analysis ▶ Off-line reconstruction of the images for various Gain / Reject level ▶ DAC normalization ⇨ Generating Comprehensive Setup and Scanning Report **<u>Three-Dimensional Top - Side - End View Imaging of Weld and Heat Affected Zone Through Linear Scanning with PA Probes:</u>** ◆ **Sector-Scan based C-Scan and 3D Data Presentation** ⇨ Electromechanically encoded or time-based line scanning with PA probe ⇨ **3D presentation - Top, Side, End View** ⇨ Amplitude / Distance mode of C-Scan - Top View image ⇨ Thickness Profiling / Flaw Detection presentation of Side / End View ⇨ Storing raw 3D data comprising all raw data B-Scans each accompanied with complete sequence of recorded raw data A-Scans into a file ⇨ Upload 3D data from a file ⇨ Comprehensive off-line analysis / postprocessing of 3D data featured with: ▶ **3D-Viewer** ▶ Off-line Recovery and Play-Back of A-Scans and Raw Data B-Scans ▶ Echo Dynamic Pattern Analysis; ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Gate Manipulation - Rebuild Top, Side, End views for various Gate Settings ▶ Off-line reconstruction of Top, Side, End views for various Gain / Reject level ▶ DAC normalization ▶ Slicing and Filtering Images ▶ Statistical Analysis ⇨ Generating Comprehensive Setup and Scanning Report		
15	<u>Inspection SW Package for ISONIC 2009 UPA-Scope - PA Modality:</u> **VLFS – Vertical Line Focusing Scanning and Imaging (typical application: inspection of planar and circumferential ER welds, welded rails, etc)** **<u>Cross-Sectional Scanning and Imaging Uniquely Representing Real Distribution Of Ultrasonic Beams In the Selected Region of Interest (ROI) with True-To-Location Visualization of Defects:</u>** ◆ **ABI-Scan (B-Scan or E-Scan as per ASME Case 2558)** ⇨ Linear electronically controlled scanning using predefined size of pulsing / receiving aperture, incidence angle, and type of ultrasonic wave within entire probe and automatic real time composing of **True-To-Geometry B-Scan** image with 100% raw data capturing ⇨ Unique Individual **Gain per Incidence Point / Gain per Focal Law Adjustment** to compensate: ● inequality of PA probe elements ● variety of wedge losses ◆ **Sector-Scan (S-Scan as per ASME Case 2557)** ⇨ Angular electronically controlled scanning using predefined pulsing / receiving aperture, and type of ultrasonic wave provided through steering of incidence angle and automatic real time composing of **regular Sector Scan (S-Scan)** or **True-To-Geometry Sector-Scan (S-Scan)** image with 100% raw data capturing ⇨ **Angle Gain Compensation:** Unique Individual **Gain per Incidence Angle / Gain per Focal Law Adjustment** compensating incidence angle-steering caused varieties of: ● transparency for probe - material boundary ● wedge losses ● effective size of emitting/receiving aperture Both modes of electronically controlled cross sectional scanning are featured with: ⇨ Freeze / Unfreeze of live image ⇨ Live A-Scan for the selected beam of live / frozen image, smart signal evaluation using conventional gating of ultrasonic signals ⇨ Versatile user configurable color palette for defects imaging, DAC normalization, reject threshold, noise suppression, etc ⇨ Zoom In / Out ⇨ Storing raw data image along with complete sequence of recorded A-Scans into a file ⇨ Upload raw data image from file ⇨ Off-line image evaluation including: ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Play-back and evaluation of A-Scans sourcing the image ▶ Echo-dynamic pattern analysis ▶ Defects outlining and pattern recognition based on A-Scan sequence analysis ▶ Off-line reconstruction of the images for various Gain / Reject level ▶ DAC normalization ⇨ Generating Comprehensive Setup and Scanning Report	SWA 909806	Optional

#	Item	Order Code (Part #)	Note
	<u>Three-Dimensional Top - Side - End View Imaging of Weld and Heat Affected Zone Through Linear Scanning with PA Probes:</u> ◆ **ABI-Scan based C-Scan and 3D Data Presentation** ◆ **Sector-Scan based C-Scan and 3D Data Presentation** ⇨ Electromechanically encoded or time-based line scanning with PA probe ⇨ **3D presentation - Top, Side, End View** ⇨ Amplitude / Distance mode of C-Scan - Top View image ⇨ Thickness Profiling / Flaw Detection presentation of Side / End View ⇨ Storing raw 3D data comprising all raw data B-Scans each accompanied with complete sequence of recorded raw data A-Scans into a file ⇨ Upload 3D data from a file ⇨ Comprehensive off-line analysis / postprocessing of 3D data featured with: ▶ **3D-Viewer** ▶ Off-line Recovery and Play-Back of A-Scans and Raw Data B-Scans ▶ Echo Dynamic Pattern Analysis; ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Gate Manipulation - Rebuild Top, Side, End views for various Gate Settings ▶ Off-line reconstruction of Top, Side, End views for various Gain / Reject level ▶ DAC normalization ▶ Slicing and Filtering Images ▶ Statistical Analysis ⇨ Generating Comprehensive Setup and Scanning Report		
16	<u>Inspection SW Package for ISONIC 2009 UPA-Scope - PA Modality:</u> **VLFS CU – Vertical Line Focusing Scanning and Imaging of Tubular Objects (typical application: inspection of longitudinal ERW in tubes and similar objects)** **<u>Cross-Sectional Scanning and Imaging Uniquely Representing Real Distribution Of Ultrasonic Beams In the Selected Region of Interest (ROI) with True-To-Location Visualization of Defects:</u>** ◆ **Sector-Scan (S-Scan as per ASME Case 2557)** ⇨ Angular electronically controlled scanning using predefined pulsing / receiving aperture, and type of ultrasonic wave provided through steering of incidence angle and automatic real time composing of **regular Sector Scan (S-Scan)** or **True-To-Geometry Sector-Scan (S-Scan)** image with 100% raw data capturing ⇨ **Angle Gain Compensation:** Unique Individual **Gain per Incidence Angle / Gain per Focal Law Adjustment** compensating incidence angle-steering caused varieties of: ● transparency for probe - material boundary ● wedge losses ● effective size of emitting/receiving aperture ⇨ Freeze / Unfreeze of live image ⇨ Live A-Scan for the selected beam of live / frozen image, smart signal evaluation using conventional gating of ultrasonic signals ⇨ Versatile user configurable color palette for defects imaging, DAC normalization, reject threshold, noise suppression, etc ⇨ Zoom In / Out ⇨ Storing raw data image along with complete sequence of recorded A-Scans into a file ⇨ Upload raw data image from file ⇨ Off-line image evaluation including: ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Play-back and evaluation of A-Scans sourcing the image ▶ Echo-dynamic pattern analysis ▶ Defects outlining and pattern recognition based on A-Scan sequence analysis ▶ Off-line reconstruction of the images for various Gain / Reject level ▶ DAC normalization ⇨ Generating Comprehensive Setup and Scanning Report **<u>Three-Dimensional Top - Side - End View Imaging of Weld and Heat Affected Zone Through Linear Scanning with PA Probes:</u>** ◆ **Sector-Scan based C-Scan and 3D Data Presentation** ⇨ Electromechanically encoded or time-based line scanning with PA probe ⇨ **3D presentation - Top, Side, End View** ⇨ Amplitude / Distance mode of C-Scan - Top View image ⇨ Thickness Profiling / Flaw Detection presentation of Side / End View ⇨ Storing raw 3D data comprising all raw data B-Scans each accompanied with complete sequence of recorded raw data A-Scans into a file ⇨ Upload 3D data from a file ⇨ Comprehensive off-line analysis / postprocessing of 3D data featured with: ▶ **3D-Viewer** ▶ Off-line Recovery and Play-Back of A-Scans and Raw Data B-Scans ▶ Echo Dynamic Pattern Analysis; ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Gate Manipulation - Rebuild Top, Side, End views for various Gate Settings	SWA 909807	Optional

#	Item	Order Code (Part #)	Note
	▶ Off-line reconstruction of Top, Side, End views for various Gain / Reject level ▶ DAC normalization ▶ Slicing and Filtering Images ▶ Statistical Analysis ⇨ Generating Comprehensive Setup and Scanning Report		
17	<u>Inspection SW Utility for ISONIC 2009 UPA-Scope - PA Modality:</u> **3D-SCAN L – Longitudinal Wave Insonification of the Material with Use of Matrix Array Probe and Composing 3D Image in Real Time** ◆ **3D L A-Scan** ⇨ Unique manual control of emitting/receiving aperture within entirely connected matrix array probe, incidence angle, beam rotation angle, focal distance / focal depth, etc for longitudinal wave ⇨ A-Scan (Full Wave / Neg Wave / Pos Wave rectification; RF) ⇨ True-To-Geometry Ray Trace (Focal Law) 3D Visualization ⇨ DAC, TCG ⇨ Smart Automatic Measurements of Gated Signals - Flank / Flank First / Top / Top First; Auto-Marking Measuring Points on A-Scan ⇨ Enhanced Signal Evaluation for Live and Frozen A-Scans including Gain Adjustments whilst in Freeze Mode ◆ **3D-Scan L** ⇨ Electronically controlled longitudinal wave scanning of predefined volume in the material using matrix array probe and real time composing of 3D-image (**3D-Scan**) of object under test with 100% raw data capturing ⇨ Freeze / Unfreeze of live 3D image ⇨ Live A-Scan for the selected beam of live / frozen 3D image, smart signal evaluation using conventional gating of ultrasonic signals ⇨ Versatile user configurable color palette for defects imaging, DAC normalization, reject threshold, noise suppression, etc ⇨ 3D-Viewing manipulator for live/frozen 3D image ⇨ Zoom In / Out ⇨ Storing 3D-image along with complete sequence of recorded A-Scans (raw data) into a file ⇨ Upload 3D-image with raw data from a file ⇨ Off-line image evaluation including: ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Play-back and evaluation of A-Scans sourcing the image ▶ Echo-dynamic pattern analysis ▶ Defects outlining and pattern recognition based on A-Scan sequence analysis ▶ Off-line reconstruction of the images for various Gain / Reject level ▶ DAC normalization ⇨ Generating Comprehensive Setup and Scanning Report	SWA 909808	Optional
18	<u>Inspection SW Utility for ISONIC 2009 UPA-Scope - PA Modality:</u> **3D-SCAN S – Shear Wave Insonification of the Material with Use of Matrix Array Probe and Composing 3D Image in Real Time** ◆ **3D S A-Scan** ⇨ Unique manual control of emitting/receiving aperture within entirely connected matrix array probe, incidence angle, beam rotation angle, focal distance / focal depth, etc for shear wave ⇨ A-Scan (Full Wave / Neg Wave / Pos Wave rectification; RF) ⇨ True-To-Geometry Ray Trace (Focal Law) 3D Visualization ⇨ DAC, TCG ⇨ Smart Automatic Measurements of Gated Signals - Flank / Flank First / Top / Top First; Auto-Marking Measuring Points on A-Scan ⇨ Enhanced Signal Evaluation for Live and Frozen A-Scans including Gain Adjustments whilst in Freeze Mode ◆ **3D-Scan S** ⇨ Electronically controlled shear wave scanning of predefined volume in the material using matrix array probe and real time composing of 3D-image (**3D-Scan**) of object under test with 100% raw data capturing ⇨ Freeze / Unfreeze of live 3D image ⇨ Live A-Scan for the selected beam of live / frozen 3D image, smart signal evaluation using conventional gating of ultrasonic signals ⇨ Versatile user configurable color palette for defects imaging, DAC normalization, reject threshold, noise suppression, etc ⇨ 3D-Viewing manipulator for live/frozen 3D image ⇨ Zoom In / Out ⇨ Storing 3D-image along with complete sequence of recorded A-Scans (raw data) into a file ⇨ Upload 3D-image with raw data from a file ⇨ Off-line image evaluation including: ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Play-back and evaluation of A-Scans sourcing the image ▶ Echo-dynamic pattern analysis ▶ Defects outlining and pattern recognition based on A-Scan sequence analysis	SWA 909809	Optional

#	Item	Order Code (Part #)	Note
	▶ Off-line reconstruction of the images for various Gain / Reject level ▶ DAC normalization ⇨ Generating Comprehensive Setup and Scanning Report		
19	Inspection SW Utility for ISONIC 2009 UPA-Scope - PA Modality: **Multi-Group – Implementation of Several (up to 5) Various Insonification Schemes Simultaneously with Use of Differently Configured Groups of Elements of Wedged Linear Array Probe**	SWA 909810	
20	Postprocessing SW Package for Office PC: **ISONIC PA PP –** ⇨ comprehensive postprocessing of inspection results files captured by **ISONIC 2009 UPA-Scope** and **ISONIC 2010** - PA Modality using Inspection SW Packages of any type ⇨ automatic creating of inspection reports	SWA909844	Delivered with every **ISONIC 2009 UPA Scope** instrument
21	Postprocessing SW Package for Office PC: **ISONIC PA ABIScan Puzzle** ⇨ composing PUZZLE file comprising raw data from several ABIScan based top view scanning files providing large area coverage with/without overlap ⇨ comprehensive off-line analysis / postprocessing of 3D PUZZLE data featured with: ▶ **Top, Side, End Puzzle Composed Views of Large Area** ▶ **3D-Viewer** ▶ Off-line Recovery and Play-Back of A-Scans ▶ Echo Dynamic Pattern Analysis; ▶ Sizing of defects – coordinates and projection size - gate based and image based ▶ Gate Manipulation - Rebuild Top, Side, End views for various Gate Settings ▶ Off-line reconstruction of Top, Side, End views for various Gain / Reject level ▶ DAC normalization ▶ Slicing and Filtering Images ▶ Statistical Analysis ⇨ generating comprehensive Setup and Scanning Report	SWA 909845	Option
22	Postprocessing SW Package for Office PC: **IOFFICE - ISONIC Office** ⇨ comprehensive postprocessing of inspection results files captured by ISONIC 2001, ISONIC 2005, ISONIC 2006, ISONIC 2007, ISONIC 2008, ISONIC 2009 UPA-Scope, ISONIC 2010 instruments using conventional and TOFD probes and Inspection SW Packages of any type ⇨ generating comprehensive inspection reports in MS Word® format	SWA99C0203	Optional
23	Dual Channel TOFD preamplifier package including: ⇨ Dual Channel TOFD preamplifier ⇨ Set of 2 low noise coaxial cables (10 meters length each) for connection to the signal input of ISONIC instrument	SA 80442	Optional Improves long cable connection to conventional and TOFD ultrasonic probes
24	ISONIC Alarmer - standard firmware configuration and hardware platform including: ⇨ Internal Speaker functioning according to alarm logic settings of conventional channel(s) in ISONIC 2005, 2006, 2007, 2008, 2009 UPA-Scope, 2010 instruments ⇨ Speaker Volume Control Wheel ⇨ Headphone Connector ⇨ 25-pin programmable Input / Output interface (blank) ⇨ USB port and cable for connecting to the instrument	SE 554780987	Optional
25	Set of test blocks for phased array inspection; material - low carbon steel	S 8001 PA	See photos below
26	Set of test blocks for phased array inspection; material - stainless steel ASTM 304	S 8001ASTM304 PA	See photos below
27	Set of test blocks for phased array inspection; material - stainless steel ASTM 316	S 8001ASTM316 PA	See photos below
28	Ultrasonic PA, conventional, and TOFD probes, fixtures, scanners, cables and other accessories depending on the inspection tasks to be resolved		Optional

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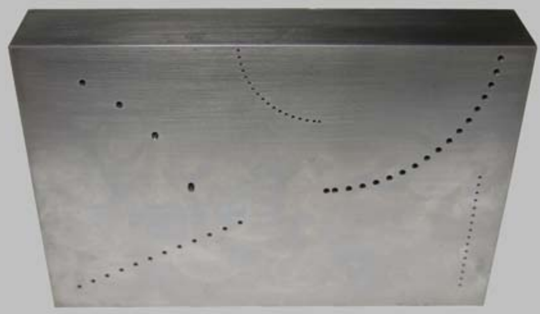
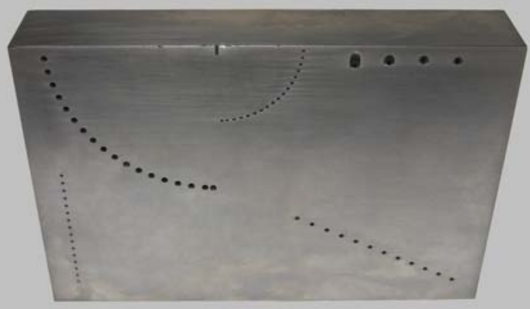
Information about typical PA probes, wedges, delay lines is available in the chapters 5.3.1, 5.4, 5.5.2.5 of this Operating Manual

S 8001 PA, S 8001ASTM304 PA, and S 8001ASTM316 PA sets consist of two blocks each made of low carbon steel, stainless steel ASTM 304, and stainless steel ASTM 316 correspondingly

Block # 1





Block # 2

4. Operating ISONIC 2009

Please read the following information before you use **ISONIC 2009 UPA-Scope**. It is essential to read and understand the following information so that no errors occur during operation, which could lead damaging of the unit or misinterpretation of inspection results

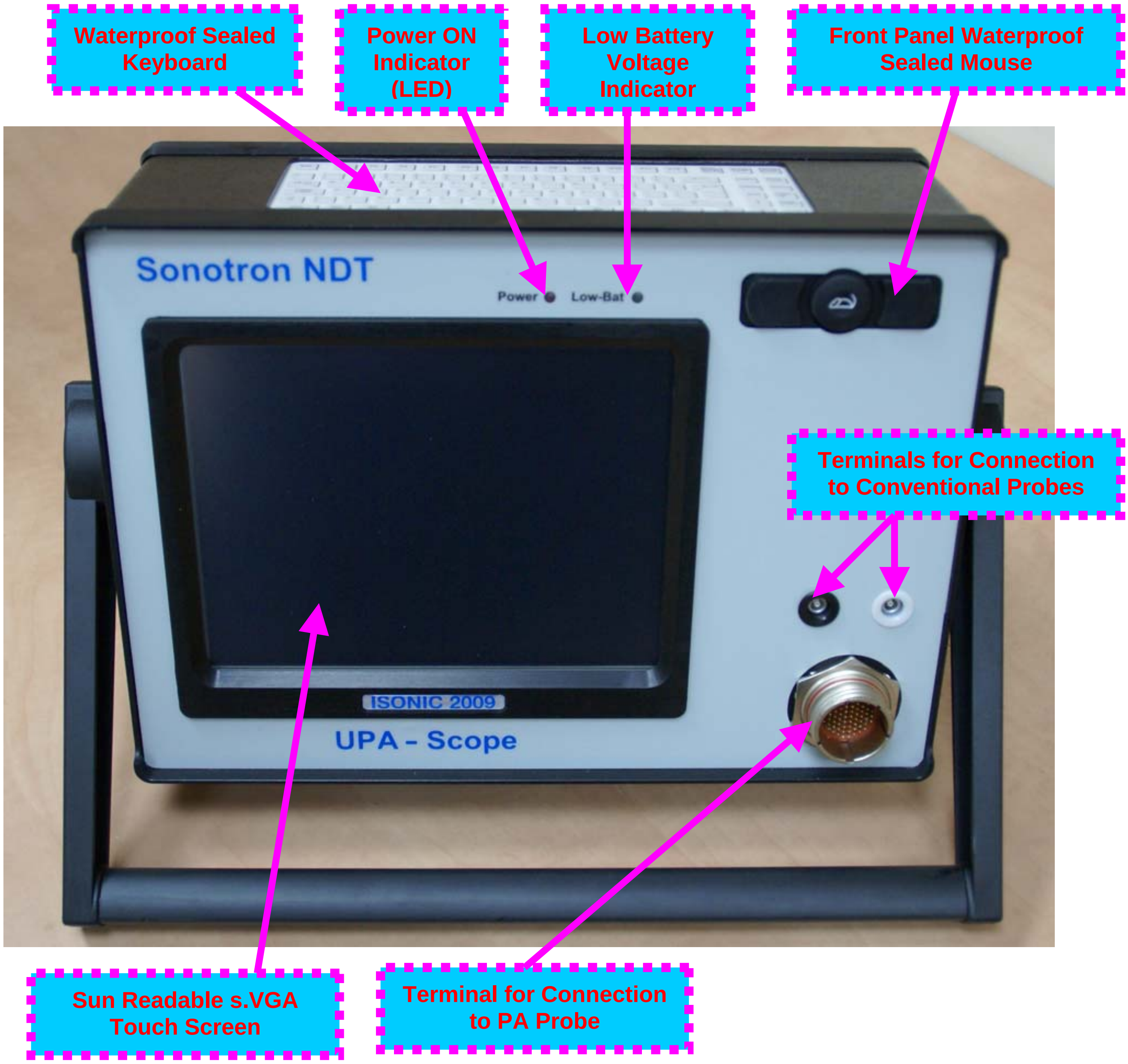
4.1. Preconditions for ultrasonic testing with ISONIC 2009 UPA-Scope

Operator of **ISONIC 2009 UPA-Scope** must be certified as at least *Level 2 Ultrasonic Examiner* additionally having the adequate knowledge of

- operating digital ultrasonic flaw detector
- basics of computer operating in the **Windows™** environment including turning computer on/off, keyboard, touch screen and mouse, starting programs, saving and opening files

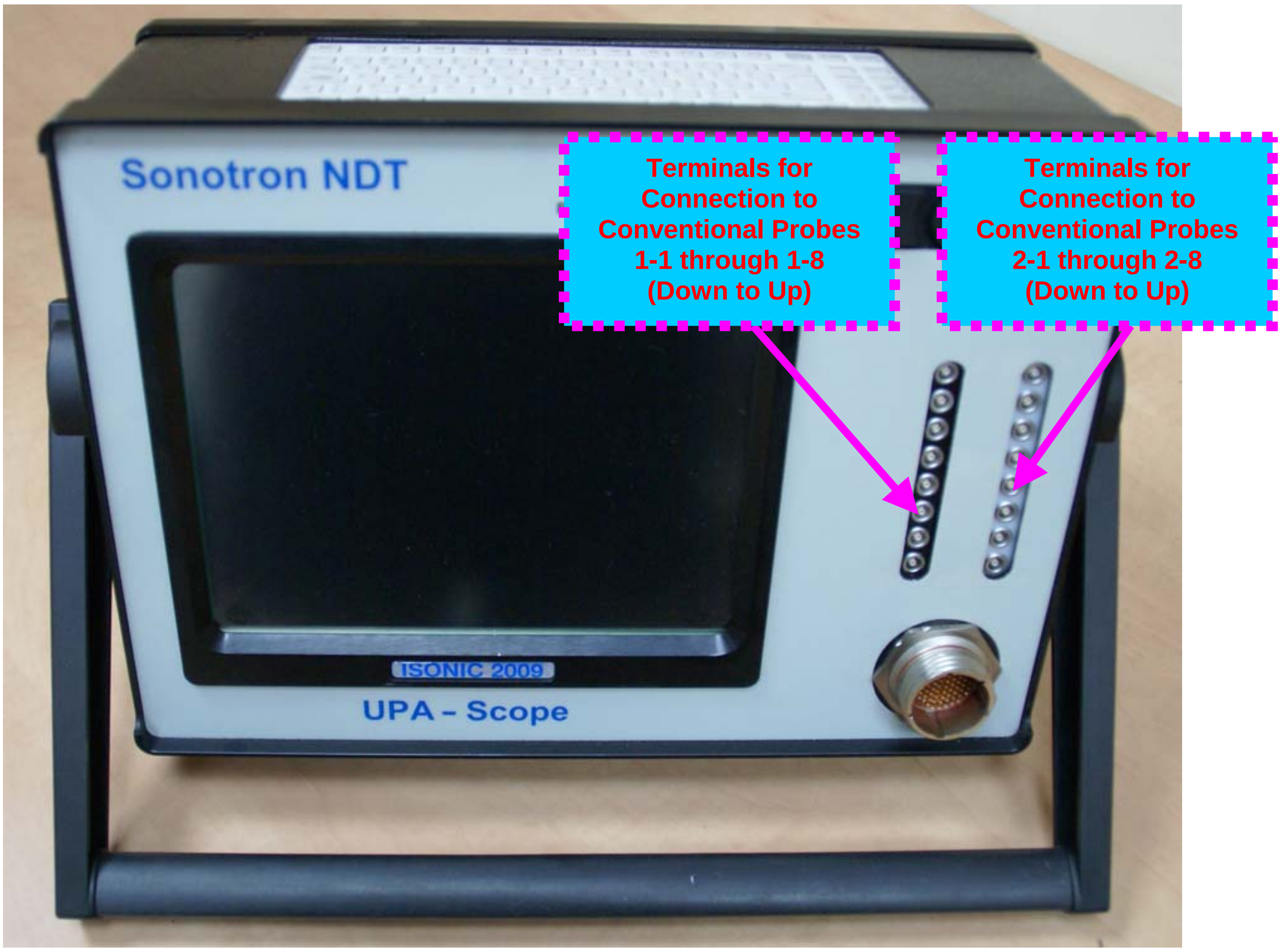
4.2. ISONIC 2009 Controls and Terminals

Item	Order Code (Part #)	Note
ISONIC 2009 UPA-Scope – Portable Digital Phased Array Ultrasonic Flaw Detector and Recorder: ***64 channels PA electronics and 1 independent channel for connection of conventional and TOFD probes***	SA 804900	Standard Configuration # 1

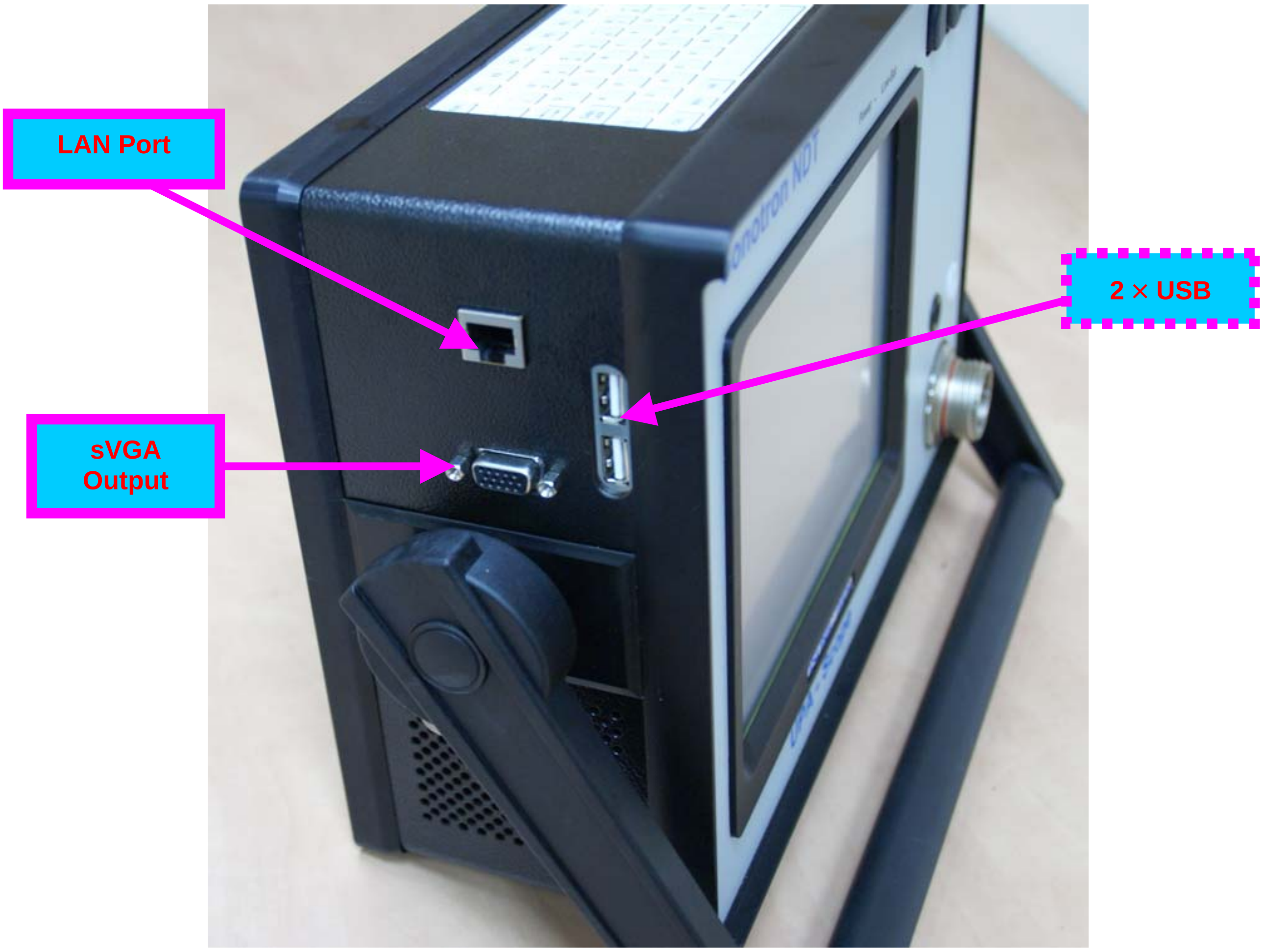


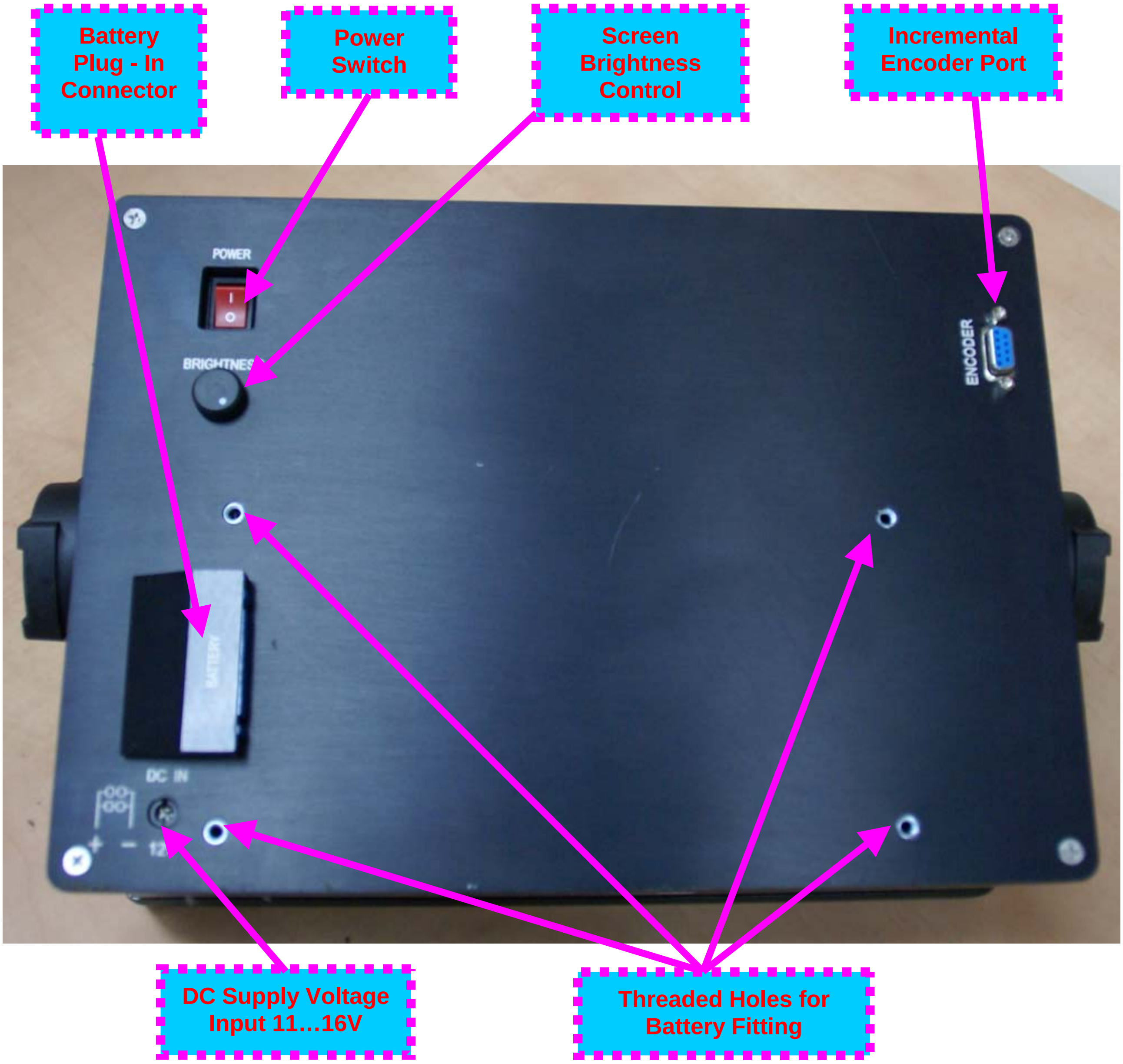
Probe Terminal	Pulser Mode: Dual	Pulser Mode: Single
Black	Receiver Input	Firing Output / Receiver Input
White	Firing Output	Not Used

Item	Order Code (Part #)	Note
ISONIC 2009 UPA-Scope – Portable Digital Phased Array Ultrasonic Flaw Detector and Recorder: ***64 channels PA electronics and 8 independent channels for connection of conventional and TOFD probes***	SA 804902	Standard Configuration # 2



Probe Terminal	UDS 3-6 Pulser Receiver Channel #	Pulser Mode: Dual	Pulser Mode: Single
1-1	1	Receiver Input	Firing Output / Receiver Input
2-1	1	Firing Output	Not Used
1-2	2	Receiver Input	Firing Output / Receiver Input
2-2	2	Firing Output	Not Used
1-3	3	Receiver Input	Firing Output / Receiver Input
2-3	3	Firing Output	Not Used
1-4	4	Receiver Input	Firing Output / Receiver Input
2-4	4	Firing Output	Not Used
1-5	5	Receiver Input	Firing Output / Receiver Input
2-5	5	Firing Output	Not Used
1-6	6	Receiver Input	Firing Output / Receiver Input
2-6	6	Firing Output	Not Used
1-7	7	Receiver Input	Firing Output / Receiver Input
2-7	7	Firing Output	Not Used
1-8	8	Receiver Input	Firing Output / Receiver Input
2-8	8	Firing Output	Not Used


LAN Port
sVGA Output
2 × USB


Battery Plug - In Connector
Power Switch
Screen Brightness Control
Incremental Encoder Port
POWER
ENCODER
DC IN
DC Supply Voltage Input 11…16V
Threaded Holes for Battery Fitting

4.3. Turning On / Off

ISONIC 2009 UPA Scope may be powered from:

- 100…250 VAC through external AC/DC converter
- External 11…16V DC source (12V – typical)
- Rechargeable battery (optionally)

AC Power Supply

- ❑ Ensure that power switch is in **O** position before connecting power cords
- ❑ Connect one end of AC power cord to AC/DC converter and plug another end into AC mains
- ❑ Connect DC power cord with suppression filter outgoing from AC/DC converter to DC Supply Voltage Input of **ISONIC 2009 UPA Scope**

External DC Power Supply

- ❑ Ensure DC mains do supply voltage between 11 V and 16 V
- ❑ Ensure that power switch is in **O** position before connecting power cord
- ❑ Connect one end of DC power cord with suppression filter to DC Supply Voltage Input of **ISONIC 2009 UPA Scope** and plug another end into DC mains

Battery

- ❑ Ensure that power switch is in **O** position
- ❑ Plug in battery and fix it using 4 screws

Power-Up and Turn Off

To Power-Up **ISONIC 2009 UPA Scope** set power switch into **I** position. An automatic system test program will then be executed; during this test various texts and information appear followed by the screen as below while booting up

Wait until **ISONIC 2009 UPA Scope Start Screen** becomes active automatically upon boot up is completed

Click on 

or press **F1** to run PA modality – refer to Chapter 5 of this Operating Manual

Click on 

or press **F2** to operate instruments with conventional and TOFD probes – refer to Chapter 6 of this Operating Manual

Click on 

or press **F3** to proceed with Windows XP Embedded settings of **ISONIC 2009 UPA-Scope** instrument, such as for example setting up drivers for external devices (printers, USB memory card, and the like), connecting to LAN, quasi-disk management, etc – refer to paragraph 8.4 of this Operating Manual

To turn **ISONIC 2009** off click on 

or press **F4** then wait until the screen as below appears:

Set power switch into **O** position upon

ⓘ

After turning **ISONIC 2009 UPA-Scope OFF** wait at least 10…30 seconds before switching it **ON** again

5. PA Modality

5.1. PA Modality Start Menu

The screen as below appears on selecting to run **ISONIC 2009 UPA Scope** in PA modality

Click on  or press **F1** to start operation

Click on  or press **F2** to proceed with instrument settings

Click on  or press **F3** to open instrument's explorer allowing uploading of all setup and inspection files captured while running PA modality

Click on  or press **F4** or **Esc** to return to **ISONIC 2009 UPA-Scope Start Screen**

5.2. Standard and Optional Modes Of Operation

The following screen appears upon clicking on 

in the PA modality start menu as per paragraph 5.1 of this Operating Manual):

Click on 

or press **F1** to run PA modality with use of linear array probes mounted onto wedges in standard modes featuring each instrument

Click on 

or press **F2** to run PA modality with use of linear array probes mounted onto straight delay lines or applied directly to the object under test in standard modes featuring each instrument

Click on 

or press **F3** to run PA modality with use of various PA probes (linear and matrix arrays) in combination with wedges or delay lines in accordance with optional modes, which may vary from instrument to instrument

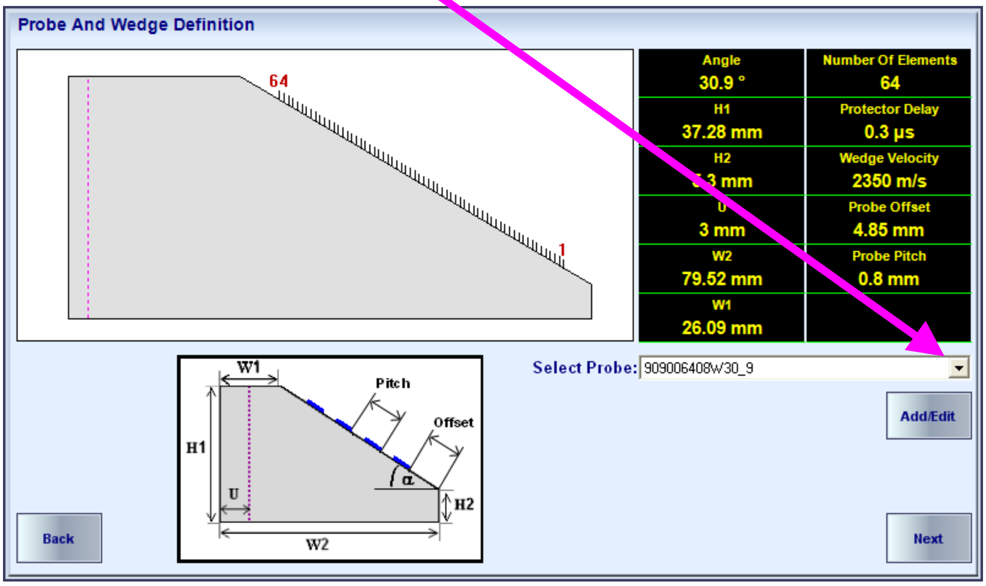
Click on 

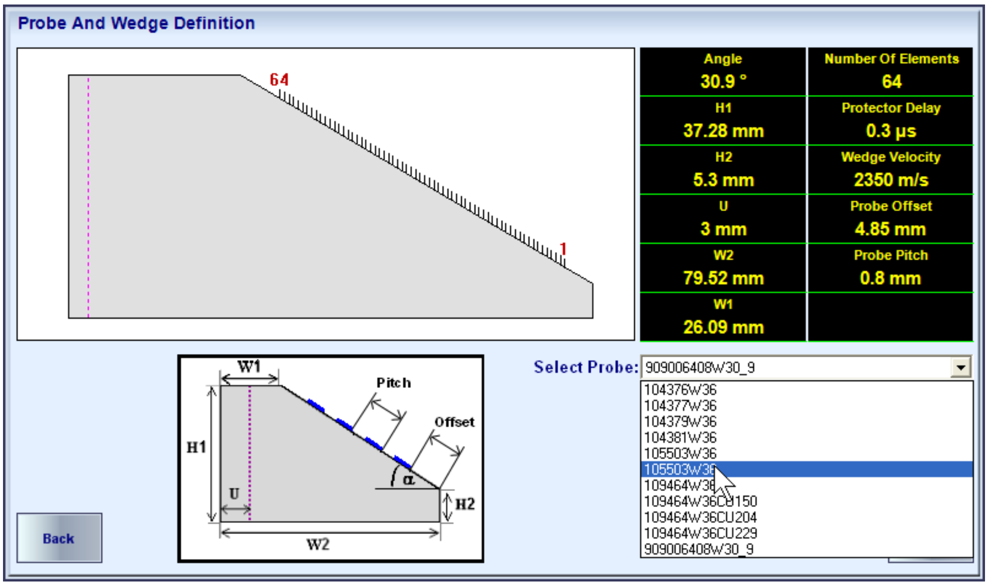
or press **F4** or **Esc** to return to PA modality start menu

5.3. Wedged Linear Array Probes – Standard Modes of Operation

5.3.1. Wedged Linear Array Probes Database

It is necessary to define new wedged linear array probe or select an existing one in the instrument's database for further operation. To proceed click on. On completion click on **Next** or press **Shift** + **Enter**

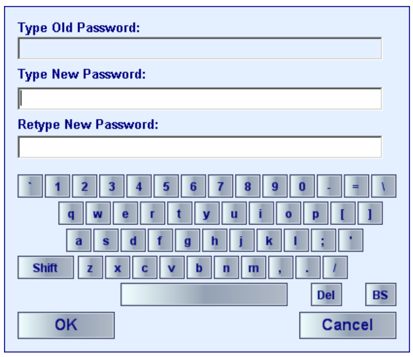




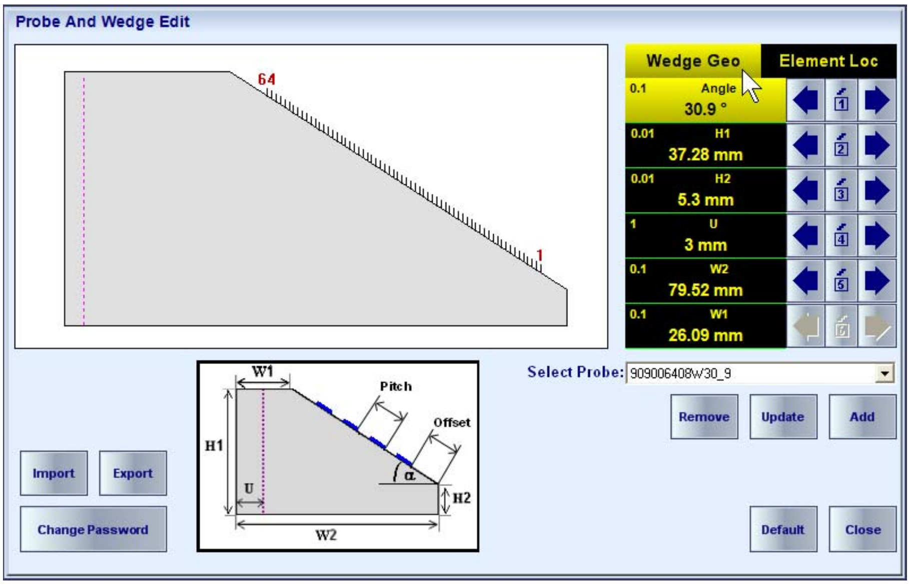
To return to the Modes of Operation Menu for PA modality click on **Back** or press **Esc**

To enter new probe into the database of modifying data about existing mode click on **Add/Edit**. This operation is password protected - for the first time new password to be entered by the supervisor so the contents of the database will not be affected unexpectedly in the future

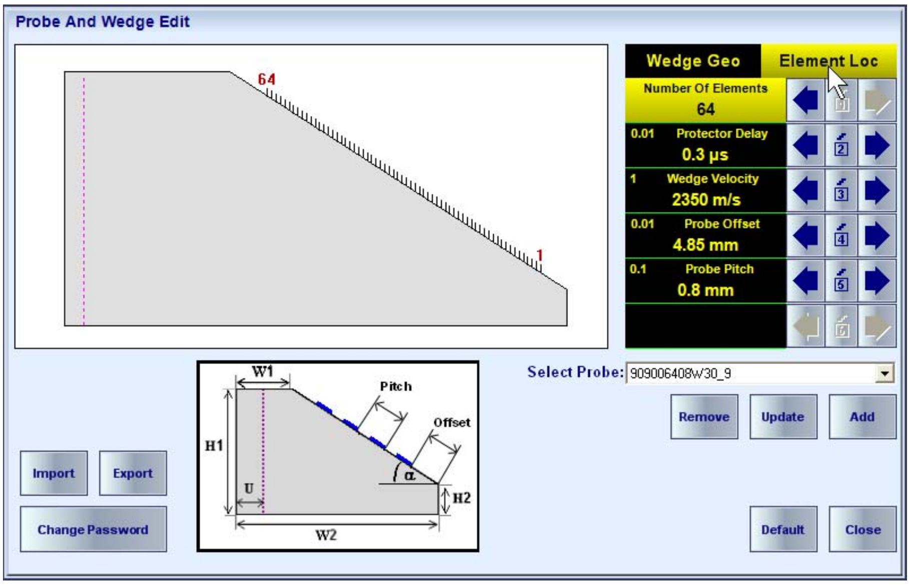
For keying in password it may be used either top panel or virtual keyboard generated on the instrument's screen



There are 2 groups of parameters to be defined for each probe / wedge, namely **Wedge Geo**metry



and **Element Loc**ation, to select a group for keying in / modifying click on it's name



For most of the parameters their meaning is obviously clear from the sketch indicated on the instrument's screen; among them there are just two parameters requiring more explanation:

- α – is designation of **Angle** (Wedge Angle)
- **U** – is part of the wedge that may not be used for forming ultrasonic field in the material, for example protective metallic shield on the front surface of the wedge

To modify / key in parameter value refer to paragraph 5.3.2 of this Operating Manual

Other controls:

- 

– export probes database from instrument into a file
- 

– import of probes database into instrument from a file
- 

– managing passwords for authorized access to database entries

- Remove – remove probe data from the database
- Default – call up the factory default to start with for newly entered probe data
- Add – add new probe's data to database (new name to be keyed in first upon clicking on that button)
- Update – confirming modified data for the probe existing in the database (probe name to be confirmed)

To return to previous **Probe and Wedge Definition** screen click on Close or press **Esc**

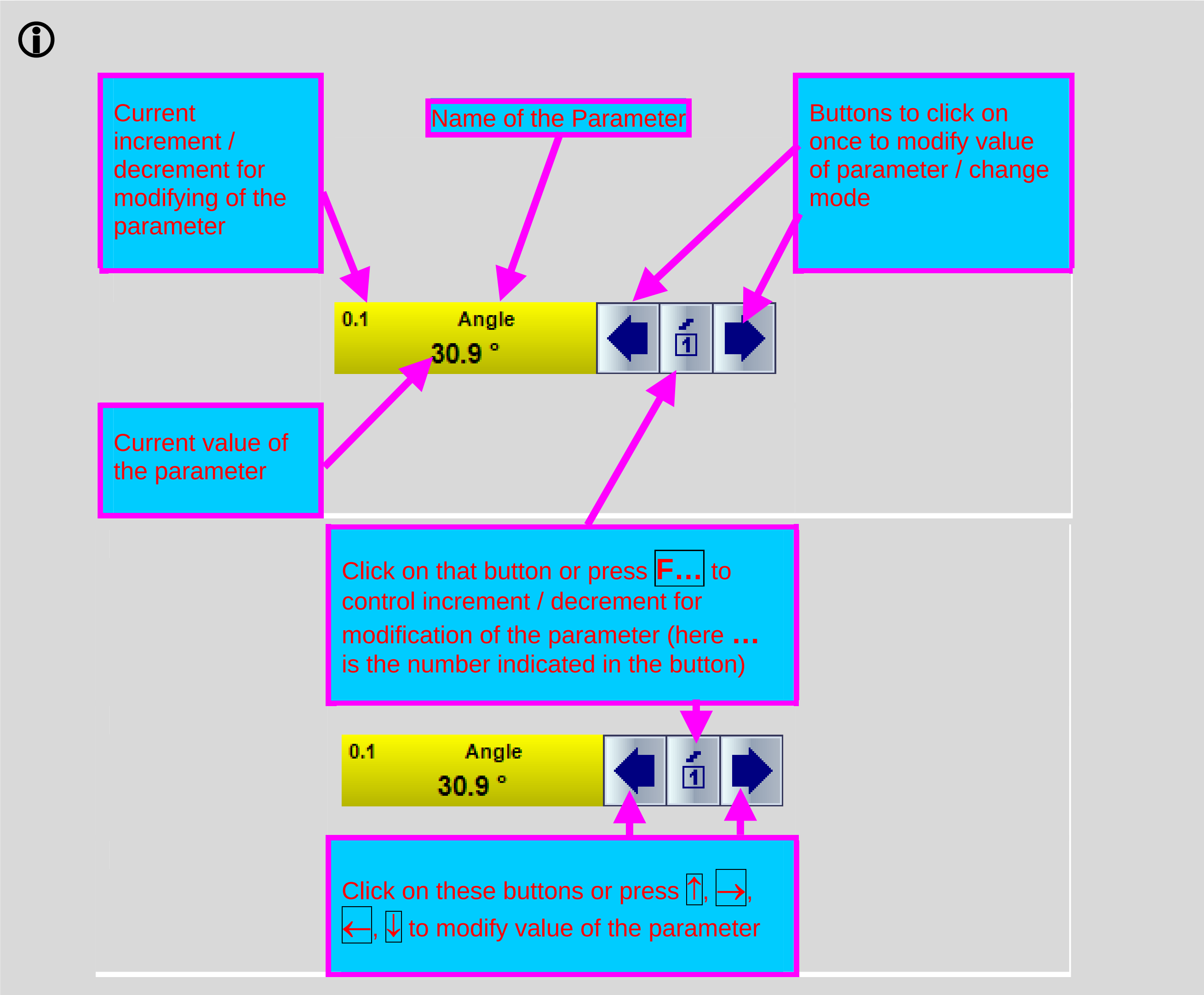
Typical linear array probes and corresponding wedges are listed below

#	*Item*	*Order Code (Part ##)*	*Note*
1	**PA-2M8E1P** - LINEAR ARRAY Frequency: **2 MHz** Pitch Size: **1 mm** Number of Elements: **8** Elevation: **9 mm**	S 4922104376	Mark on the probe 104376
2	**PA-4M16E0.5P** - LINEAR ARRAY Frequency: **4 MHz** Pitch Size: **0.5 mm** Number of Elements: **16** Elevation: **9 mm**	S 4922104377	Mark on the probe 104377
3	**VKPA-8/16** - 36° wedge (55° central angle for shear wave in low carbon steel) for S 4922104376 and S 4922104377 probes	S 4922104378	Suitable for flat surfaces and curved surfaces with OD ≥ 1000 mm Linear array probes equipped with that wedge are defined in the instrument database as ☐ 104378W36 ☐ 104377W36
4	**VKPA-8/16 CU XXX** - 36° wedge (55° central angle for shear wave in low carbon steel) - axially contoured for XXX mm OD /// for S 4922104376 and S 4922104377 probes	S 4922104378 CU XXX	Suitable for OD < 1000 mm Linear array probes equipped with that wedge are defined in the instrument database as ☐ 104378W36CUxxx ☐ 104377W36 CUxxx whereas xxx is OD expressed in mm
5	**PA-5M32E0.5P** - LINEAR ARRAY Frequency: **5 MHz** Pitch Size: **0.5 mm** Number of Elements: **32** Width (Elevation): **10 mm**	S 4922104379	Mark on the probe 104379
6	**PA-5M16E1P** - LINEAR ARRAY Frequency: **5 MHz** Pitch Size: **1 mm** Number of Elements: **16** Elevation: **10 mm**	S4922105503	Mark on the probe 105503
7	**PA-7.5M32E0.5P** - LINEAR ARRAY Frequency: **7.5 MHz** Pitch Size: **0.5 mm** Number of Elements: **32** Elevation: **10 mm**	S 4944109464	Mark on the probe 109464
8	**VKPA-32** - 36° wedge (55° central angle for shear wave in low carbon steel) for S 4922104379, S4922105503, and S 4944109464 probes	S 4922104380	Suitable for flat surfaces and curved surfaces with OD ≥ 1000 mm Linear array probes equipped with that wedge are defined in the instrument database as ☐ 104379W36 ☐ 105503W36 ☐ 109464W36
9	**VKPA-32 CU XXX** - 36° wedge (55° central angle for shear wave in low carbon steel) – axially contoured for XXX mm OD /// for S 4922104379, S4922105503, and S 4944109464 probes	S 4922104380 CU XXX	Suitable for OD < 1000 mm Linear array probes equipped with that wedge are defined in the instrument database as ☐ 104379W36CUxxx ☐ 105503W36CUxxx ☐ 109464W36CUxxx whereas xxx is OD expressed in mm

#	*Item*	*Order Code (Part ##)*	*Note*
10	**PA-5M64E1P** - LINEAR ARRAY Frequency: **5 MHz** Pitch Size: **1 mm** Number of Elements: **64** Width: **10 mm**	S 4922104381	Mark on the probe 104381
11	**VKPA-64** - 36° wedge (55° central angle for shear wave in low carbon steel) for S 4922104381 probe	S 4922705119	Suitable for flat surfaces and curved surfaces with OD ≥ 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 104381W36
12	**VKPA-64 CU XXX** - 36° wedge - 36° wedge (55° central angle for shear wave in low carbon steel) – axially contoured for XXXX mm OD /// for S 4922104381 probe	S 4922705119 CU XXXX	Suitable for OD < 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 104381W36CUxxx whereas xxx is OD expressed in mm
13	**PA-2.25M16E1P** - LINEAR ARRAY Frequency: **2.25 MHz** Pitch Size: **1 mm** Number of Elements: **16** Elevation: **13 mm**	S 4922105504	Mark on the probe 105504
14	**VKPA-16/1** - 36° wedge (55° central angle for shear wave in low carbon steel) for S 4922105504 probe	S 4922104679	Suitable for flat surfaces and curved surfaces with OD ≥ 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 105504W36
15	**VKPA-16/1 CU XXX** - 36° wedge (55° central angle for shear wave in low carbon steel) – axially contoured for XXX mm OD /// for S 4922105504 probe	S 4922104679 CU XXX	Suitable for OD < 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 105504W36CUxxx whereas xxx is OD expressed in mm
16	**PA-2.25M16E1.5P** - LINEAR ARRAY Frequency: **2.25 MHz** Pitch Size: **1.5 mm** Number of Elements: **16** Elevation: **19 mm**	S 4922105505	Mark on the probe 105505
17	**VKPA-16/1.5** - 36° wedge (55° central angle for shear wave in low carbon steel) for S 4922105505 probe	S 4922104680	Suitable for flat surfaces and curved surfaces with OD ≥ 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 105505W36
18	**VKPA-16/1.5 CU XXX** - 36° wedge (55° central angle for shear wave in low carbon steel) – axially contoured for XXX mm OD /// for S 4922105505 probe	S 4922104680 CU XXX	Suitable for OD < 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 105505W36CUxxx whereas xxx is OD expressed in mm

#	Item	Order Code (Part ##)	Note
19	**PA-1.5M16E1P** - LINEAR ARRAY Frequency: **1.5 MHz** Pitch Size: **1 mm** Number of Elements: **16** Elevation: **12 mm**	S 4922107553	Mark on the probe 107553
20	**VPKA-38-16-1-21** - 38° wedge (59° central angle for shear wave in low carbon steel) for S 4922107553 probe	S 4944262021	Suitable for flat surfaces and curved surfaces with OD ≥ 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 107553W39-21
21	**VPKA-38-16-1-12** - 38° wedge (59° central angle for shear wave in low carbon steel) for S 4922107553 probe	S 4944262012	Suitable for flat surfaces and curved surfaces with OD ≥ 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 107553W39-12
22	**VPKA-38-16-1-21 CU XXX** - 38° wedge (59° central angle for shear wave in low carbon steel) – axially contoured for XXX mm OD /// for S 4922107553 probe	S 4944262021 CU XXX	Suitable for OD < 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 107553W39-21CUxxx whereas xxx is OD expressed in mm
23	**VPKA-38-16-1-12 CU XXX** - 38° wedge (59° central angle for shear wave in low carbon steel) – axially contoured for XXX mm OD /// for S 4922107553 probe	S 4944262012 CU XXX	Suitable for OD < 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 107553W39-12CUxxx whereas xxx is OD expressed in mm

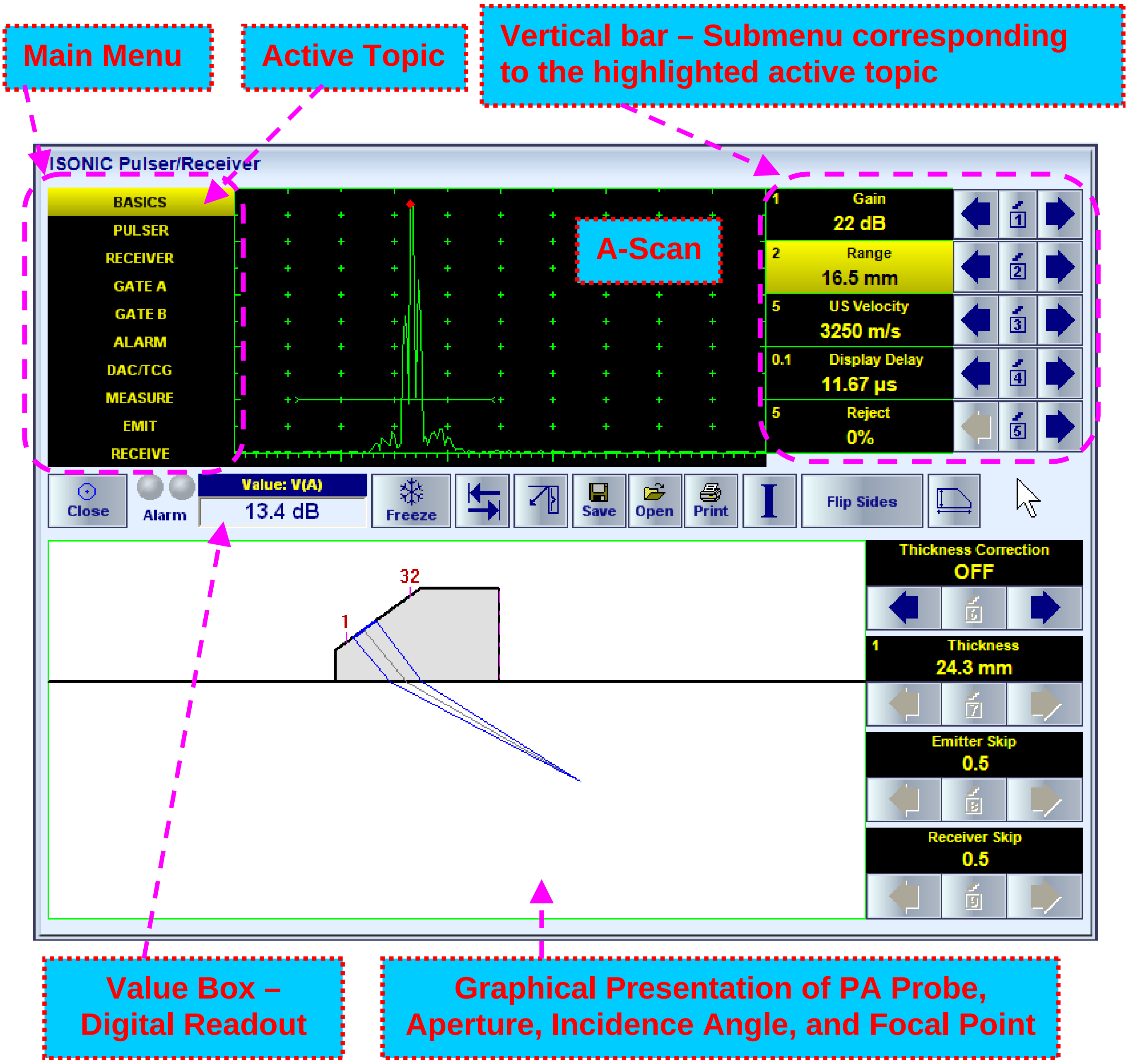
5.3.2. General Rule for Keying In / Modifying Parameter

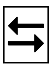


5.3.3. ISONIC PA Pulser Receiver – Wedged Linear Array Probes

5.3.3.1. Operating Surface

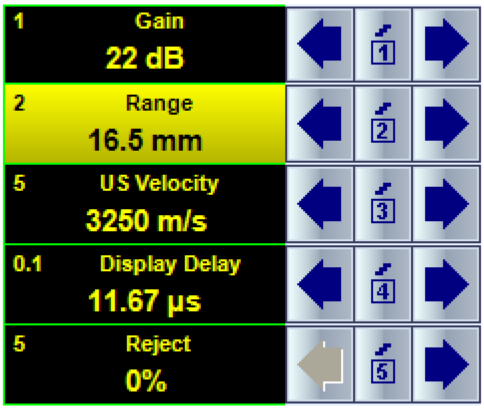
ISONIC 2009 UPA Scope comprises 64 identical pulser receiver channels, which may be used in any combination to form ultrasonic beams in the material and receive echoes with use of PA probes. Manual control is implemented through main operating SW, which is similar to the operating surface of Sonontron NDT's flaw detectors working with conventional and TOFD probes



The **Main Menu** consists of ten topics; each topic is associated with corresponding **submenu** appearing as vertical bar showing names for five parameters or modes of operation, their current settings and current value of increment/decrement for a parameter. The active topic is highlighted. To select a topic click on its name or on  or press 

To modify parameter or mode within the active topic proceed according to paragraph 5.3.2 of this Operating Manual

5.3.3.2. Sub Menu BASICS



All settings controllable through **BASICS** sub menu are typical for conventional ultrasonic flaw detector and have the same meaning for the PA modality. To modify the desired setting proceed according to paragraph 5.3.2 of this Operating Manual. Also please refer to the below notes

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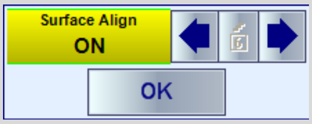
Gain and Range
Modifying of **Gain** and **Range** settings is also possible through a number of other submenus

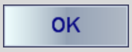
US Velocity
Like in regular ultrasonic flaw detectors (conventional modality) proper **US Velocity** setting is important for correct:

- A-Scan time base setting
- Automatic measurements of reflector coordinates

Whilst implementing PA modality proper **US Velocity** setting is additionally important for correct forming of focal laws for the emitting and receiving signals. Hence **US Velocity** to be keyed in precisely for the desired type of wave to be generated in the material and for the expectedly received signals

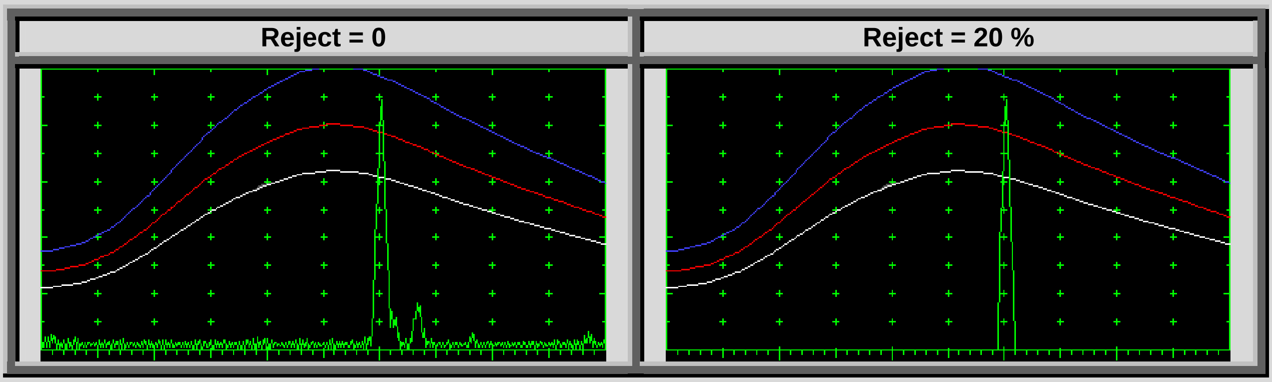
Display Delay
Display Delay may be controlled manually as in the regular ultrasonic flaw detector. However **Probe Delay** of PA probe is depending on plenty of factors such as emitting and receiving aperture and focal law to be implemented – refer to paragraphs 5.3.3.9, 5.3.3.10, and 5.3.3.11 of this Operating Manual. And for practical use very often it is important to equalize **Display Delay** and **Probe Delay** so start point of the A-Scan will correspond to the material surface. To activate / deactivate automatic performing of such equalizing (**Surface Align**) click on :



then click on  or  or press ↑, →, ←, ↓ then click on  or press **Enter** or **Esc**. Automatic **Surface Align** will be deactivated automatically upon performing manual modifying of **Display Delay**

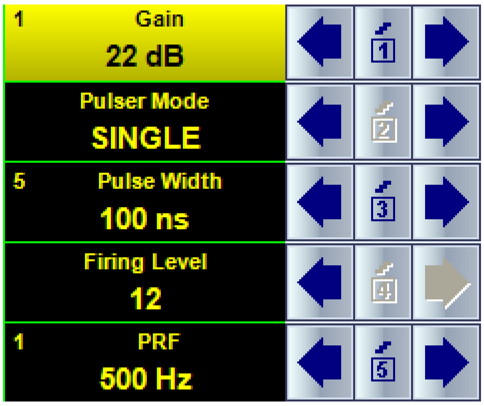
Reject

- Signals below **Reject** level (small signals) are suppressed
- Signals exceeding **Reject** level (large signals) are presented on the A-Scan without affecting their original height
- Part of large signal wave form below **Reject** level is suppressed



- **Reject** level may be applied to rectified signals only (Display Modes **Full**, **NegHalf** and **PosHalf** - refer to paragraph 5.3.3.4 of this Operating Manual)
- **Reject** setup is also possible through a number of other submenus following the same rules as above

5.3.3.3. Sub Menu PULSER



All settings controllable through **PULSER** sub menu are typical for conventional ultrasonic flaw detector and have the same meaning for the PA modality. To modify the desired setting proceed according to paragraph 5.3.2 of this Operating Manual. Also please refer to the below notes

ⓘ

Pulser Modes

There are two Pulser Modes available:

- **SINGLE** – for that mode emitting and receiving aperture within entire PA probe are fully matching; focal point, incidence angle, and type of wave for the receiving and emitting aperture are identical and controlled synchronously
- **DUAL** – for that mode emitting and receiving aperture within entire PA probe may be either fully matching or fully mismatching or partially matching; focal point, incidence angle, and type of wave are controlled separately

Refer to paragraphs 5.3.3.4 of this Operating Manual

Pulse Width

- **Pulse Width** (Duration of Half Wave of Bipolar Square Wave Initial Pulse) is tunable between 50 ns to 600 ns in 5 ns steps
- Durations of positive and negative half wave of the initial pulse are varying synchronously
- Attempt to decrease **Pulse Width** below 50 ns switches initial pulse OFF and channel may be used then as receiver only

Firing Level

There are 12 grades (1 through 12) for setting **Firing Level –** amplitude of initial pulse is controlled from 100 V peak to peak (**Firing Level = 1**) to 300 V peak to peak (**Firing Level = 12**)

PRF

PRF is indicated for single pulsing / receiving cycle (single focal law)

5.3.3.4. Sub Menus EMIT and RECEIVE

5.3.3.4.1. Definitions

Emitting **Aperture** – quantity of elements of linear array probe involved into emitting of ultrasonic wave

Receiving **Aperture** – quantity of elements of linear array probe involved into receiving of ultrasonic signals

Start – number of the first element of the emitting / receiving aperture

Focal Distance – material travel distance between incidence point and focal point

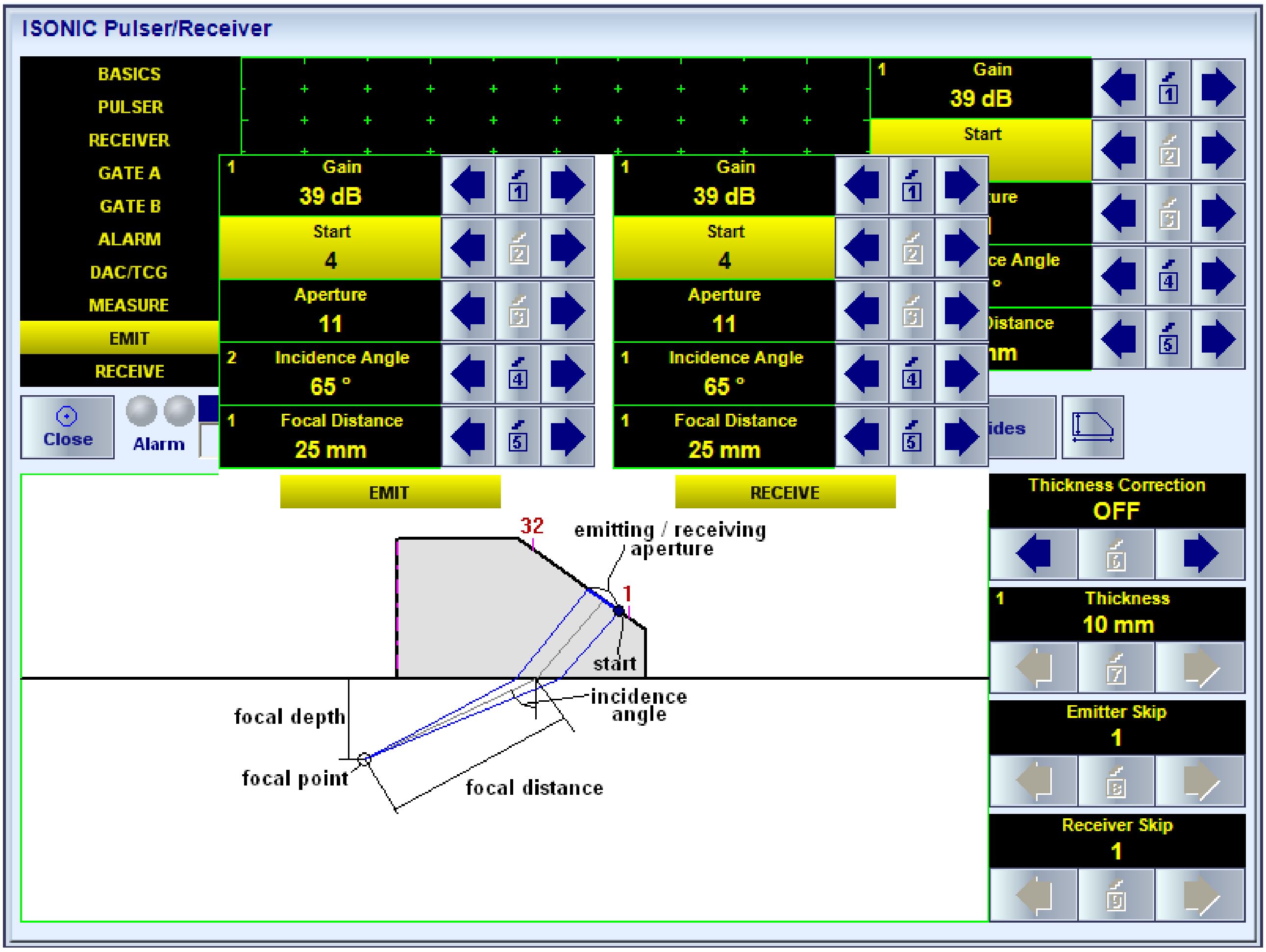
Focal Depth – depth of the focal point measured relatively contact surface of the material

Ultrasonic wave in the material is formed through superimposing of waves generated by all elements of the emitting aperture. The incidence angle and focal distance (depth) for the emitted ultrasonic wave are controlled electronically through phasing of initial pulses generated by the instrument on the elements of emitting aperture

Every element of the receiving aperture receives ultrasonic pulses from the material independently on others and converts them into electrical signals. Electrical signals from all elements of the receiving aperture are gained and digitized independently on each other then superimposed mathematically with use of digital phasing providing control of incidence angle and focal distance (depth) for the superimposed signal

5.3.3.4.2. Pulser Mode = SINGLE – Full Matching of Emitting and Receiving Aperture

For **Pulser Mode = SINGLE** emitting and receiving aperture within entire PA probe are fully matching; focal point, incidence angle, and type of wave for the receiving and emitting aperture are identical and controlled synchronously

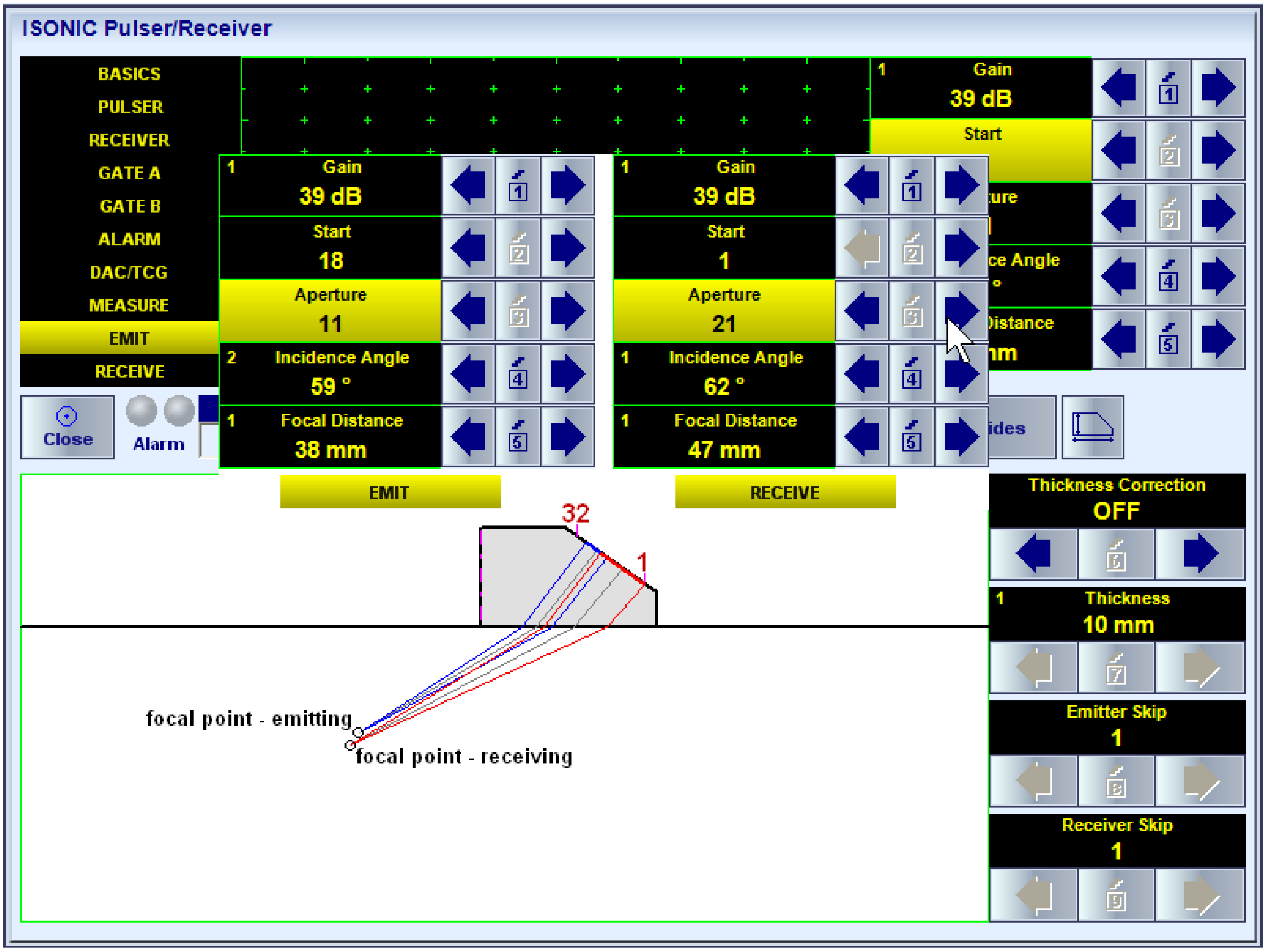


5.3.3.4.3. Pulser Mode = DUAL – Partial Matching of Emitting and Receiving Aperture

For **Pulser Mode = DUAL** emitting and receiving aperture within entire PA probe may be:

- fully matching
- fully mismatching
- partially matching

For all above the focal point, incidence angle, and type of wave are controlled separately separately from each other for the emitting and receiving aperture

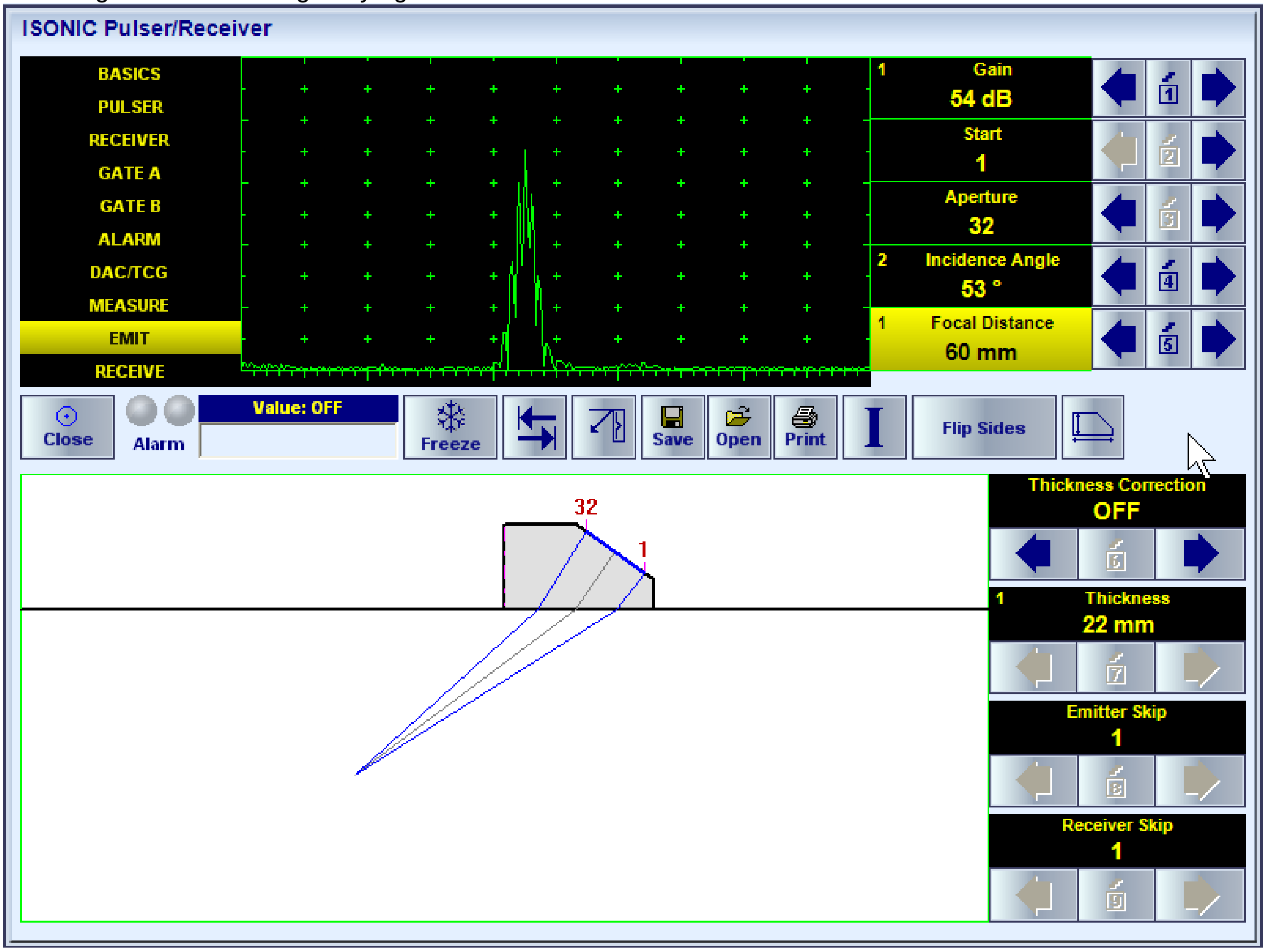


5.3.3.4.4. Material Thickness

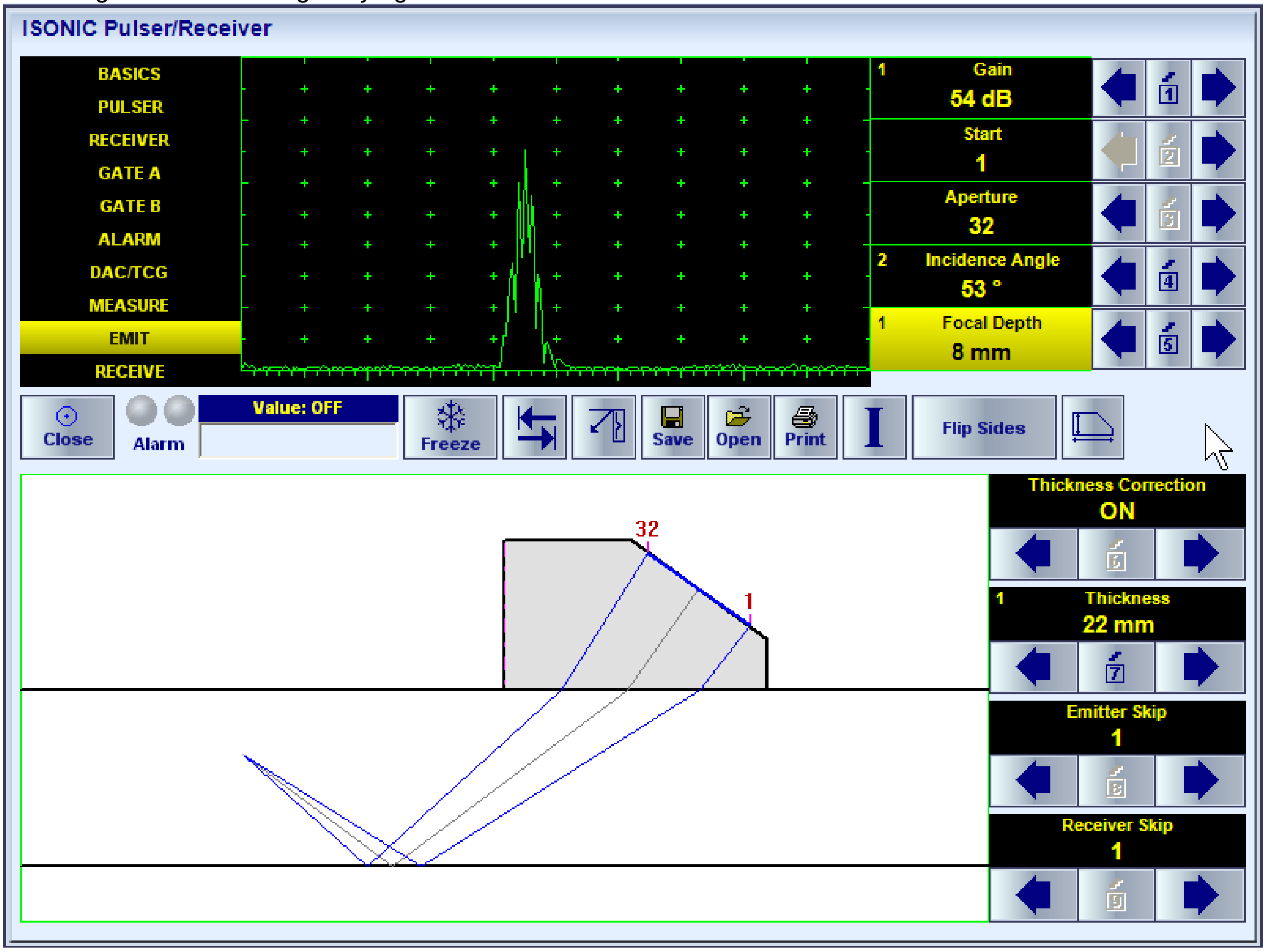
The are two modes of pulsing / receiving – with (**Thickness Correction = ON**) and without (**Thickness Correction = OFF**) considering thickness of the material

Thickness Correction = OFF	Thickness Correction = ON
Parameter of focusing is **Focal Distance**: For the given **Focal Distance** varying of incidence angle will cause varying of **Focal Depth** – refer to paragraph 5.3.3.4.1 of this Operating Manual	Parameter of focusing is **Focal Depth**: For the given **Focal Depth** varying of incidence angle will cause varying of **Focal Distance** – refer to paragraph 5.3.3.4.1 of this Operating Manual; i.e. focusing is performed along horizontal line parallel to the contact surface of the material
Imaging of the ultrasonic beam is implemented as for semi-finite space, the reflections from the walls are ignored	Imaging of the ultrasonic beam is implemented through considering of **Skips**, **Incidence Angle**, and material **Thickness**

Thickness Correction = OFF
Parameters **Thickness**, **Emitter Skip**, **Receiver Skip** ignored
Focusing is defined through keying in **Focal Distance**

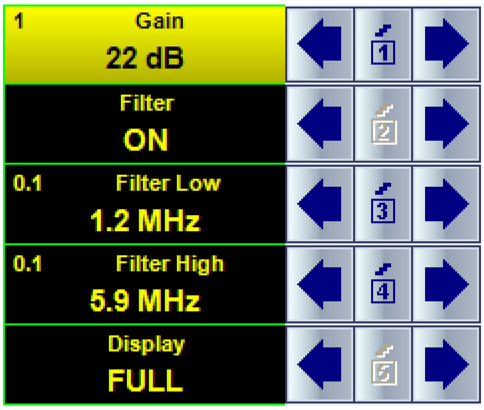


Thickness Correction = ON
Parameters **Thickness**, **Emitter Skip**, **Receiver Skip** are considered
Focusing is defined through keying in **Focal Distance**



To modify the desired setting (**Thickness Correction**, **Thickness**, **Emitter Skip**, **Receiver Skip**) proceed according to paragraph 5.3.2 of this Operating Manual. Also please refer to the below notes

5.3.3.5. Sub Menu RECEIVER

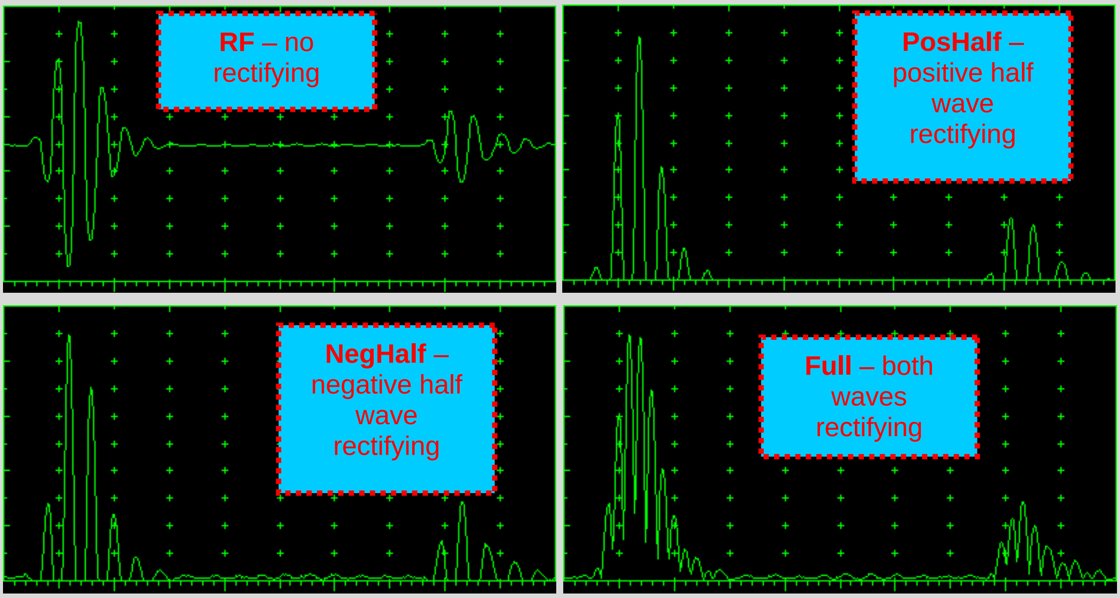


All settings controllable through **RECEIVER** sub menu are typical for conventional ultrasonic flaw detector and have the same meaning for the PA modality. To modify the desired setting proceed according to paragraph 5.3.2 of this Operating Manual. Also please refer to the below notes

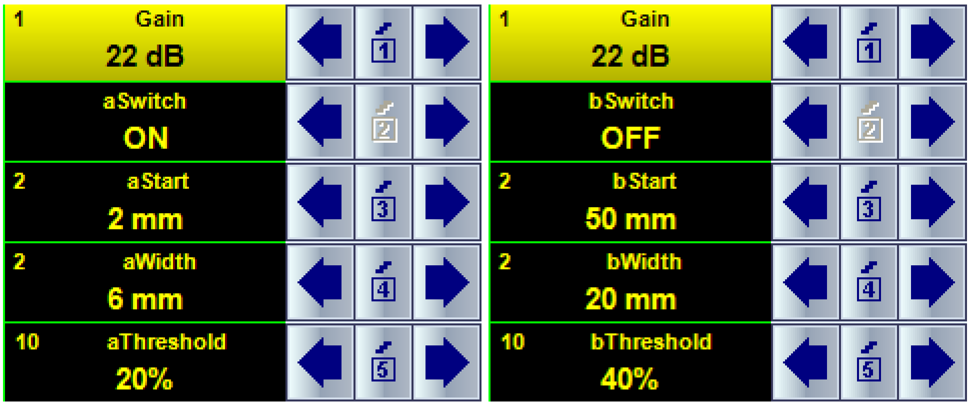
ⓘ

<u>**Display Mode**</u>

There are four **Display modes** for *time domain signal presentation*:



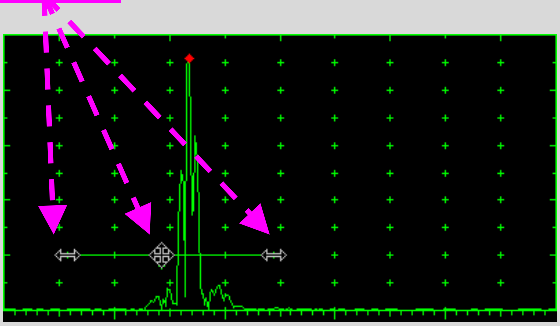
5.3.3.6. Sub Menus GATE A and GATE B



All settings controllable through **GATE A** and **GATE A** sub menus are typical for conventional ultrasonic flaw detector and have the same meaning for the PA modality. To modify the desired setting proceed according to paragraph 5.3.2 of this Operating Manual. Also please refer to the below notes

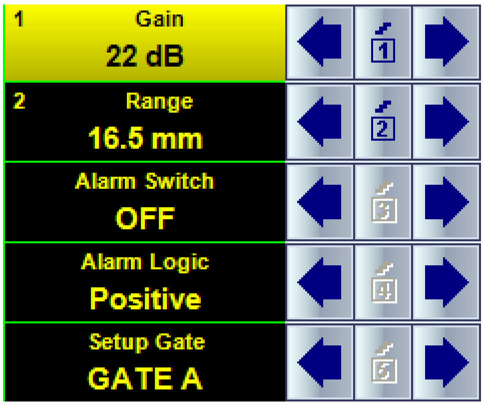
ⓘ

- **aStart** setup is also possible through a number of other submenus following the same rules as above
- Counting of **aStart** value starts after completing count of **Probe Delay** – refer to paragraphs 5.2.12 and 5.2.13 of this Operating Manual
- Counting of **bStart** value starts after finishing of **Probe Delay** count (refer to paragraph 5.2.12 and 5.2.13 of this Operating Manual)
- **Gates A** and **B** may be manipulated through **Drag and Drop** provided that they are visible in the **A-Scan** area. Mouse pointer changes shape upon placing it above appropriate part of the gate



To control gate press and hold left mouse button or touch screen with stylus the and drag and drop through releasing of left mouse button or touch screen stylus

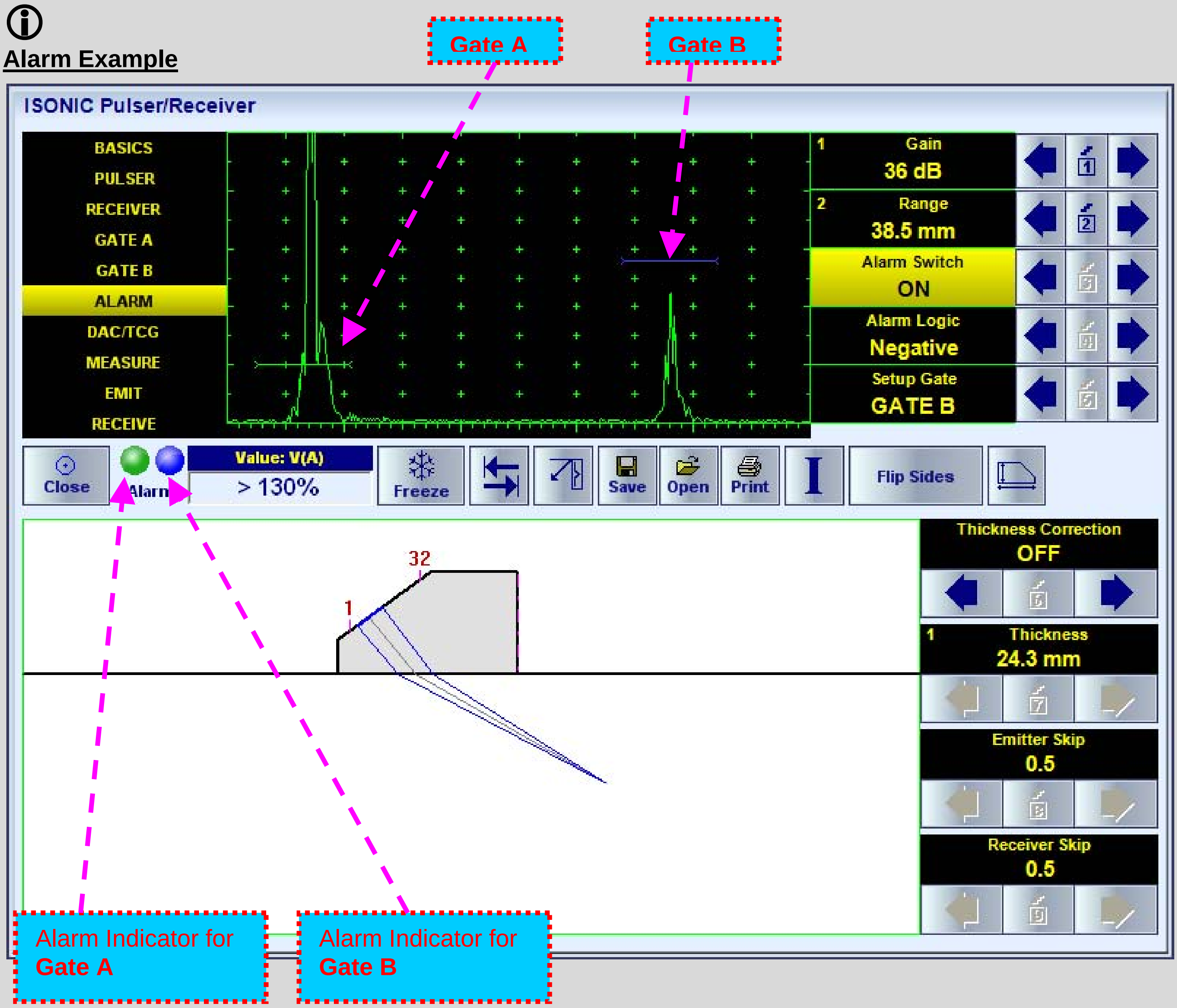
5.3.3.7. Sub Menu ALARM



All settings controllable through **ALARM** sub menu are typical for conventional ultrasonic flaw detector and have the same meaning for the PA modality. To modify the desired setting proceed according to paragraph 5.3.2 of this Operating Manual. Also please refer to the below notes

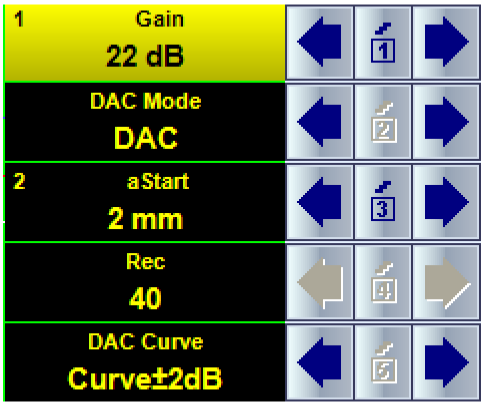
ⓘ

Alarm Example



- There is a pulse matching with **Gate A** and exceeding its threshold; the **Alarm Logic** setting for **Gate A** is **Positive** ⇒ **Alarm Indicator** for **Gate A** is active
- There is a pulse matching with **Gate B** and not exceeding its threshold; the **Alarm Logic** setting for **Gate B** is **Negative** ⇒ **Alarm Indicator** for the **Gate B** is active

5.3.3.8. Sub Menu DAC/TCG



All settings controllable through **DAC/TCG** sub menu are typical for conventional ultrasonic flaw detector and have the same meaning for the PA modality. To modify the desired setting proceed according to paragraph 5.3.2 of this Operating Manual. Also please refer to the below notes

ⓘ

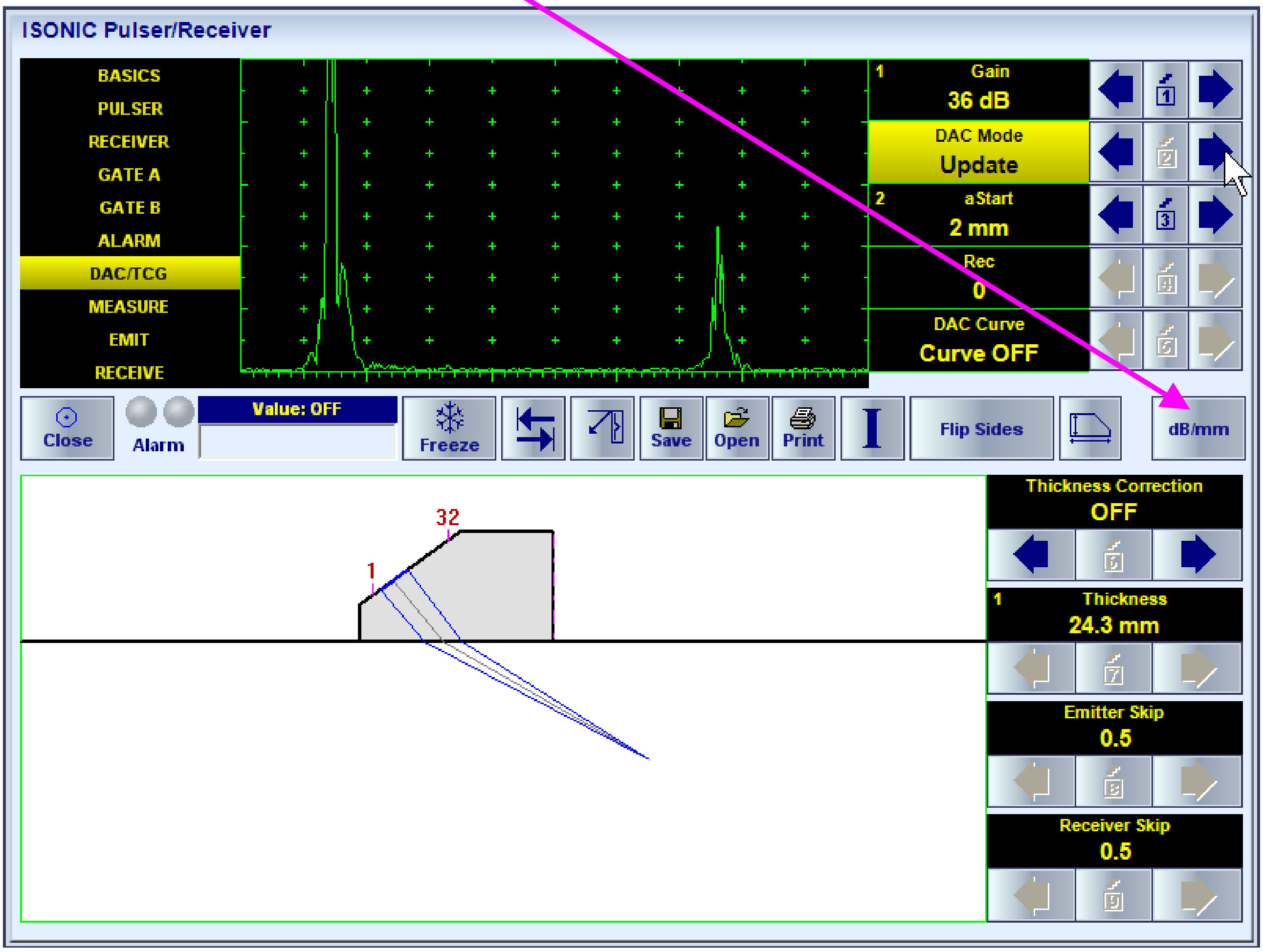
- There are four possible modes for **DAC/TCG**:
  - There are four possible modes for **DAC/TCG**:
    - **OFF** - **DAC Curve** switches automatically to **OFF** while in **OFF**
    - **DAC** - available if quantity of stored echoes is 2 (two) or more. **DAC Curve** switches automatically to **ON** while in **DAC** mode. Both experimental and theoretical methods for creating **DAC** are available
    - **TCG** - available if quantity of stored echoes is 2 (two) or more. **DAC Curve** switches automatically to **OFF** while in **TCG** mode
    - **Update** - allows to create/update new/existing **DAC**. **Update** of existing **DAC** performed through erasing of a number of sequentially recorded echoes, starting from the latest one, and/or recording of new echoes. The maximal number of echoes recorded into the one **DAC** is 40 (forty). **DAC Curve** switches automatically to **ON** if the number of recorded echoes is 2 (two) or more and switches automatically to **OFF** if number of recorded echoes is less than 2 (two) while in **Update** mode
- It is possible to Create / Modify / Activate **DAC** and **TCG** for all **Display** modes (**RF**, **Full**, **Negative**, and **Positive**)
- To create / modify **DAC/TCG** refer to paragraph 5.3.3.8 of this Operating Manual

5.3.3.9. Create / Modify DAC

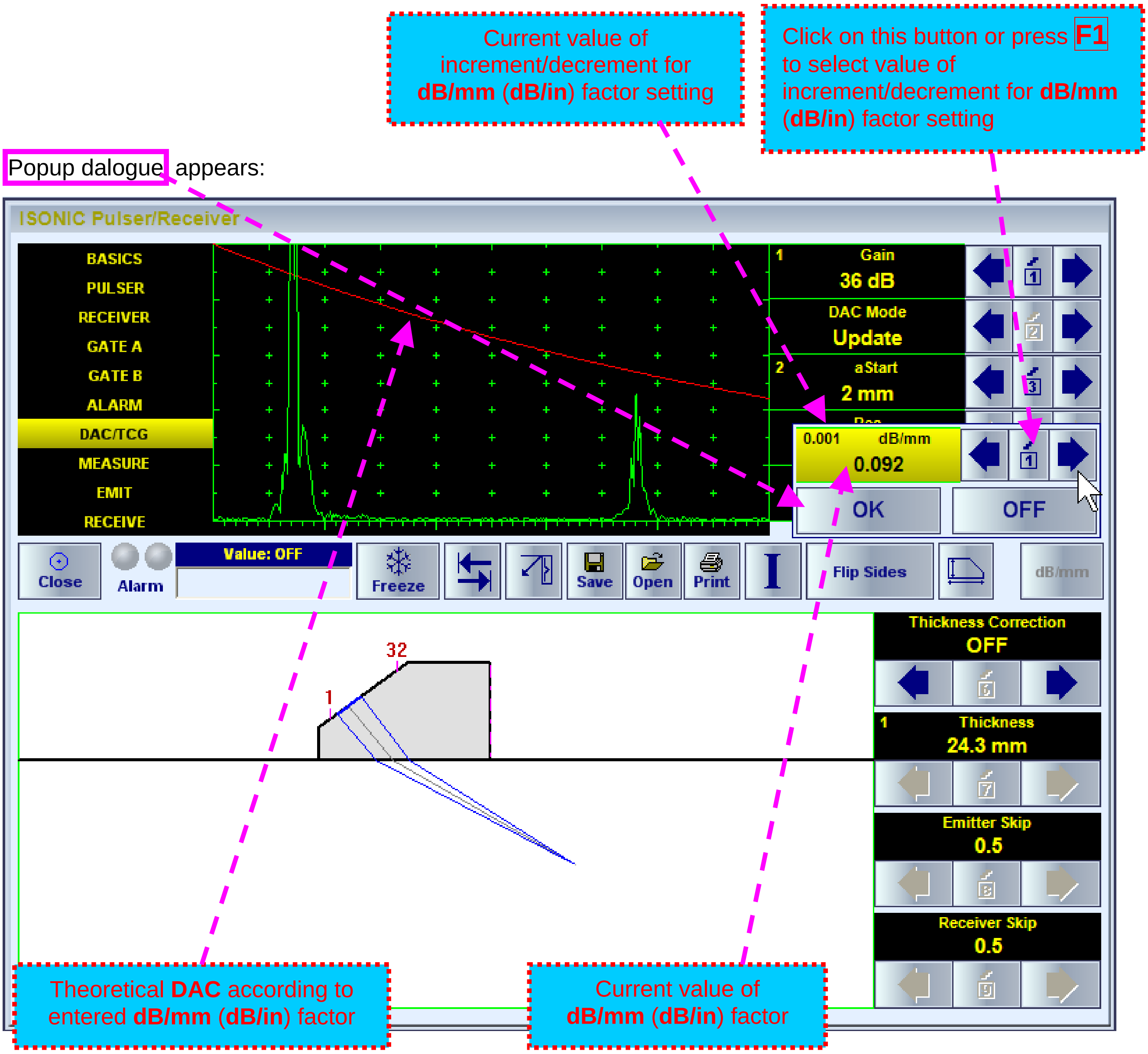
5.3.3.9.1 Theoretical DAC: dB/mm (dB/in)

Theoretical **DAC** represents exponential law for distance amplitude curve determined by **dB/mm** (**dB/in**) factor applied to pure material travel distance. The start point of **DAC** is contact surface and at that point DAC starts at 100% of A-Scan height. Theoretical **DAC** count starts immediately upon completion of **Probe Delay** count – refer to paragraphs 5.3.3.9 of this Operating Manual

Set **DAC/TCG/DGS** to **Update** then click on



Popup dalogue appears:



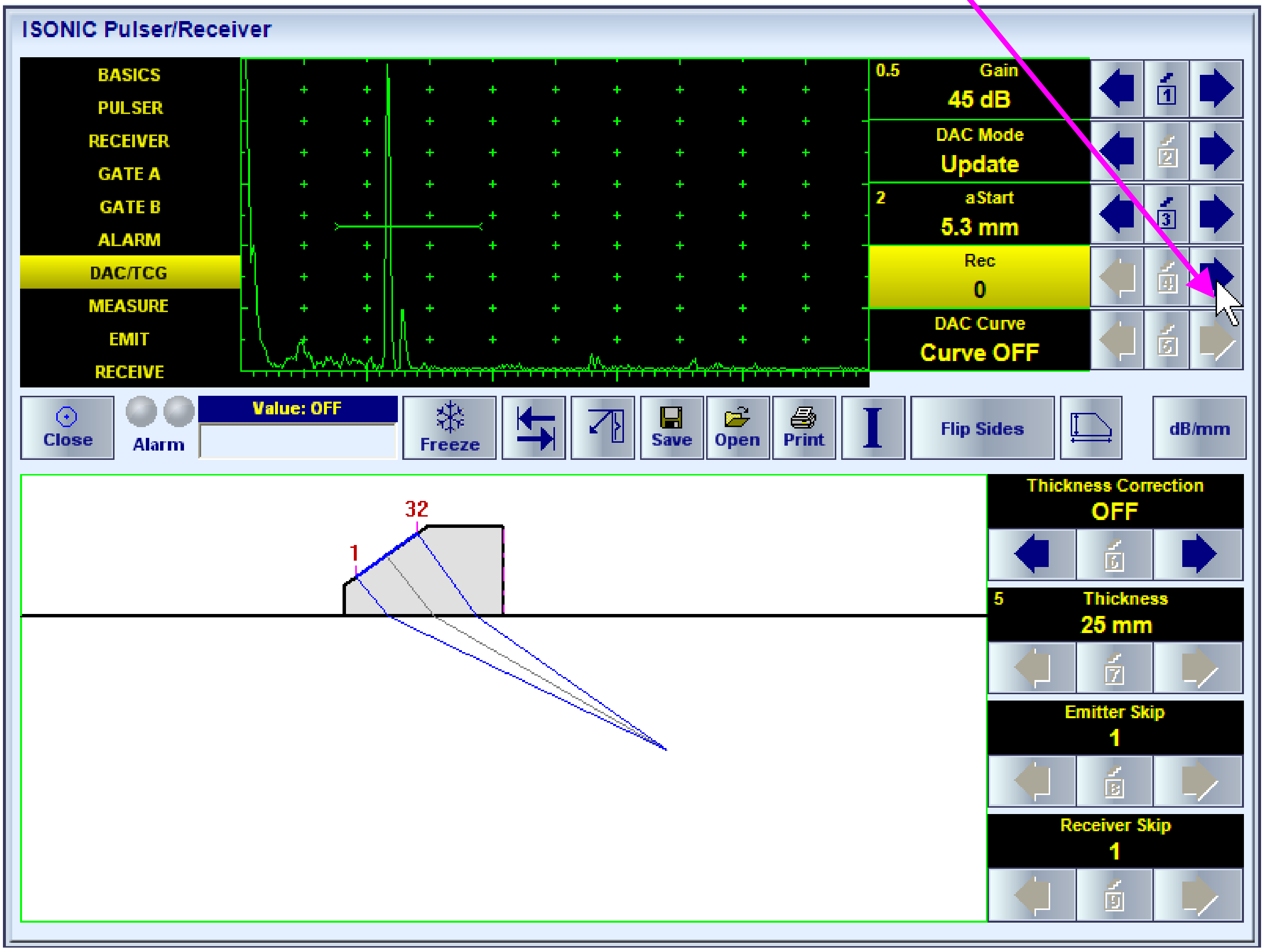
To control **dB/mm** (**dB/in**) factor click on [◄] or [►] or press ↑, →, ←, ↓ then click on [OK] or press **Enter** of **Esc**. This will return to main operating surface and activate theoretical **DAC**. Button [dB/mm] obtains dark gray color upon while theoretical **DAC** setup is completed

Set **DAC/TCG/DGS** to **DAC** to activate theoretical **DAC** or to **TCG** if it is necessary to perform time correction of gain in accordance with exponential law

To modify or switch theoretical **DAC** off set **DAC/TCG/DGS** to **Update** then click on [dB/mm]. In the appeared popup dialogue set new value for **dB/mm** (**dB/in**) factor or click on [OFF]. On completion click on [OK] or press **Enter** of **Esc**

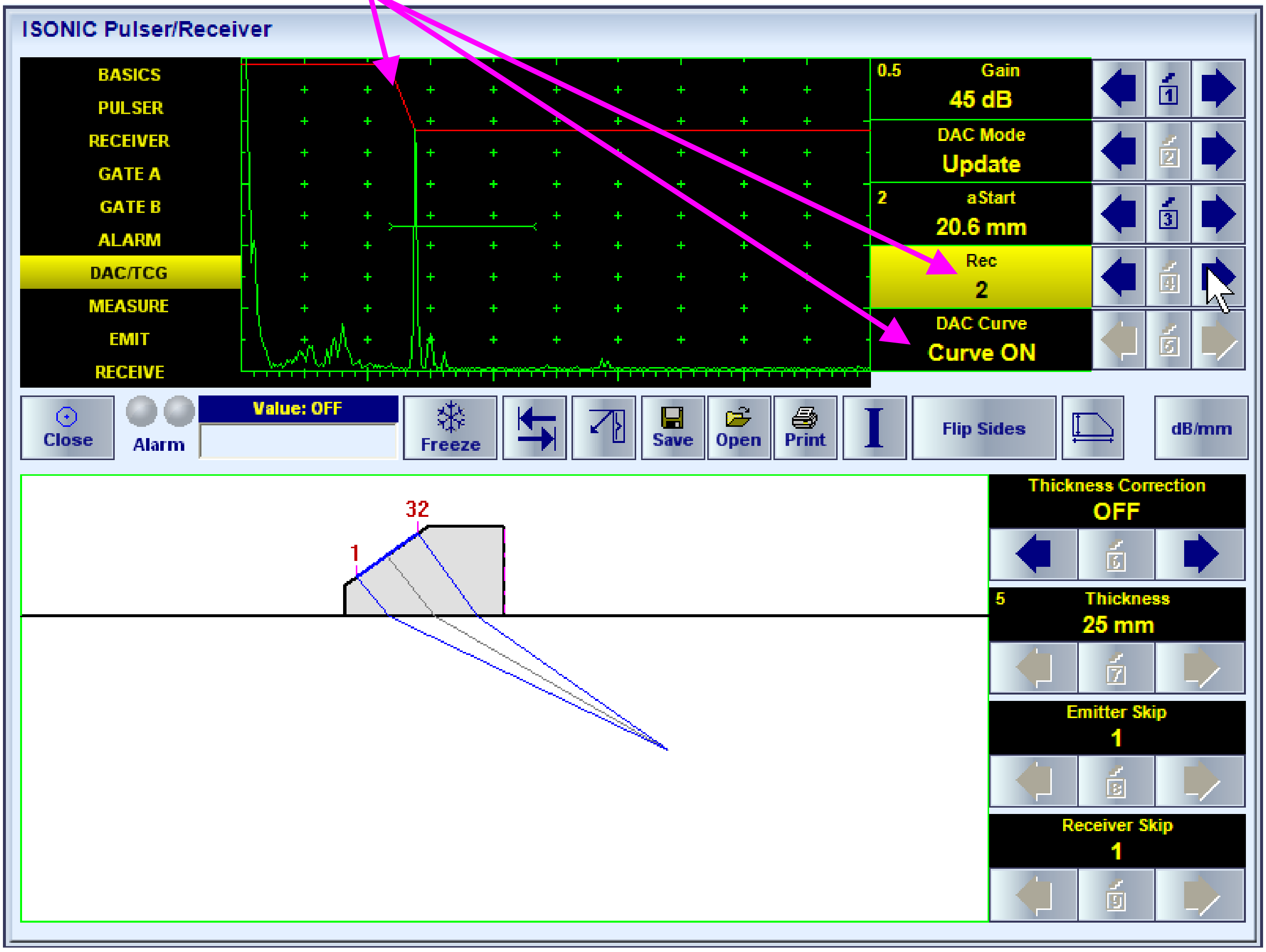
5.3.3.9.2 Experimental DAC: Recording Signals From Variously Located Reflectors

Prior to building experimental **DAC** switch theoretical **DAC** off and **Gate A** on. Set **DAC/TCG** to **Update**. Place probe onto **DAC** calibration block and maximize echo from the reflector closest to the probe (first echo) then place **Gate A** over received signal and capture first *DAC echo* through click on or press or ↑, →

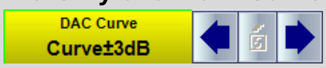


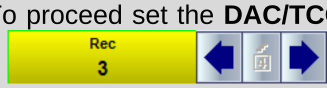
As a result the *first DAC echo* will be stored accompanied with corresponding indication: 

Place probe onto DAC calibration block and maximize echo from next reflector then place **Gate A** over received signal and capture *next DAC echo.* As result next *DAC echo* will be stored causing appropriate modifying of corresponding indications

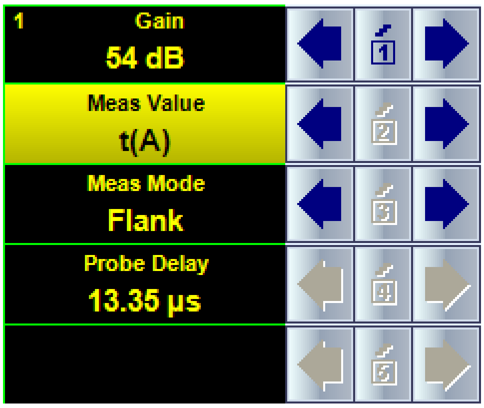


ⓘ

- The highest echo in the **Gate A** will be stored said echo may either exceed **Gate A** threshold level or not
- Stored echo must be below 100% of **A-Scan** height
- A total number of 40 echoes may be stored one by one by the same way as described above
- After creating a **DAC** (2 or more echoes stored) the **DAC** and / or **TCG** may be activated
- There are two styles of **DAC** indication in the **DAC** mode: **Main Curve Only** and **Main Curve ± N dB**, where **N** may be setup between ±1 and ±14 dB with 1 dB increment: 

- It's possible to erase the last stored echo from the **DAC**. To proceed set the **DAC/TCG** to **Update** and switch on **Gate A** then click on click on  or press ←, ↓ : 

5.3.3.10. Sub Menu MEASURE



All settings controllable through **MEASURE** sub menu are typical for conventional ultrasonic flaw detector and have the same meaning for the PA modality. To modify the desired setting proceed according to paragraph 5.3.2 of this Operating Manual. Also please refer to the below notes

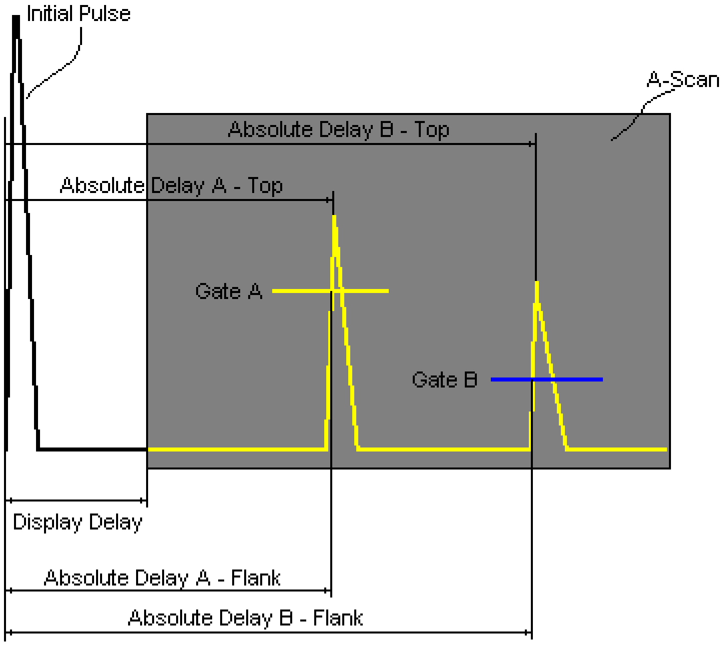
ⓘ

- Refer to paragraph 5.3.3.11 of this Operating Manual for information about values available for automatic measurement and indication in the **Value Box (Digital Readout)**
- There are four Measurement Modes possible:
  - Flank
  - Top
  - Flank-First
  - Top-First
- Probe Delay is determined by instrument automatically for all possible combinations of the following parameters:

Pulser Mode = SINGLE	**Pulser Mode = DUAL**
Aperture **Start** **Incidence Angle** **Focal Distance** (for **Thickness Correction = ON**) or **Focal Depth** (for **Thickness Correction = OFF**) **USVelocity** **Wedge Velocity**	**EMIT Aperture** **EMIT Start** **EMIT Incidence Angle** **RECEIVE Aperture** **RECEIVE Start** **RECEIVE Incidence Angle** **Focal Distance** (for **Thickness Correction = ON**) or **Focal Depth** (for **Thickness Correction = OFF**) **USVelocity** **Wedge Velocity**

5.3.3.11. A-Scan Based Measurements

5.3.3.11.1. Measured Values



Value 1: T(A) / Value 2: T(B)

Time of Flight - **µs** of an echo matching with **Gate A** / **Gate B** measured respectfully *Incidence Point*:

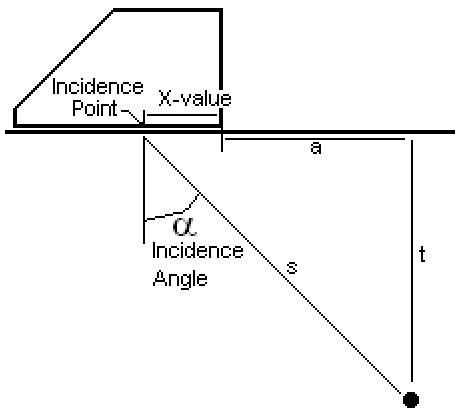
T(A) = Absolute Delay A - Probe Delay
T(B) = Absolute Delay B - Probe Delay

Value 3: s(A) / Value 4: s(B)

Material Travel Distance - **mm** or **in** of an echo matching with **Gate A** / **Gate B** measured respectfully *Incidence Point*:

s(A) = ½ · T(A) · US Velocity
s(B) = ½ · T(B) · US Velocity

Value 5: a(A) / Value 6: a(B)



Projection Distance - **mm** or **in** of reflector returning an echo matching with **Gate A** / **Gate B**, measured respectfully front surface of the PA probe with taking into account migration of *Incident Point* and varying *X-Value* in accordance with varying *Incidence Angle* α:

a(A) = s(A) · sin (α) – X-value
a(B) = s(B) · sin (α) – X-value

Value 7: t(A) / Value 8: t(B)

Depth - **mm** or **in** of reflector returning an echo matching with **Gate A** / **Gate B**:

t(A) = s(A) · cos (α)
t(B) = s(B) · cos (α)

Value 9: ΔT - µs:

ΔT = T(B) – T(A)

Value 10: Δs - mm or **in**:

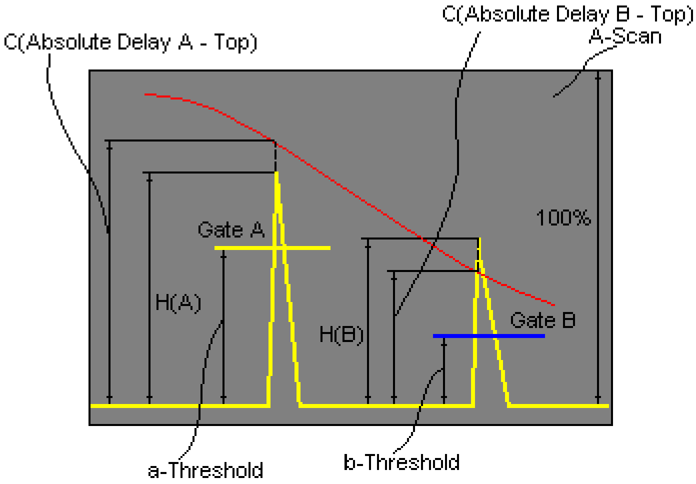
Δs = s(B) – s(A)

Value 11: Δa - mm or **in**:

Δa = a(B) – a(A)

Value 12: Δt - mm or **in**:

Δt = t(B) – t(A)



Value 13: H(A) / Value 14: H(B)

Amplitude - % of A-Scan height of an echo matching with **Gate A** / **Gate B**

Value 15: V(A) / Value 16: V(B)

Amplitude - dB of an echo matching with **Gate A** / **Gate B** with respect to **aThreshold**:

$$V(A) = 20 \cdot \log_{10} (H(A) / aThreshold)$$

$$V(B) = 20 \cdot \log_{10} (H(B) / bThreshold)$$

Value 17: ΔV - dB:

$$\Delta V = V(B) - V(A)$$

Value 18: ΔVC(A) (**dB to DAC**) – **dB**:

$$\Delta VC(A) = 20 \cdot \log_{10} (H(A) / C (Absolute\ Delay\ A\_Top))$$

Value 19: ΔVC(B) (**dB to DAC**) – **dB**:

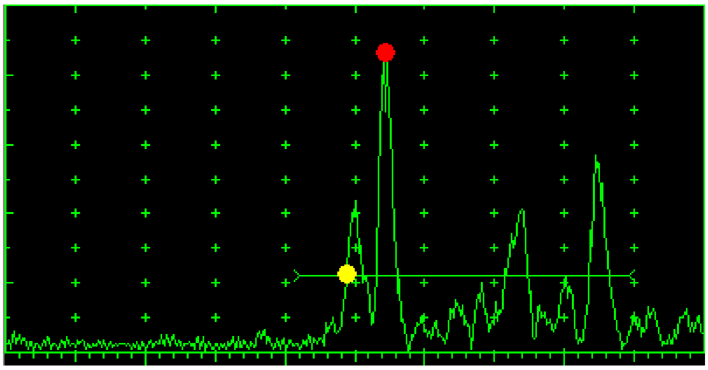
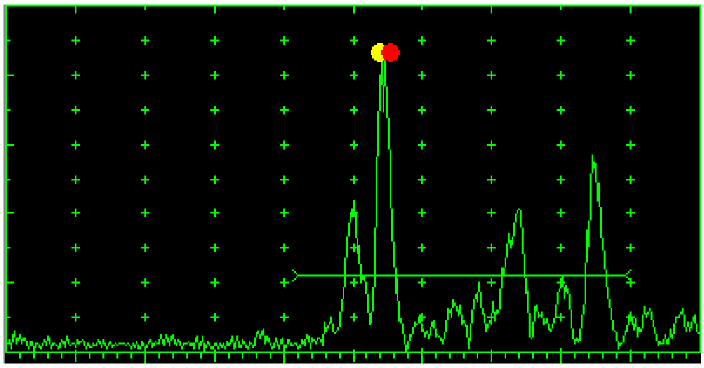
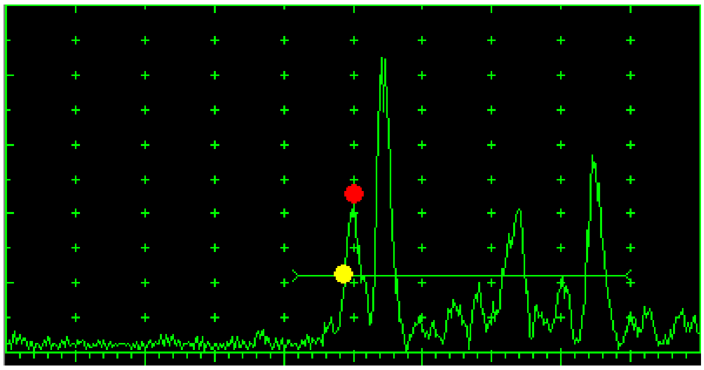
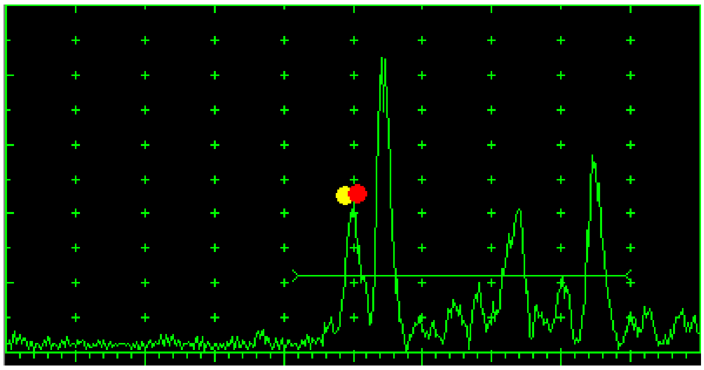
$$\Delta VC(B) = 20 \cdot \log_{10} (H(B) / C (Absolute\ Delay\ B\_Top))$$

ⓘ

- To proceed the corresponding **Gate** or both **Gates** to be active
- **ΔVC(A)** (**dB to DAC**) measurements require active **DAC**
- Amplitude measurements of echoes may be performed provided their heights don't exceed 130% of **A-Scan** height
- For 2 and more echoes matching with the **Gate** - refer to paragraph 5.3. 3.11.2 of this Operating Manual

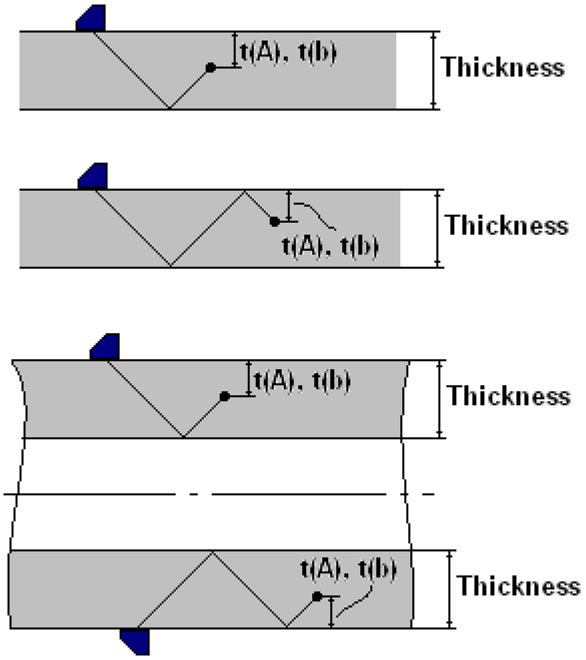
5.3.3.11.2. Measuring Modes

The table below represents distinguishing points on an **A-Scan**, which will be taken for automatic measurements depending on **Meas Mode** setting

Meas Mode setting	**A-Scan**
Meas Mode **Flank** ● - **T(A), T(B), s(A), s(B), t(A), t(B), a(A), a(B), ΔT, Δs, Δt, Δa** ● - **V(A), V(B), H(A), H(B), ΔV, ΔVC(A), ΔVC(B)**	
Meas Mode **Top** ● - **T(A), T(B), s(A), s(B), t(A), t(B), a(A), a(B), ΔT, Δs, Δt, Δa** ● - **V(A), V(B), H(A), H(B), ΔV, ΔVC(A), ΔVC(B)**	
Meas Mode **Flank-First** ● - **T(A), T(B), s(A), s(B), t(A), t(B), a(A), a(B), ΔT, Δs, Δt, Δa** ● - **V(A), V(B), H(A), H(B), ΔV, ΔVC(A), ΔVC(B)**	
Meas Mode **Top-First** ● - **T(A), T(B), s(A), s(B), t(A), t(B), a(A), a(B), ΔT, Δs, Δt, Δa** ● - **V(A), V(B), H(A), H(B), ΔV, ΔVC(A), ΔVC(B)**	

5.3.3.11.3. Thickness Correction

The sketch below represents positioning of PA Probe on the plate and on the tube wall (longitudinal insonification).



With reference to paragraph 5.3.3.4.4 of this Operating Manual on case of

Thickness Correction = ON

for half skip, full skip, and multi skip insonification **t(A)**, **t(B)** readings will represent actual depth of the targeted reflector provided the **Thickness** is entered properly

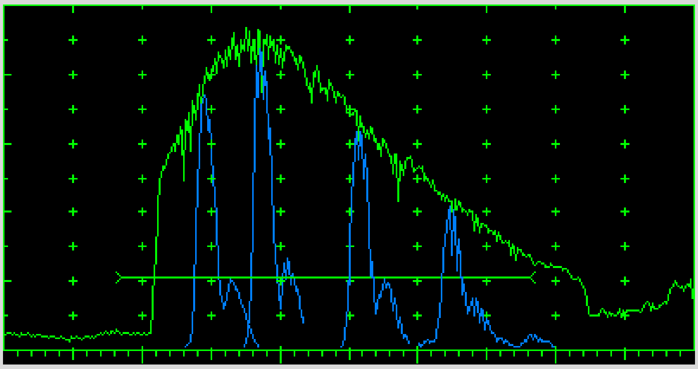
5.3.3.12. Freeze A-Scan

To freeze / freeze peak / unfreeze the **A-Scan** click on or press 

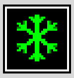
or **F10** or **<Alt>+<F>**

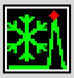
ⓘ

- **Freeze Peak** mode allows representing of Hilbert envelop for sequence of echoes obtained while manipulating probe over some reflector. This function may be useful for localization of echo maximum whilst in the A-Scan mode:



- **Freeze Peak** mode may not be activated for **RF** signal presentation

- Appearing of  at the upper left corner of **A-Scan** indicates that it is frozen (**Freeze**)

- Appearing of  at the upper left corner of **A-Scan** indicates that **Freeze Peak** mode is active

- The following operations are available for the frozen **A-Scan**:
  - Varying **Gain** in ± **6 dB** range
  - Manipulating **Gates A** and **B**
  - Varying **Alarm** mode
  - Selecting parameter (**Meas Value**) for automatic measurements and obtaining corresponding digital readout

- Caption of appropriate button changes window upon freeze / freeze peak / unfreeze **A-Scan**:

5.3.3.13. Save A-Scan and Calibration Data Into a File

Click on 

or press **F11**

5.3.3.14. Load A-Scan and Calibration Data From a File

Click on 

or press **F12**

5.3.3.15. Print A-Scan Settings List

Click on 

5.3.3.16. Preview Current PA Probe in Use

Click on 

5.3.3.17. Direction of Graphical Presentation

Click on 

5.3.3.18. Activate Main Recording Menu

Click on 

or press **Shift** + **Enter**

5.3.3.19. Return to Linear Array Probes Database

Click on 

or press **Esc**

5.3.4. Main Recording Menu

Click on 

or press **F1** to proceed with ABI Scan (other known names – B-Scan and E-Scan) based inspections

Click on 

or press **F2** to proceed with Sector Scan (S-Scan) based inspections

Click on 

or press **F3** to proceed with unique Tandem B-Scan based inspections (64 elements PA probe is necessary)

Click on 

or press **F4** or **Esc** to return to **ISONIC PA Pulser Reciver**

5.3.4.1. ABI Scan (B-Scan, E-Scan)

B-Scan (E-Scan) image is obtained through insonification of the material at fixed incidence angle through electronic shift of predetermined aperture within entire linear array comprising more elements than aperture size. Movie illustrating electronic scanning required for creation of **B-Scan** is available for viewing / download at **http://www.sonotronndt.com/PDF/OM2009/BScan_Wedge.wmv**

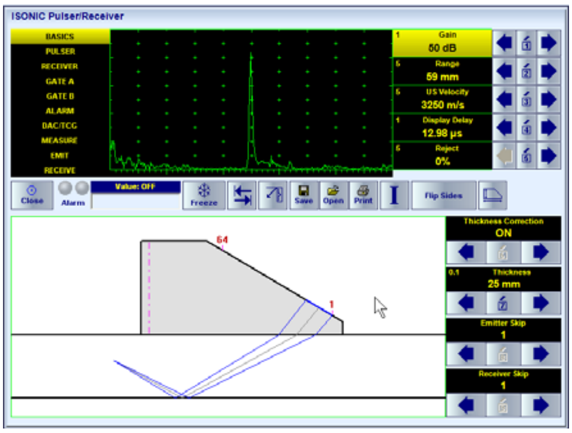
5.3.4.1.1. Settings of PA Pulser Receiver

With reference to paragraph 5.3.3 of this Operating Manual the following settings to be provided

#	*Parameter or Mode*	*Required Settings*	*Note*
1	**Pulser Mode**	**SINGLE**	
2	**Aperture**	**4 ≤ Aperture ≤ N/2** whereas **N** is total ***Number Of Elements*** in the linear array probe	
3	**Incidence Angle**	According to inspection procedure	
5	**Thickness Correction**	**ON**	
5	**Thickness**	Equal to the actual value of material thickness	
6	**Emitter / Receiver Skip**	In accordance with the inspection procedure	
7	**Focal Depth**	In accordance with the inspection procedure	
8	**USVelocity**	Equal to the actual value of ultrasound velocity in the object under test either for shear or longitudinal waves	
9	**Start**	**1**	Only at the stage of setting **Gain**
10	**Gain**	**Gain** setting to be performed according to inspection procedure providing required echo heights from defects to be detected	
11	**DAC/TCG**	**DAC/TCG** settings to meet requirements of inspection procedure	
12	**Pulse Width, Firing Level**	**Pulse Width** and **Firing Level** settings to optimize signal to noise ratio **Pulse Width** to be around 1/F where F is frequency of PA probe	To synchronize with **Gain** setting – finalize setting of **Pulse Width** and **Firing Level** before setting of the **Gain**
13	**Filter, Low Cut, and High Cut Frequencies**	**Filter** and **Low Cut** and **High Cut** settings to match with frequency of PA probe to optimize signal to noise ratio	To synchronize with **Gain** setting – finalize setting of **Filter, Low Cut, and High Cut** before setting of the **Gain**
14	**Display**	**Display** setting may be either **Full, RF, PosHalf,** or **NegHalf** – follow requirements the inspection procedure	
15	**Surface Alignment**	**ON**	
16	**Range**	To provide representation of all reflectors used for **Gain** and **DAC** calibration	Only at the stage of setting **Gain** and **DAC**

On completing calibration of **ISONIC PA Pulser Receiver**:

- Place PA probe into position providing receiving of maximized echo from reference reflector, for example – side drilled hole (SDH), then hold it in the found position
- Perform **Range** setting providing appearance of the said echo at 50% of the A-Scan width
- Remember existing **Gain** setting as **G0** then bring the amplitude of reference reflector to standard level (~80% of A-Scan height)
- Click on  or press **Shift** + **Enter** to proceed with *Gain Per Shot Correction*

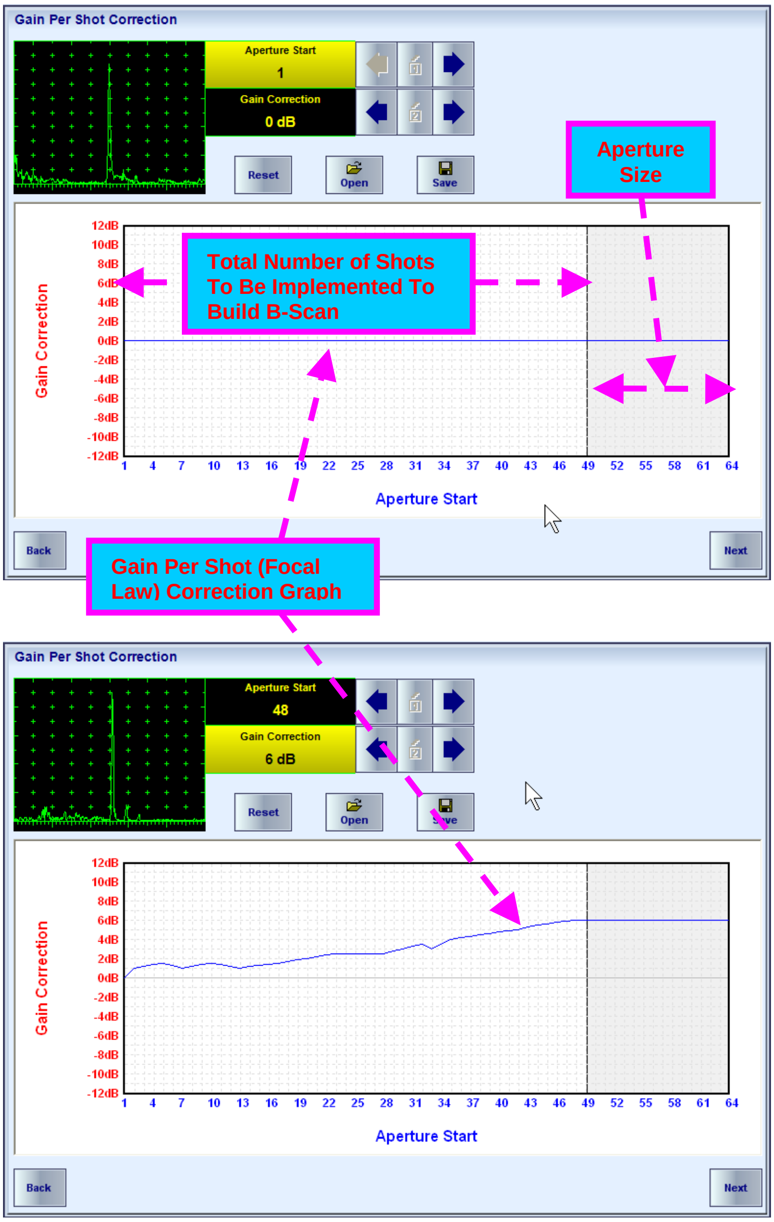

ISONIC Pulser/Receiver
BASICS
PULSER
RECEIVER
GATE A
GATE B
ALARM
DAC/TCG
MEASURE
EMIT
RECEIVE
Gain
50 dB
Range
59 mm
US Velocity
3250 m/s
Display Delay
12.98 µs
Reject
0%
Close
Alarm
Value: OFF
Freeze
Save
Open
Print
Flip Sides
Thickness Correction
ON
Thickness
25 mm
Emitter Skip
1
Receiver Skip
1

5.3.4.1.2. Gain Per Shot Correction

The following effects to be compensated to equalize the sensitivity over entire B-Scan insonification with wedged linear array probes:

- Inequality of elements of PA probe (parameters elements PA probe may deviate in certain range)
- Wedge sound path / losses are different for each implemented pulsing receiving shot (focal law)

This is a unique feature of **ISONIC 2009 UPA Scope** that each focal law may be implemented with individually adjusted gain – the screen below allows performing *Gain Per Shot* (*Gain Per Focal Law*) correction:



For *Gain Per Shot Correction* setup it is necessary:

- Increment [Aperture Start 2] from 1 to total number of focal laws composing B-Scan, said number may be defined as **N – Aperture** where **N** is total ***Number Of Elements*** in the linear array probe
- For each new [Aperture Start 2] manipulate probe over the calibration block to maximize echo from reference reflector; maximized echo for such manipulations should appear at the position of 50% of the **A-Scan** width
- Upon maximizing echo from reference reflector bring it's height to the standard level through use of [Gain Correction 6 dB] control

As a result it will created *Gain Per Shot Correction Graph* according to which **Gain** of the instrument will be individually adjusted for each focal law

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- **Gain Correction** for **Aperture Start = 1** to be **0 dB**
- *Gain Per Shot Correction Graph* may be stored into a file and uploaded at any moment for future use – use [Save] and [Open]
- Click on [Reset] will reset *Gain Per Shot Correction*

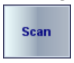
On completion:

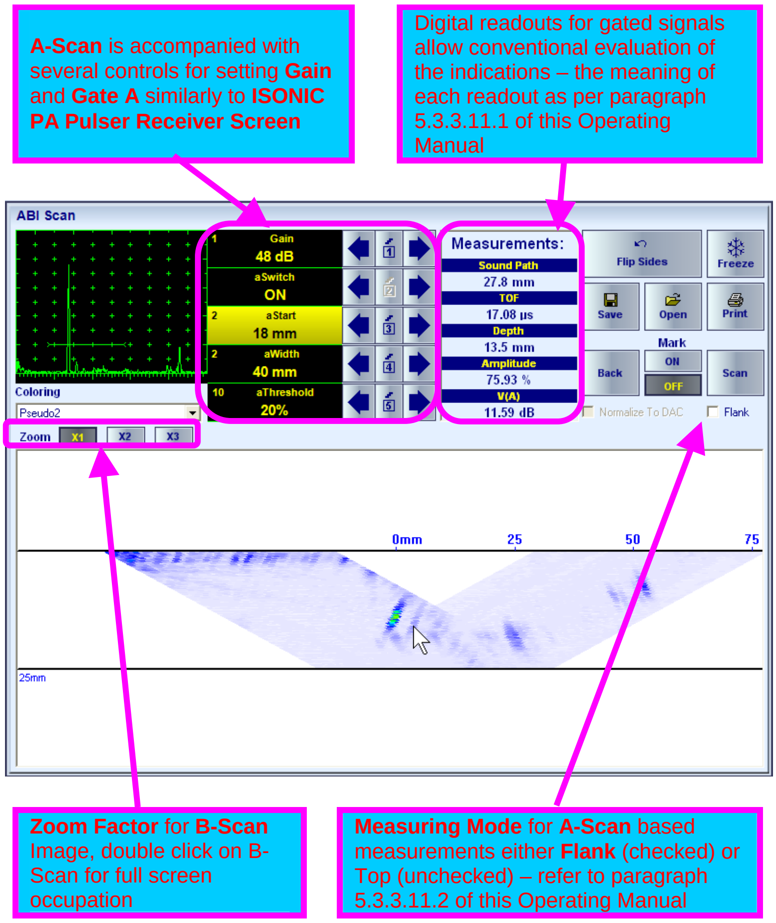
- Click on [Back] or press **Esc** to return to **ISONIC PA Pulser Receiver** then return **Gain** setting to **G0** as per paragraph 5.3.4.1.1 of This Operating Manual
- Click on [I] or press **Shift** + **Enter** – this will return *Gain Per Shot Correction* screen
- Click on [Next] or press **Shift** + **Enter** to proceed with **B-Scan**

5.3.4.1.3. B-Scan – ABI Scan Screen

ABI Scan screen represents **B-Scan** and **A-Scan** for one of the beams selected by an operator through placing cursor over it. It is possible to mark a beam, for which **A-Scan** will be reproduced permanently until negating – use  control

To return to **ISONIC PA Pulser Receiver** click on  or press **Esc**

To proceed to 3D data recording through linear scanning (**C-Scan**) click on  or press **Shift** + **Enter**



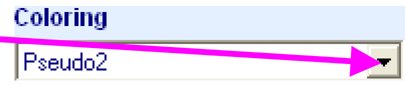
ⓘ

- On the **B-Scan** “**0 mm**” mark corresponds to the front surface of the wedge
- To proceed to 3D data recording it is necessary to activate **Gate A** (**aSwitch = ON**) in the **ABI Scan** screen whilst **aStart** settings to provide appearance of the **Gate A** on the **A-Scan**
- Use of the following controls is equivalent to the same controls of **ISONIC PA Pulser Receiver**:

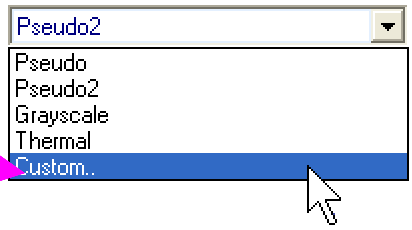
5.3.4.1.4. Color Palette – ABI Scan Screen

On the **B-Scan** image ach color represents corresponding signal amplitude

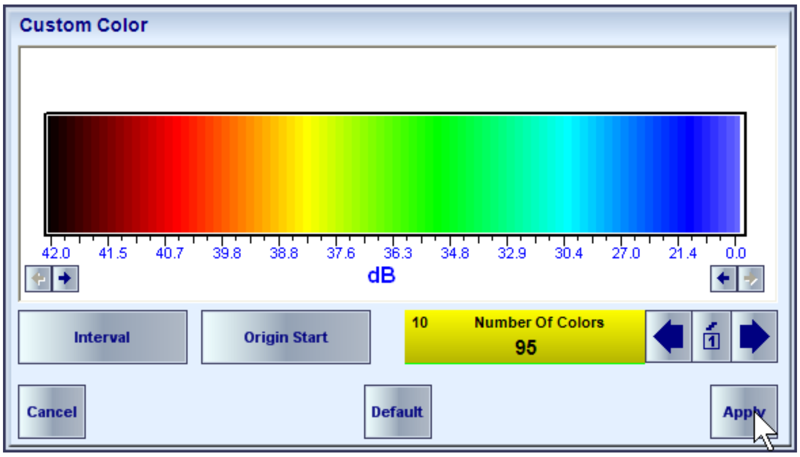
There are 4 customizable color palettes available, to select / customize click on



then select the needful

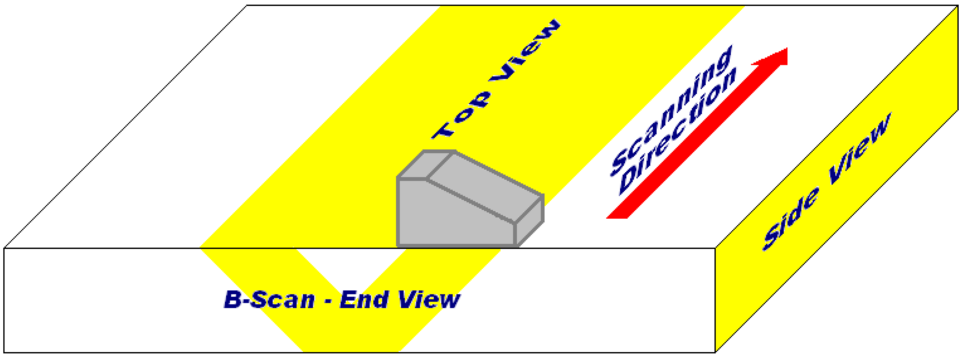


Customize palette through appropriate dialogue control:



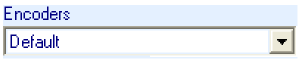
5.3.4.1.5. 3D Data Recording Through Linear Scanning (C-Scan, Top and Side Views)

3D data recording is provided through linear scanning according to the sketch below

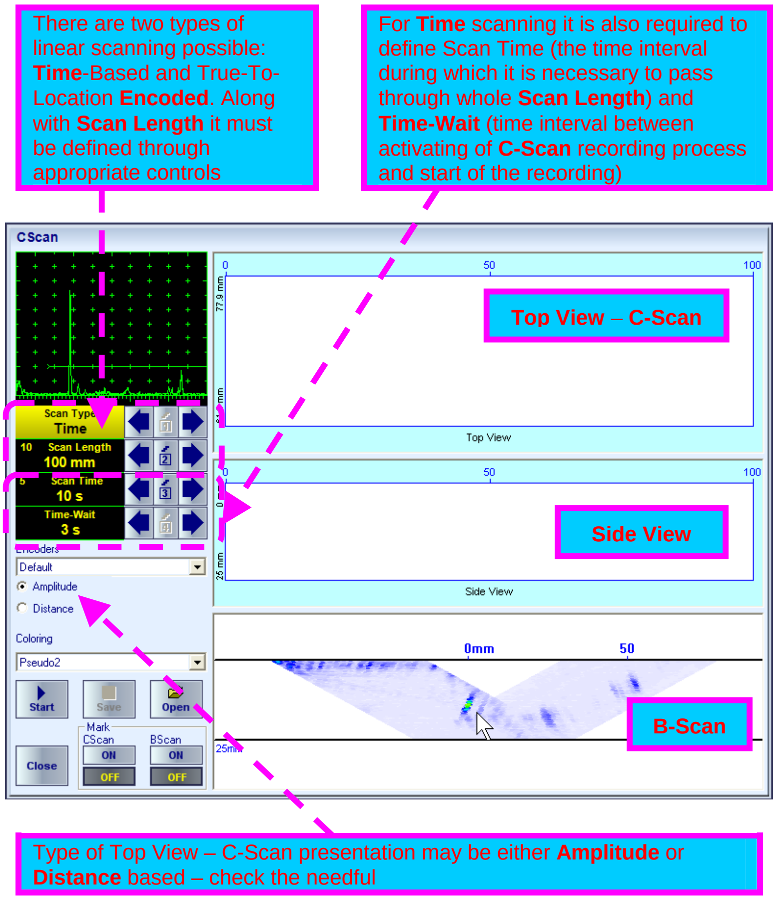


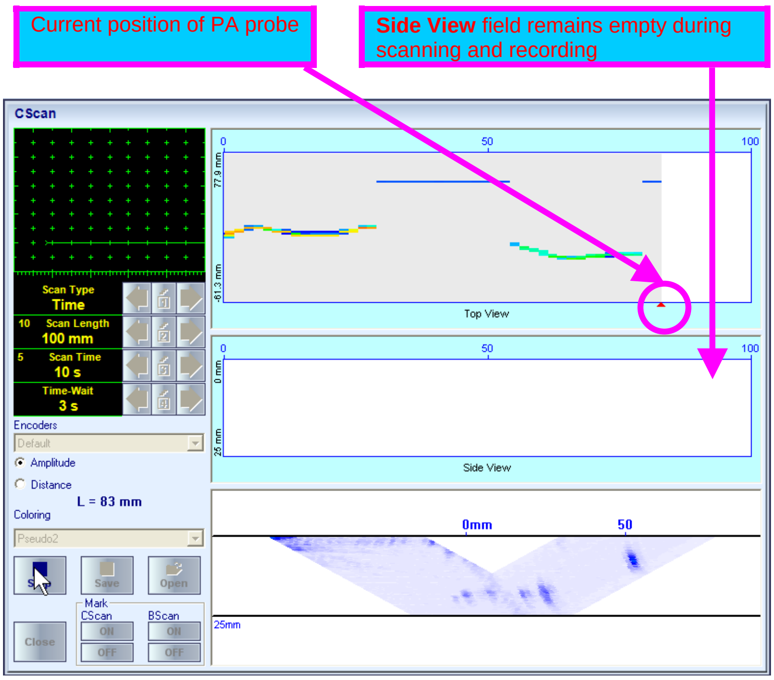
C-Scan screen represents **A-Scan**, **B-Scan**, **Top View – C-Scan** and **Side View** project ional images. **A-Scan** is for one of the beams selected by an operator through placing cursor over it. It is possible to mark a beam, for which **A-Scan** will be reproduced permanently until negating – use  control

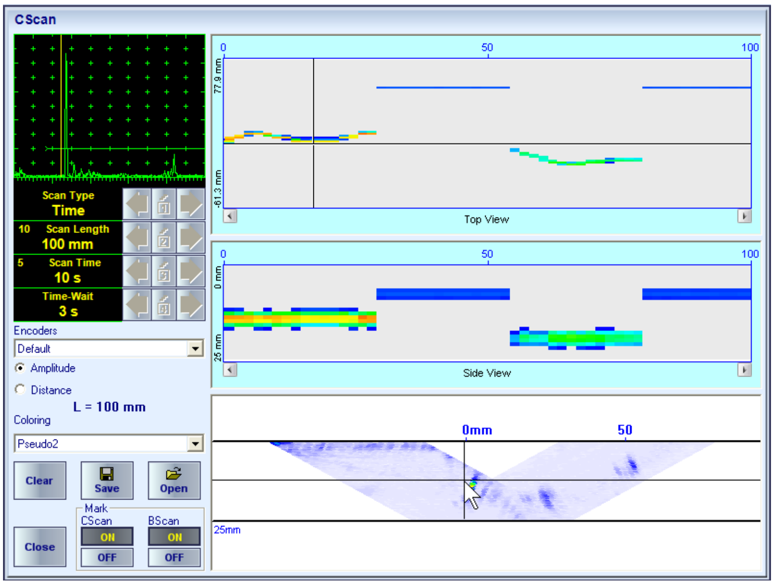
To return to **ABI Scan** screen click on  or press **Esc**

On case of **Encoded** scanning connect encoder to the instrument and fit probe into encoder (refer to paragraph XXXXX of this Operating Manual), the type of the selected encoder to be defined through 

To start scanning with recording click on .  becomes invisible since the recording starts and  occupies its position. Click on  to terminate recording prior to automatic completion







Stop becomes invisible upon completion / termination of **3D** recording and Clear occupies its position automatically along with filling creating **Side View** image and freezing **Top** and **Side Views**

To play back retrieved **B-Scans** captured during scanning use CScan ON/OFF control. To play back **A-Scans** composing selected retrieved B-Scan use BScan ON/OFF control

Click on Save to store captured data into a file

Click on Open to upload captured data from a file

Click on Clear will empty **Top** and **Side Views** and replace Clear with Start

5.3.4.2. Sector Scan (S-Scan)

S-Scan image is obtained through insonification of the material through varying of incidence angle in a certain range whilst the aperture is fixed. Movie illustrating electronic scanning required for creation of **S-Scan** is available for viewing / download at
http://www.sonotronndt.com/PDF/OM2009/S_Scan_Wedge.wmv

5.3.4.2.1. Settings of PA Pulser Receiver

With reference to paragraph 5.3.3 of this Operating Manual the following settings to be provided

#	*Parameter or Mode*	*Required Settings*	*Note*
1	**Pulser Mode**	**SINGLE**	
2	**Aperture**	**4** ≤ **Aperture** ≤ **N** whereas **N** is total ***Number Of Elements*** in the linear array probe	
3	**Incidence Angle**	A value within required varying range for incidence angle in accordance with the inspection procedure	Only at the stage of setting **Gain**
5	**Thickness Correction**	**OFF** – regular **S-Scan** **ON** – **TTGI S-Scan** (TTGI – unique *True To Geometry Imaging* technology from Sonotron NDT)	
5	**Thickness**	Equal to the actual value of material thickness	For **TTGI S-Scan** only
6	**Emitter / Receiver Skip**	In accordance with the inspection procedure	For **TTGI S-Scan** only
7	**Focal Depth**	In accordance with the inspection procedure	For **TTGI S-Scan** only
8	**Focal Distance**	In accordance with the inspection procedure	For regular **S-Scan** only
9	**USVelocity**	Equal to the actual value of ultrasound velocity in the object under test either for shear or longitudinal waves	
9	**Start**	According to inspection procedure **Start** ≤ **N – Aperture** whereas **N** is total ***Number Of Elements*** in the linear array probe	Only at the stage of setting **Gain**
10	**Gain**	**Gain** setting to be performed according to inspection procedure providing required echo heights from defects to be detected	
11	**DAC/TCG**	**DAC/TCG** settings to meet requirements of inspection procedure	
12	**Pulse Width, Firing Level**	**Pulse Width** and **Firing Level** settings to optimize signal to noise ratio **Pulse Width** to be around 1/F where F is frequency of PA probe	To synchronize with **Gain** setting – finalize setting of **Pulse Width** and **Firing Level** before setting of the **Gain**
13	**Filter, Low Cut, and High Cut Frequencies**	**Filter** and **Low Cut** and **High Cut** settings to match with frequency of PA probe to optimize signal to noise ratio	To synchronize with **Gain** setting – finalize setting of **Filter, Low Cut, and High Cut** before setting of the **Gain**
14	**Display**	**Display** setting may be either **Full, RF, PosHalf,** or **NegHalf** – follow requirements the inspection procedure	
15	**Surface Alignment**	**ON**	
16	**Range**	For **Thickness Correction = OFF** (regular **S-Scan**) **Range** to cover whole area according to the inspection procedure For **Thickness Correction = ON** (**TTGI S-Scan**) **Range** setting is important at the stage of **Gain** and **DAC** setup only providing representation of all reflectors used for **Gain** and **DAC** calibration	

On completing calibration of **ISONIC PA Pulser Receiver**:

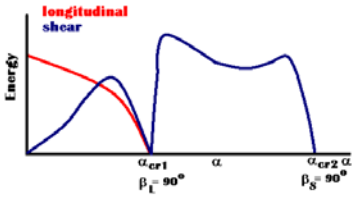
- Keep **Incidence Angle** setting to remain the same is it was used for calibration of **Gain**, remember this setting as α_0
- If the intend is performing of regular **S-Scan** remember existing **Range** setting as **R0**; for **TTGI S-Scan** simply ignore this note
- Set **Range** value to **200 mm** (or **8 in**)
- Remember **USVelocity** settings as **USVel0**
- If the intend is performing of shear wave inspection the set **USVelocity** to **3250 m/s** (**128.1 in/ms**); if intend is performing of compression (longitudinal) wave inspection then set **USVelocity** to **5920 m/s** (or **231.1 in/ms**)
- Remember existing **Gain** setting as **G0**

- Place PA probe into position providing receiving of maximized echo from 100 mm radius reflector in the V1 calibration block, bring maximized echo to the standard level (~80% of **A-Scan** height) then hold probe it in the found position
- Click on  or press **Shift** + **Enter** to proceed with *Gain Per Shot Correction*

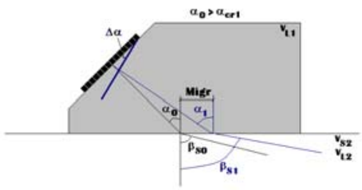
5.3.4.2.2. Angle Gain Compensation

The following effects to be compensated to equalize the sensitivity over entire B-Scan insonification with wedged linear array probes:

- Among other factors echo amplitude is determined by energy of refracted wave, which strongly depends on incidence angle as transparency of probe-material interface varies along with varying of incidence angle



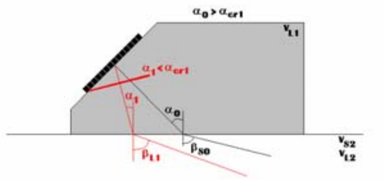
$$EchoAmplitude \sim Energy$$

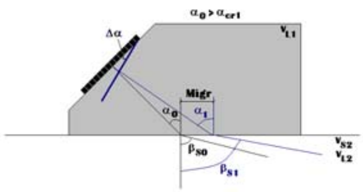


- Among other factors echo amplitude depends on effective size of the aperture, which varies along with varying of incidence angle

$$EffectiveSize = N \times PitchSize \times Cos(\Delta\alpha)$$

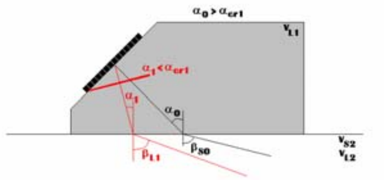
$$EchoAmplitude \sim EffectiveSize^2$$



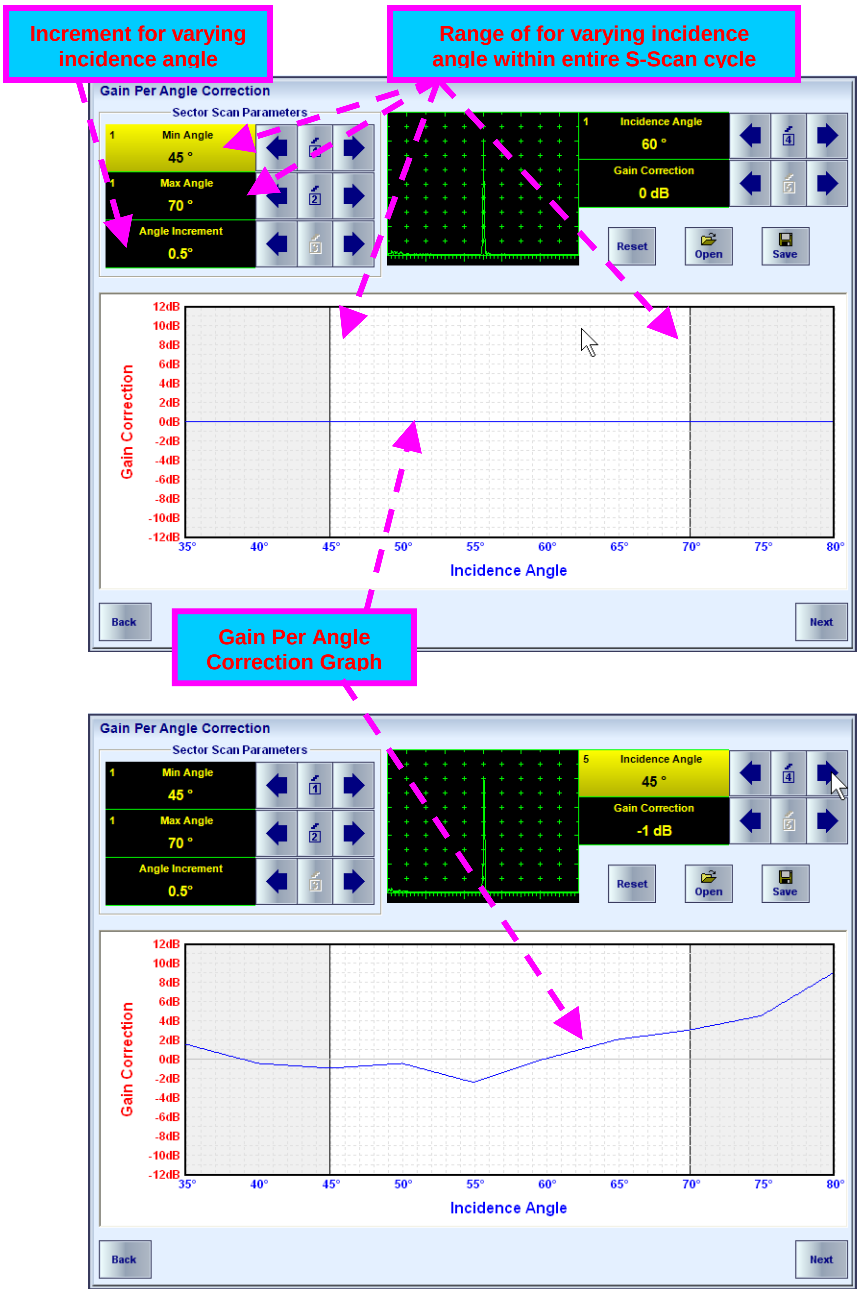


- Wedge sound path / losses are different for each implemented pulsing receiving shot (focal law) due to migration of incidence point

$$EchoAmplitude \sim Exp(-V_{L1} \times probe\_delay)$$



This is a unique feature of **ISONIC 2009 UPA Scope** that each focal law may be implemented with individually adjusted gain – the screen below allows performing *Gain Per Angle* (*Gain Per Focal Law*) correction as well as keying in *range of varying incidence angle within entire S-Scan cycle* and *increment of varying incidence angle*:



For *Gain Per Angle Correction* setup it is necessary:

- Increment [Incidence Angle 45 °] between desired minimal to maximal values
- For each new [Incidence Angle 45 °] manipulate probe over the V1 block to maximize echo from 100 mm radius reflector; maximized echo for such manipulations should appear at the position of 50% of the A-Scan width
- Upon maximizing echo from 100 mm radius reflector bring it's height to the standard level through use of [Gain Correction 1.5 dB] control

As a result it will created *Gain Per Angle Correction Graph* according to which **Gain** of the instrument will be individually adjusted for each focal law within entire **S-Scan**

ⓘ

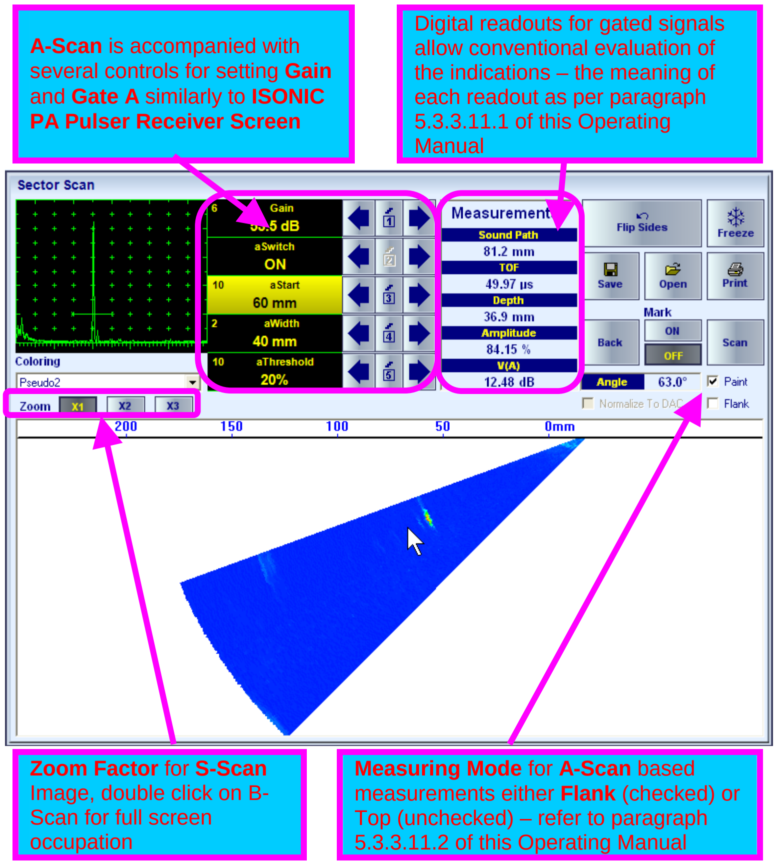
- **Gain Correction** for **Incidence Angle = α_0** to be **0 dB**
- *Gain Per Angle Correction Graph* may be stored into a file and uploaded at any moment for future use – use [Save] and [Open]
- Click on [Reset] will reset *Gain Per Angle Correction*

On completion:

- Click on [Back] or press **Esc** to return to **ISONIC PA Pulser Receiver** then:
    - o return **Gain** setting to **G0** as per paragraph 5.3.4.2.1 of This Operating Manual
    - o return **USVelocity** to **USVel0** as per paragraph 5.3.4.2.1 of This Operating Manual
    - o return **Range** setting as **R0** as per paragraph 5.3.4.2.1 of This Operating Manual for regular **S-Scan**; for **TTGI S-Scan** simply ignore this note
- Click on [I] or press **Shift** + **Enter** – this will return *Gain Per Angle Correction* screen
- Click on [Next] or press **Shift** + **Enter** to proceed with **B-Scan**

5.3.4.2.3. S-Scan – Sector Scan Screen

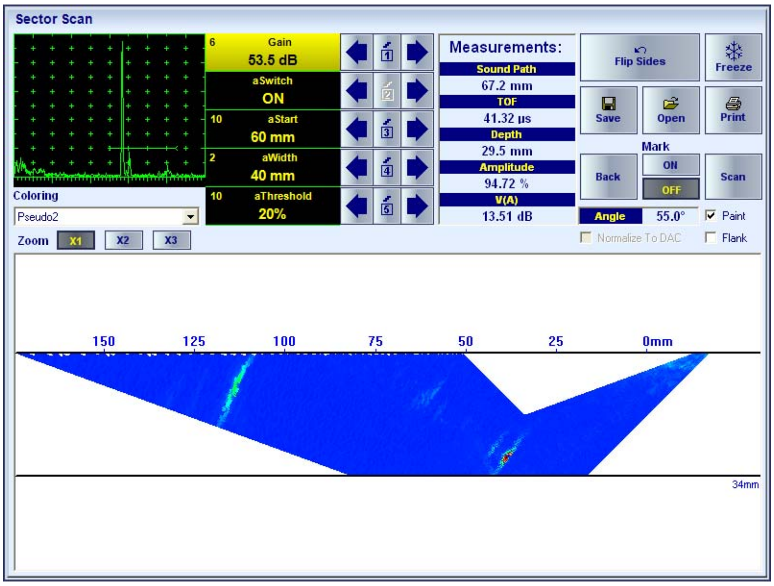
regular **S-Scan**



Sector Scan screen represents regular **S-Scan** or **TTGI S-Scan** and **A-Scan** for one of the beams selected by an operator through placing cursor over it. It is possible to mark a beam, for which **A-Scan** will be reproduced permanently until negating – use Mark ON OFF control

To return to **ISONIC PA Pulser Receiver** click on Back or press **Esc**

To proceed to 3D data recording through linear scanning (**C-Scan**) click on Scan or press **Shift** + **Enter**



ⓘ

- On the **S-Scan** "**0 mm**" mark corresponds to the front surface of the wedge
- To proceed to 3D data recording it is necessary to activate **Gate A** (**aSwitch = ON**) in the **Sector Scan** screen whilst **aStart** settings to provide appearance of the **Gate A** on the **A-Scan**
- Use of the following controls is equivalent to the same controls of **ISONIC PA Pulser Receiver**:

5.3.4.2.4. Color Palette – Sector Scan Screen

Refer to paragraph 5.3.4.1.4 of this Operating Manual

5.3.4.2.5. 3D Data Recording Through Linear Scanning (C-Scan, Top and Side Views)

Refer to paragraph 5.3.4.1.5 of this Operating Manual

5.3.4.3. Tandem B-Scan

Tandem B-Scan is unique technology implemented by **ISONIC 2009 UPA Scope** instrument for the detection of vertically oriented planar defects, for example – fatigue cracks. It is executed with use of 64 elements linear array probes through **Dual** mode of pulsing receiving. Sequence of the realized pulsing receiving shots provides sequential passing by focal point through centers of cells composing insonified region of interest (ROI) in the material. Emitting and receiving aperture and ultrasonic beam trace are varying for each implemented focal law. Movie illustrating electronic scanning required for creating of **Tandem B-Scan** is available for viewing / download at http://www.sonotronndt.com/PDF/OM2009/Tandem_B_Scan.wmv

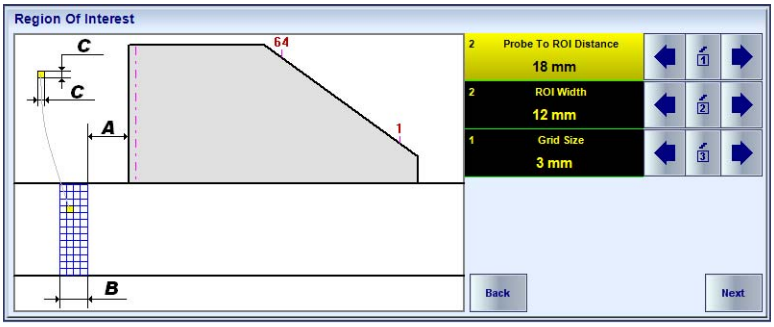
5.3.4.3.1. Preliminary Settings of PA Pulser Receiver

With reference to paragraph 5.3.3 of this Operating Manual the following *preliminary settings* to be provided

#	*Parameter or Mode*	*Required Settings*	*Note*
1	**Pulser Mode**	**DUAL**	
2	**Thickness Correction**	**ON**	
3	**Thickness**	Equal to the actual value of material thickness	
4	**USVelocity**	Equal to the actual value of shear wave velocity in the object under test	
5	**DAC/TCG**	**OFF**	
6	**Pulse Width, Firing Level**	**Pulse Width** and **Firing Level** settings to optimize signal to noise ratio **Pulse Width** to be around 1/F where F is frequency of PA probe	To synchronize with **Gain** setting
7	**Filter, Low Cut, and High Cut Frequencies**	**Filter** and **Low Cut** and **High Cut** settings to match with frequency of PA probe to optimize signal to noise ratio	To synchronize with **Gain** setting – finalize setting of **Filter, Low Cut, and High Cut** before setting of the **Gain**
8	**Display**	**Display** setting may be either **Full, RF, PosHalf,** or **NegHalf** – follow requirements the inspection procedure	
9	**Surface Alignment**	**ON**	
10	**Gain**	**50…60 dB**	Recommended value to start with

5.3.4.3.2. Region of Interest

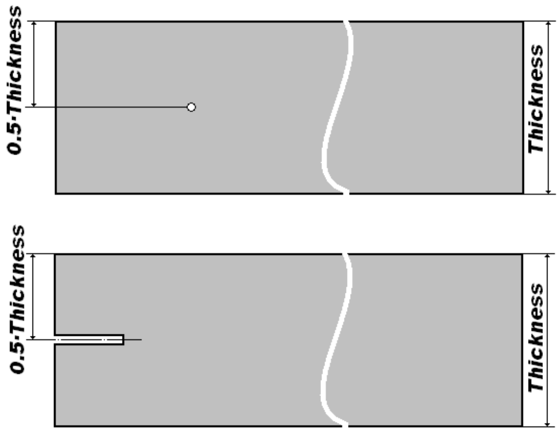
On completing with preliminary settings of **ISONIC PA Pulser Receiver** click on  or press **Shift** + **Enter** to proceed with defining of ROI (*Region Of Interest*) through specially dedicated screen. After defining **ROI Width**, **Probe To ROI Distance**, and **Grid Size** click on  or press **Shift** + **Enter** to enter to *Gain Per Shot Correction* screen



A = Probe To ROI Distance B = ROI Width C = Grid Size

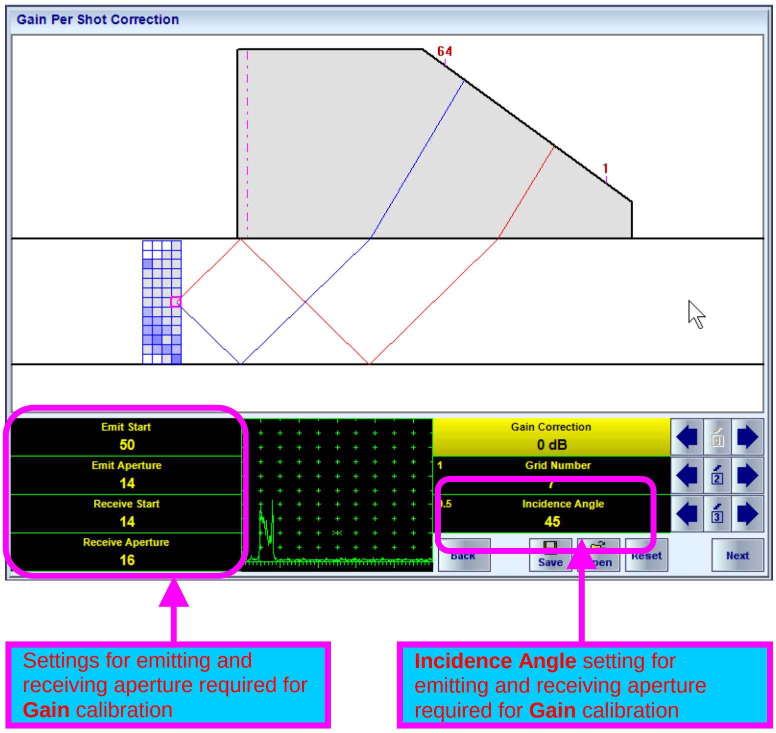
5.3.4.3.3. Calibration Block For Tandem B-Scan Technology

Calibration block for the implementation of **Tandem B-Scan** technology to be manufactured from the same material as object under test. It must contain reference reflector either FBH (flat bottom hole) or SDH (side drilled hole) situated according to the sketch and free vertical wall. Diameter of FBH / SDH to be defined according to the requirements to inspection sensitivity. Length of calibration block to allow performing of all manipulations described in the present chapter



5.3.4.3.4. Automatic Ray Tracing

Upon entering *Gain Per Shot Correction* screen **ISONIC 2009 UPA Scope** instrument performs *automatic ray tracing providing insonifying grids within entire ROI*. At that stage PA probe to remain uncoupled to the calibration block. As a result a number of grids composing ROI will be painted while some grids will remain unpainted (white). Unpainted grids indicate areas within ROI, which may not be insonified for the selected **Probe to ROI Distance** in the previous screen. It is possible to return back to *Region Of Interest* screen and to progress to *Gain Per Shot Correction* screen again several times to maximize number of insonified grids. On reaching the goal click on the grid situated as it is shown on the screenshot whilst PA probe is still not coupled to calibration block – the ray tracing will be shown for the selected grid – the emitted beam (blue) and beam corresponding to the echo from flat or compact reflector provided the reflector would be situated in the designated grid (red). The ray tracing clearly indicates number of skips (**EMIT Skip** (**ESk**) and **RECEIVE Skip** (**RSk**) settings) implemented by the emitted and received beam in that case.



Also the numerical indication for the following settings of emitting and receiving aperture appears:

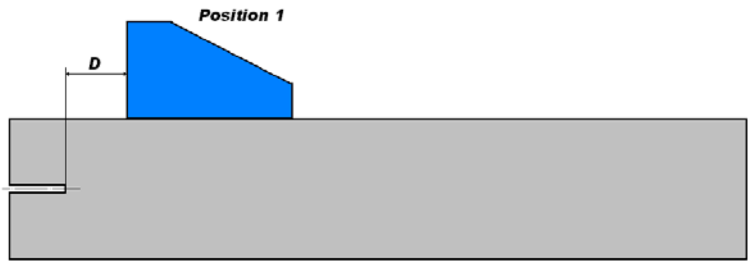
- **EMIT Star (ESt)**
- **EMIT Aperture (EA)**
- **RECEIVE Start (RS)**
- **Receive Aperture (RA)**
- **Incidence Angle (α)** – the same value for emitting and receiving aperture

Remember required settings the click on **Back** or press **Esc** to return to *Region Of Interest* screen, in which click on **Back** or press **Esc** to return to **ISONIC PA Pulser Receiver** screen for **Gain** calibration

5.3.4.3.5. Setting Gain For Tandem B-Scan Technology

In the **ISONIC PA Pulser Receiver** screen provide settings as below:

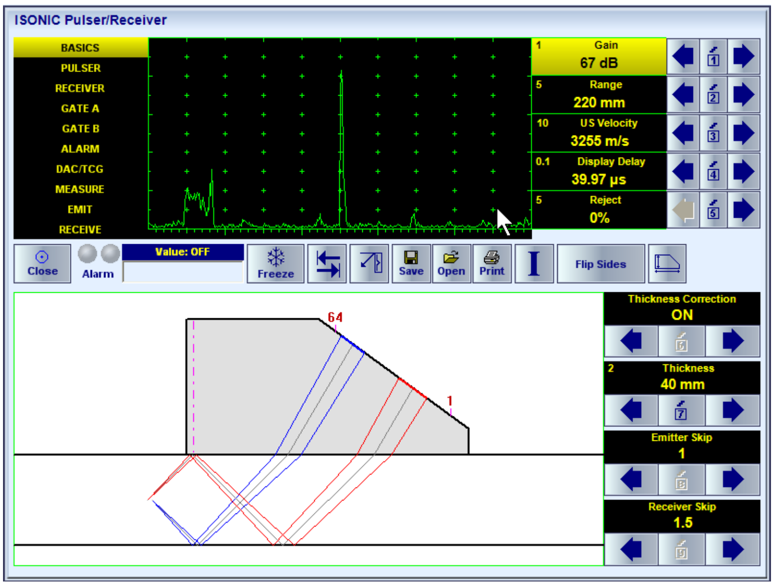
#	*Parameter or Mode*	*Required Settings*	*Note*
1	**EMIT Skip**	**ESk**	
2	**EMIT Start**	**ESt**	
3	**EMIT Aperture**	**EA**	
4	**EMIT Angle**	α	
5	**RECEIVE Skip**	**RSk**	
6	**RECEIVE Start**	**RS**	
7	**RECEIVE Aperture**	**RS**	
8	**RECEIVE Angle**	α	
9	**Range**	$Range = \frac{Thickness \times [2 \times (EMITSkip + RECEIVESkip) - 1]}{Cos(\alpha)}$	This **Range** setting provides appearance of the echo from reference reflector at 50% of **A-Scan** width



Upon completion pace probe into ***Position 1*** on the calibration block whereas

D = Probe to ROI Distance + 0.5×Grid Size

and provide **Gain** setting bringing the echo from reference reflector to the standard level, for example 80% of the A-Scan height. Remember obtained Gain value as **G0**

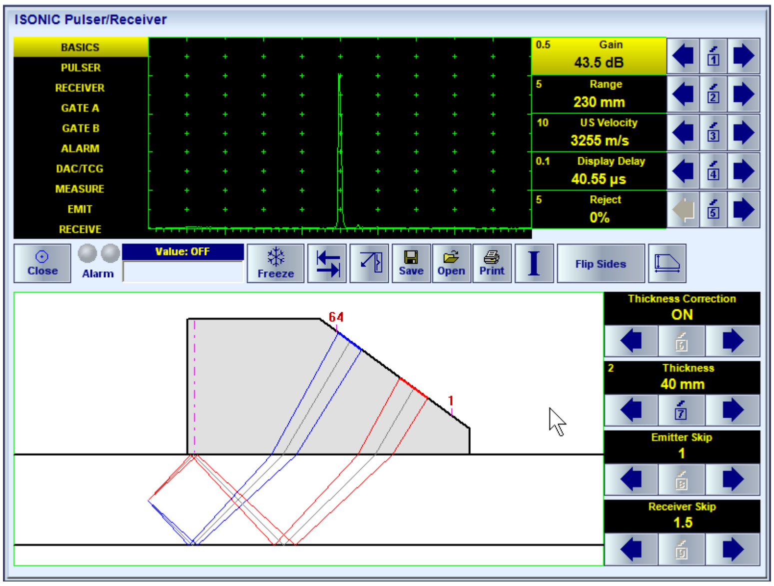


5.3.4.3.6. Gain Per Shot Correction

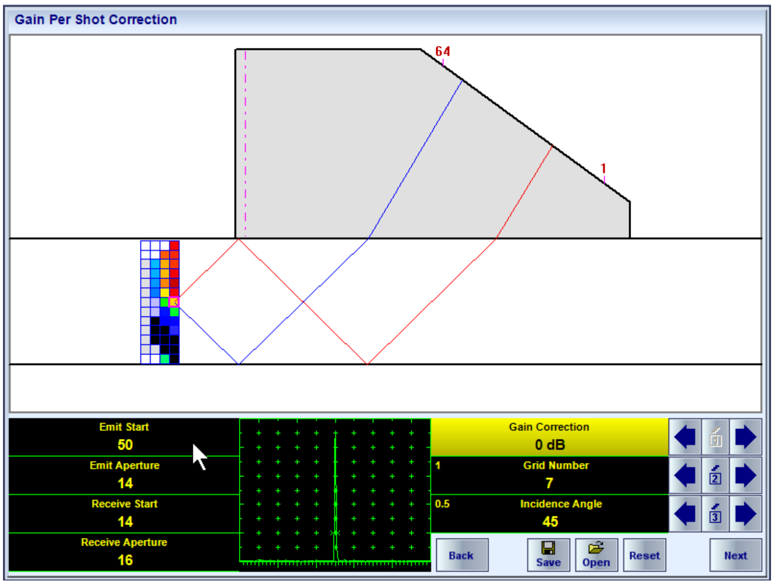
Then place probe into ***Position 2***, whereas

D = Probe to ROI Distance + 0.5×Grid Size

and provide **Gain** setting bringing the echo from vertical wall to the standard level



Continue holding of PA probe in the ***Position 2*** and click on  or press **Shift** + **Enter** – this will open *Region Of Interest* screen, from which proceed further to *Gain Per Shot Correction* screen immediately through click on  or press **Shift** + **Enter**



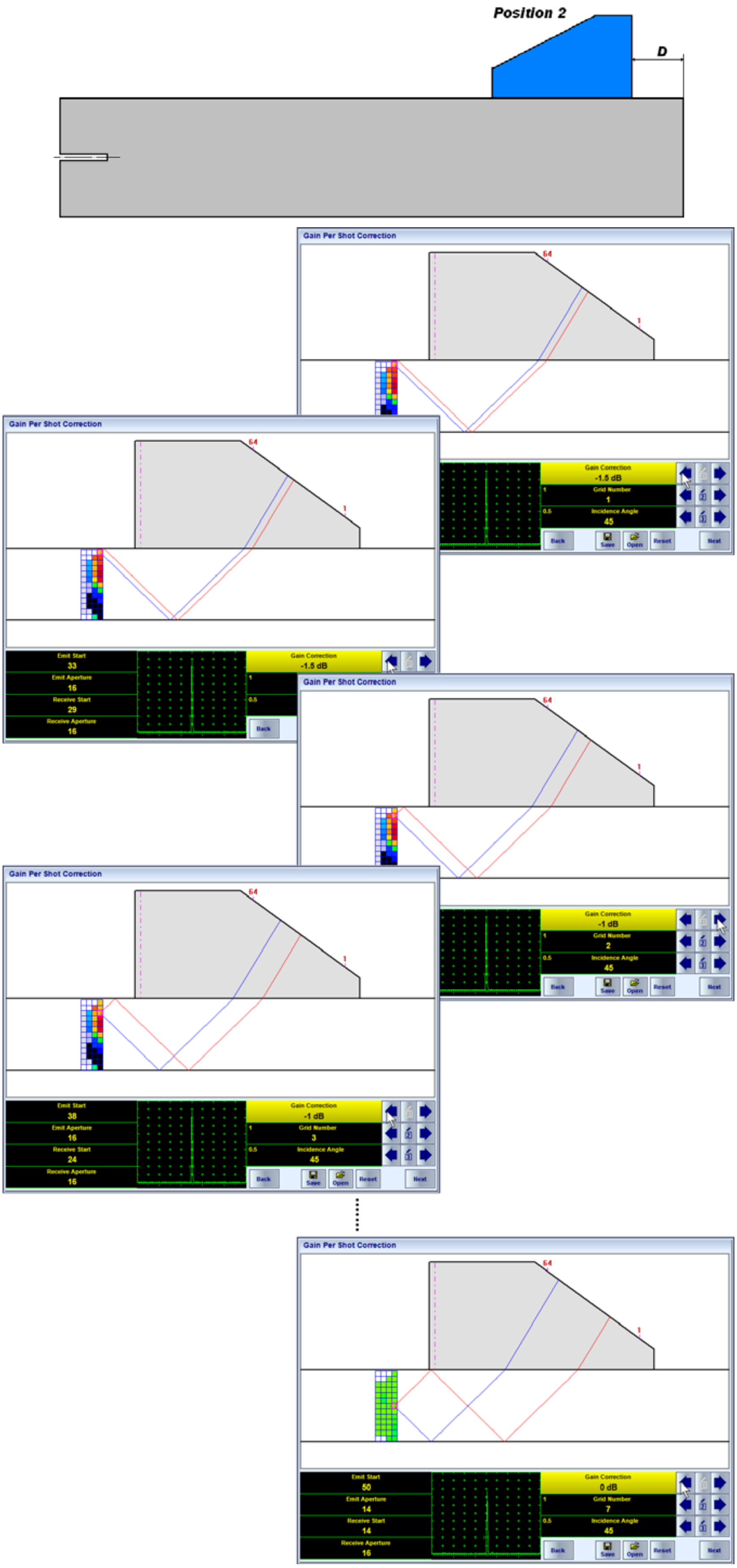
Click on the grid situated as it is shown on the screenshot to ensure that the amplitude of echo received from the middle of vertical wall is kept at the standard level

This is a unique feature of **ISONIC 2009 UPA Scope** that each focal law may be implemented with individually adjusted gain. This allows equalizing of sensitivity within entire ROI whilst implementing **Tandem B-Scan** insonification. To proceed holding of PA probe in the ***Position 2*** and click on each grid one by one. For every greed **A-Scan** time base settings (**Display Delay** and **Range**) are adjusted automatically by such way that the echo from vertical wall is indicated at the same horizontal position – 50% of **A-Scan** width so it is necessary just to bring echo amplitude for each grid to the standard level using

Gain Correction
0 dB

control

At the end of the procedure all grids will have the same color as the greed corresponding to the echo received from the middle of vertical wall



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- **Gain Correction** for the echo received from the middle of vertical wall to be **0 dB**
- *Gain Per Shot Correction Matrix* may be stored into a file and uploaded at any moment for future use – use Save and Open
- Click on Reset will reset *Gain Per Shot Correction*

On completion:

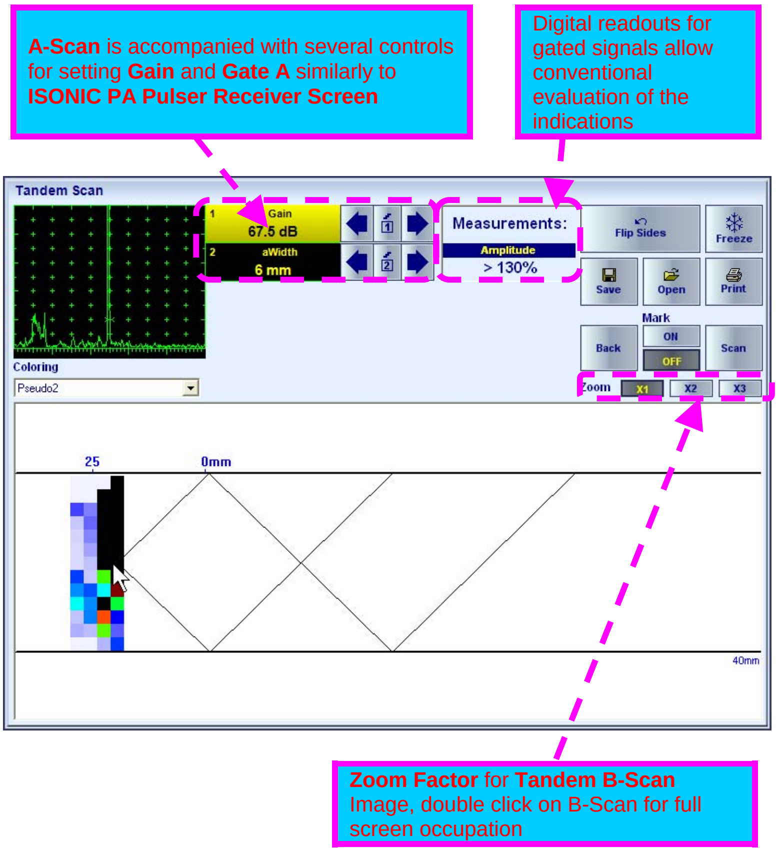
- Return to **ISONIC PA Pulser Receiver** then return **Gain** setting to **G0** as per paragraph 5.3.4.3.5 of This Operating Manual
- Return to *Gain Per Shot Correction* screen and Click on Next or press **Shift** + **Enter** to proceed with **Tandem B-Scan**

5.3.4.3.7. Tandem B-Scan

Tandem Scan screen represents **Tandem B-Scan** and **A-Scan** for one of the beams selected by an operator through placing cursor over it. It is possible to mark a beam, for which **A-Scan** will be reproduced permanently until negating – use Mark ON OFF control

To return to **ISONIC PA Pulser Receiver** click on Back or press **Esc**

To proceed to 3D data recording through linear scanning (**C-Scan**) click on Scan or press **Shift** + **Enter**



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- On the **Tandem B-Scan** "**0 mm**" mark corresponds to the front surface of the wedge
- Use of the following controls is equivalent to the same controls of **ISONIC PA Pulser Receiver**:

5.3.4.3.8. Color Palette – Tandem Scan Screen

Refer to paragraph 5.3.4.1.4 of this Operating Manual

5.3.4.3.9. 3D Data Recording Through Linear Scanning (C-Scan, Top and Side Views)

Refer to paragraph 5.3.4.1.5 of this Operating Manual and screenshot below

5.4. Linear Array Probes With Straight Delay Line – Standard Modes of Operation

Use of linear array probe with straight delay line with **ISONIC 2009 UPA Scope** is based on the same principles and controls as for wedged linear array probes. The following modes of functioning are possible:

- Selecting of PA probe from database, editing existing and adding new PA probe data, exportation and importation of PA probe data base to/from another instrument – refer to paragraph 5.3.1 of this Operating Manual
- PA Pulser Receiver – refer to paragraph 5.3.3 of this Operating Manual. The difference is in the incidence angle manipulation range only: **–89…+89 deg** for linear array equipped / not equipped with delay line vs **35…80 deg** for wedged linear array
- Imaging and recording – B-Scan cross sectional imaging and 3D data recording through linear scanning (C-Scan, Top, and Side Views) – refer to paragraph 5.3.4.1 of this Operating Manual. It is necessary just to note that incidence angle may be manipulated over wider range and dual mode of Pulsing / Receiving with partially of fully separated emitting and receiving aperture is allowed for linear array equipped / not equipped with delay line vs wedged linear array
- Imaging and recording – Sector Scan cross sectional imaging and 3D data recording through linear scanning (C-Scan, Top, and Side Views) – refer to paragraph 5.3.4.1 of this Operating Manual. It is necessary just to note that incidence angle may be manipulated over wider range and dual mode of Pulsing / Receiving with partially of fully separated emitting and receiving aperture is allowed for linear array equipped / not equipped with delay line vs wedged linear array

Typical PA probes and delay lines are listed below

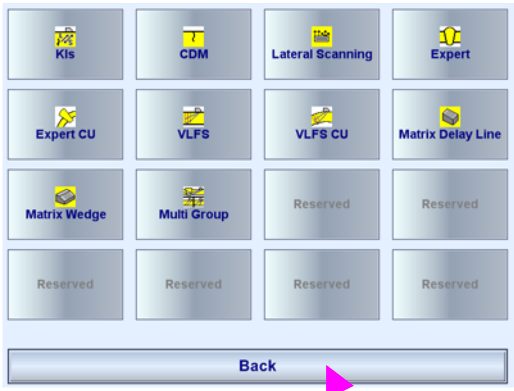
#	*Item*	*Order Code (Part ##)*	*Note*
1	**PA-2M8E1P** - LINEAR ARRAY Frequency: **2 MHz** Pitch Size: **1 mm** Number of Elements: **8** Elevation: **9 mm**	S 4922104376	Mark on the probe 104376
2	**PA-4M16E0.5P** - LINEAR ARRAY Frequency: **4 MHz** Pitch Size: **0.5 mm** Number of Elements: **16** Elevation: **9 mm**	S 4922104377	Mark on the probe 104377
3	**V20PA-8/16** - 20 mm delay line for S 4922104376 and S 4922104377 probes	S 4922104681	
4	**V40PA-8/16** - 40 mm delay line for S 4922104376 and S 4922104377 probes	S 4922104700	
5	**PA-5M32E0.5P** - LINEAR ARRAY Frequency: **5 MHz** Pitch Size: **0.5 mm** Number of Elements: **32** Width (Elevation): **10 mm**	S 4922104379	Mark on the probe 104379
6	**PA-5M16E1P** - LINEAR ARRAY Frequency: **5 MHz** Pitch Size: **1 mm** Number of Elements: **16** Elevation: **10 mm**	S4922105503	Mark on the probe 105503
7	**PA-7.5M32E0.5P** - LINEAR ARRAY Frequency: **7.5 MHz** Pitch Size: **0.5 mm** Number of Elements: **32** Elevation: **10 mm**	S 4944109464	Mark on the probe 109464
8	**V20PA-32** - 20 mm delay line for S 4922104379, S4922105503, and S 4944109464 probes	S 4922104682	
9	**V40PA-32** - 40 mm delay line for S 4922104379, S4922105503, and S 4944109464 probes	S 4922104701	

#	*Item*	*Order Code (Part ##)*	*Note*
10	**PA-5M64E1.3P** - LINEAR ARRAY for inspection of composites with built-in delay line ("solid" water) Frequency: **5 MHz** Pitch Size: **1.3 mm** Number of Elements: **64** Width (Elevation): **8 mm**	S 4922104678	
11	**PA-5M64E1P** - LINEAR ARRAY Frequency: **5 MHz** Pitch Size: **1 mm** Number of Elements: **64** Width: **10 mm**	S 4922104381	Mark on the probe 104381
12	**V20PA-64 -** 20 mm delay line for S 4922104381 probe	S 4922104683	
13	**V40PA-64 -** 40 mm delay line for S 4922104381 probe	S 4922104702	
14	**PA-2.25M16E1P** - LINEAR ARRAY Frequency: **2.25 MHz** Pitch Size: **1 mm** Number of Elements: **16** Elevation: **13 mm**	S 4922105504	Mark on the probe 105504
15	**V20PA-16/1** - 20 mm delay line for S 4922105504 probe	S 4922104684	
16	**PA-2.25M16E1.5P** - LINEAR ARRAY Frequency: **2.25 MHz** Pitch Size: **1.5 mm** Number of Elements: **16** Elevation: **19 mm**	S 4922105505	Mark on the probe 105505
17	**V20PA-16/1.5** - 20 mm delay line for S 4922105505 probe	S 4922104685	

5.5. Optional SW Packages and Utilities

5.5.1. Options Menu

Options menu screen is presented below



To run selected optional SW package click on it's icon. Click on or press **Esc** to return to the menu of PA modalities modes

5.5.2. Linear Array PA Probes

5.5.2.1. K_{ls} Optional SW Utility – Delta Technique

Delta Technique is based on shear wave insonifying defects and analyzing both direct shear wave echo and diffracted mode converted longitudinal wave echo. *Delta Technique* is mainly applicable to the evaluation of detected defects if it is necessary to characterize them as either sharp (crack) or volumetric (porosity, slag, etc). In the **ISONIC 2009 UPA Scope** *Delta Technique* has been implemented with use of single wedged linear array probe through **K_{ls}** optional SW utility providing simultaneous observation and evaluation of both echoes

On start it is necessary to define new wedged linear array probe or select an existing one in the instrument's database – this procedure is identical to the described in the paragraph 5.3.1 of this Operating Manual

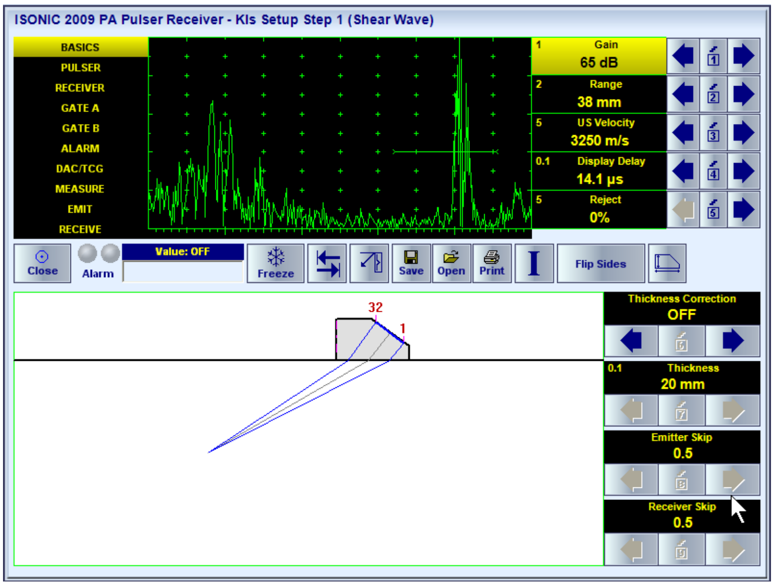
At the first evaluation step **ISONIC PA Pulser Receiver** to provide indication of the maximized direct shear wave echo from the reflector under evaluation. The following preliminary settings are required:

#	*Parameter or Mode*	*Setting*
1	**Pulser Mode**	**SINGLE**
2	**Aperture**	**4 ≤ Aperture ≤ N/2** whereas **N** is total ***Number Of Elements*** in the linear array probe
3	**Incidence Angle**	According to inspection procedure
4	**USVelocity**	Equal to the actual value of **shear wave** ultrasound velocity in the object under test
5	**Pulse Width, Firing Level**	**Pulse Width** and **Firing Level** settings to optimize signal to noise ratio **Pulse Width** to be around 1/F where F is frequency of PA probe
6	**Filter, Low Cut, and High Cut Frequencies**	**Filter** and **Low Cut** and **High Cut** settings to match with frequency of PA probe to optimize signal to noise ratio
7	**Display**	**Display** setting may be either **Full, RF, PosHalf,** or **NegHalf** – follow requirements the inspection procedure
8	**Surface Alignment**	**ON**
9	**aSwitch**	**ON**
10	**bSwitch**	**OFF**

Then maximize shear wave echo from defect under evaluation and:

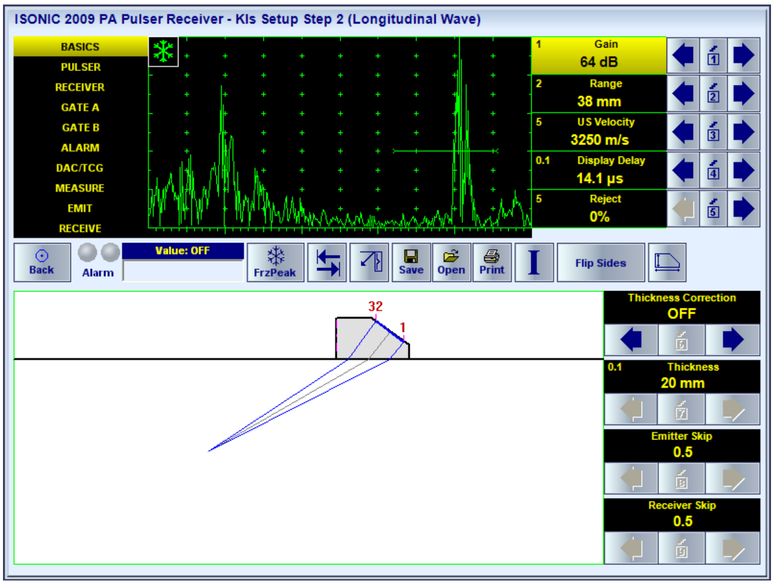
- ♦ manipulate **Gain** to bring the echo amplitude to 80…100% of the **A-Scan** height
- ♦ manipulate **Range** to bring the echo to horizontal position of 80% of the **A-Scan** width
- ♦ place **Gate A** over the echo
- ♦ save current settings into a ***.par** file, for that purpose click on **Save** or press **F11** then click on **Current Pulser Receiver**

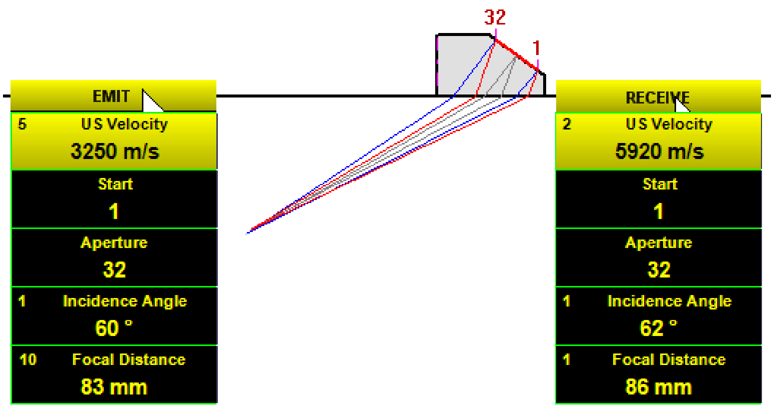
Continue holding of PA Probe in the position of receiving maximized shear wave echo and click on **I** or press **Shift** + **Enter** to proceed to the *second evaluation step*



At the second evaluation step **ISONIC PA Pulser Receiver** to provide indication of the diffracted mode converted longitudinal wave echo from the reflector under evaluation whilst PA Probe remains in the position found at the *first evaluation step*. For that purpose:

- ♦ load ***.par** file just saved at the *first evaluation step* – for that purpose click on **Open** or press **F12** then click on **Current Pulser Receiver**
- ♦ set **aSwitch** to **OFF** and **bSwitch** to **ON**
- ♦ switch **Pulser Mode** to **DUAL** and enter **RECEIVE** submenu





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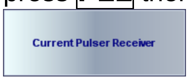
It is a special unique feature of **ISONIC 2009 UPA Scope** instrument utilized in K_{Is} optional SW utility that for **DUAL** setting of **Pulser Mode** it is possible to control **USVelocity** settings for the emitting and receiving aperture independently on each other:

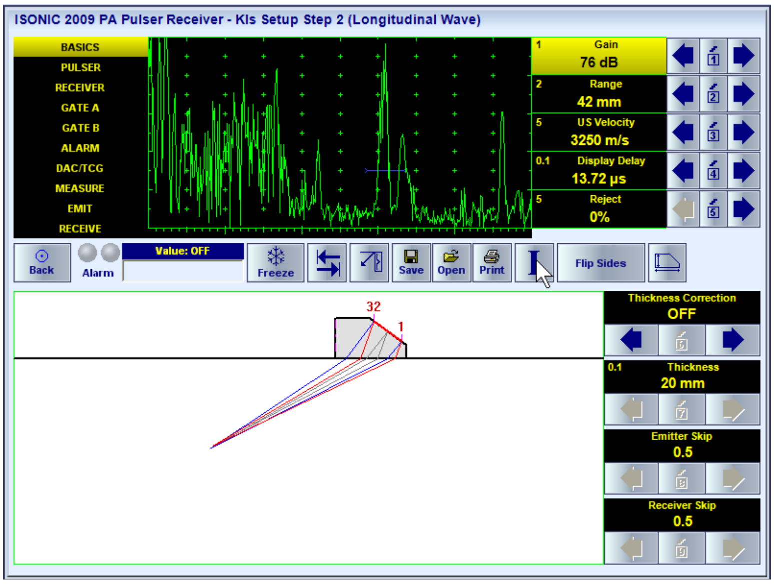
- ◻ **USVelocity** setting in the **BASICS** and **EMIT** submenu defines type of wave to be emitted and **A-Scan** time base
- ◻ **USVelocity** setting in the **RECEIVE** submenu defines type of wave for the received signals

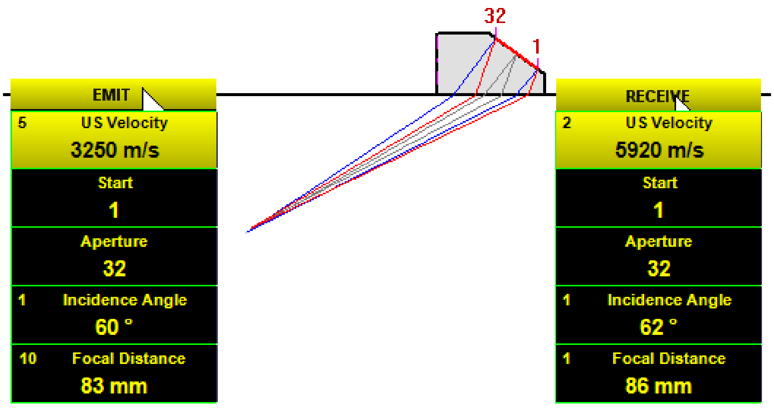
- in the **RECEIVE** submenu set **USVelocity** equal to **longitudinal wave** velocity in the material, then manipulate incidence angle (and **Focal Distance** on case of **Thickness Correction = OFF**) for the receiving aperture to provide matching of focal points for emitting and receiving – for above-provided settings the diffracted mode converted longitudinal wave echo from the reflector under evaluation to appear to horizontal position of approximately 60% of the **A-Scan** width
- switch to **BASICS** submenu and manipulate **Gain** to bring the echo to 80…100% of the **A-Scan** height
- place **Gate B** over the echo
- save current settings into a ***.par** file,

for that purpose click on 

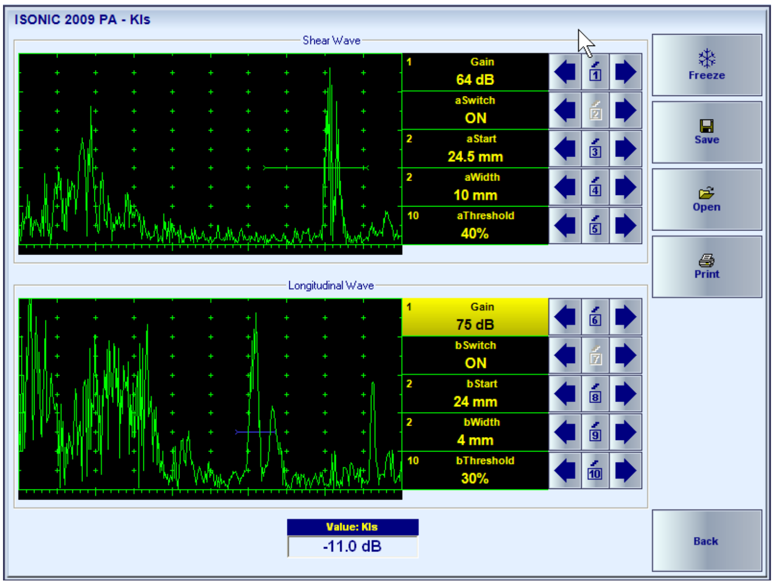
or press **F11** then click on 

Continue holding of PA Probe in the position of receiving maximized shear wave echo and click on  or press **Shift** + **Enter** to proceed to the *third evaluation step*

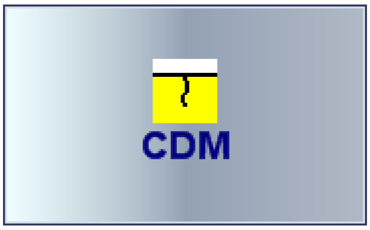




At the *third evaluation step* it is provided indication of both **A-Scans** on one screen through implementation of both created focal laws in a loop sequence. Value $\mathbf{K_{Is}}$ representing ratio between longitudinal and shear wave echoes is determined in indicated in the corresponding display window – that is quantitative parameter for the distinguishing between firmly sharp reflectors ($\mathbf{K_{Is} \geq -20dB}$) and volumetric reflectors ($\mathbf{K_{Is} \leq -30\ dB}$)



5.5.2.2. CDM Optional Utility – Sizing Of Near Surface Cracks (Crack Depth Measurement)



CDM optional SW utility of **ISONIC 2009 UPA Scope** instrument is dedicated to precise determining of the depth for cracks visible on the outer surface of various objects – pressure vessels, heavy thickness pipes, etc. For that purpose it is provided longitudinal wave insonification through wall cross section of object under test, receiving and imaging of tip diffraction echo along with back-wall echo and lateral wave signal, and precise sizing of the crack under evaluation through automatic computations based on measured time of flight for the above signals; 5 MHz and 2 MHz 64- or 32-elements linear arrays with straight delay lines either regular or special to be used. On start it is necessary to define new linear array probe with delay line or select an existing one in the instrument's database – this procedure is identical to the described in the paragraph 5.3.1 of this Operating Manual

In the **CDM Setup – Step 1** screen **ISONIC PA Pulser Receiver** to provide indication of the back-wall echo. The following preliminary settings are required:

#	***Parameter or Mode***	***Setting***
1	**Pulser Mode**	**DUAL**
2	**USVelocity**	Equal to the actual value of **longitudinal wave** ultrasound velocity in the object under test
3	**EMIT Aperture**	**N/4** whereas **N** is total ***Number Of Elements*** in the linear array probe
4	**EMIT Start**	**1**
5	**RECEIVE Aperture**	**N/4** whereas **N** is total ***Number Of Elements*** in the linear array probe
6	**RECEIVE Start**	**¾×N + 1**
7	**Surface Alignment**	**ON**
8	**Thickness Correction**	**ON**
9	**Thickness**	To be equal to actual wall thickness **WT**
10	**Emitter Skip**	**0.5**
11	**Receiver Skip**	**0.5**
12	**EMIT Focal Depth**	To be equal to actual wall thickness **WT**
13	**RECEIVE Focal Depth**	To be equal to actual wall thickness **WT**
14	**EMIT Incidence Angle**	> 0; To be calibrated synchronously with **RECEIVE Incidence Angle** by such a way that focal points for emitting and receiving aperture will match on the bottom surface: **EMIT Incidence Angle = – RECEIVE Incidence Angle**
15	**RECEIVE Incidence Angle**	< 0; To be calibrated synchronously with **EMIT Incidence Angle** by such a way that focal points for emitting and receiving aperture will match on the bottom surface: **RECEIVE Incidence Angle = – EMIT Incidence Angle**
16	**Pulse Width, Firing Level**	**Pulse Width** and **Firing Level** settings to optimize signal to noise ratio **Pulse Width** to be around 1/F where F is frequency of PA probe
17	**Filter, Low Cut, and High Cut Frequencies**	**Filter** and **Low Cut** and **High Cut** settings to match with frequency of PA probe to optimize signal to noise ratio
18	**Display**	**Display** setting may be either **Full, RF, PosHalf,** or **NegHalf** – follow requirements the inspection procedure
19	**aSwitch**	**ON**
20	**bSwitch**	**OFF**
21	**Meas Mode**	**Flank**

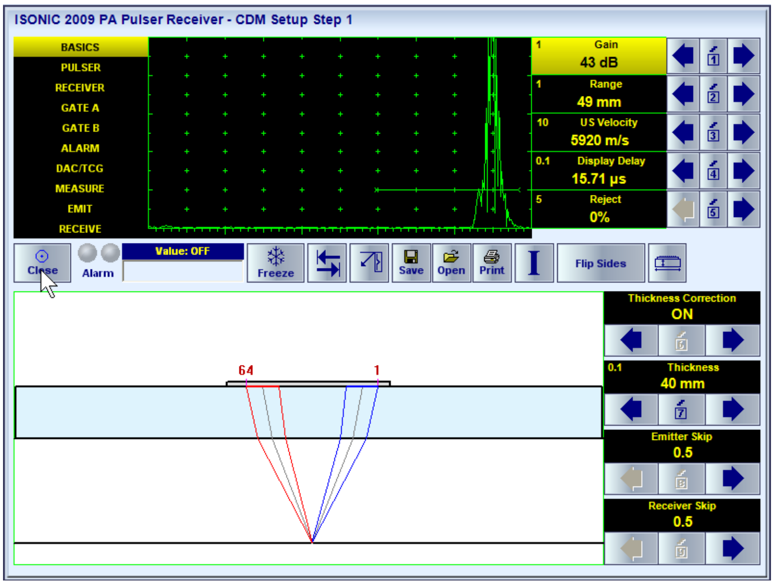
Upon preliminary settings are completed place PA probe onto the object under test outside of the crack area then:

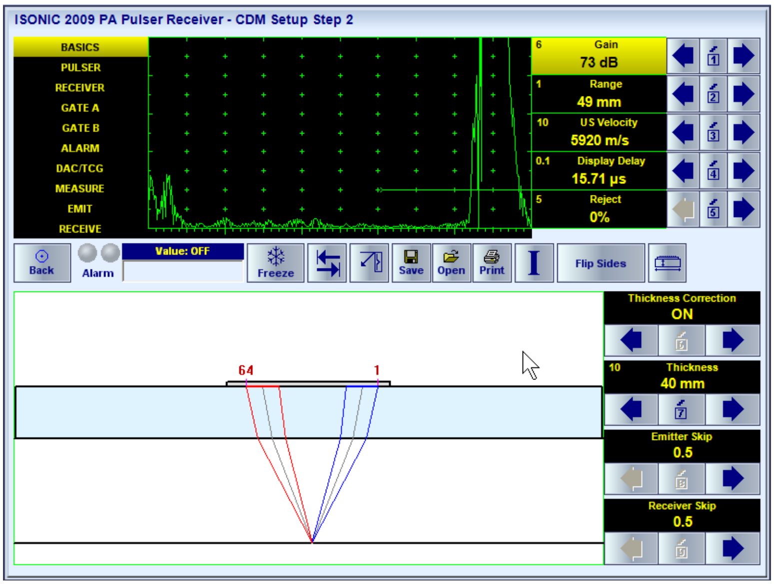
- obtain back wall echo and calibrate **Gain** to bring echo amplitude to 100% of **A-Scan** height
- set **Range** to provide appearance of back echo at approximately 90% of **A-Scan**
- cover back echo by **Gate A**
- save current settings into a ***.prs** file, for that purpose click on [Save] or press **F11** then click on [Current Pulser Receiver]

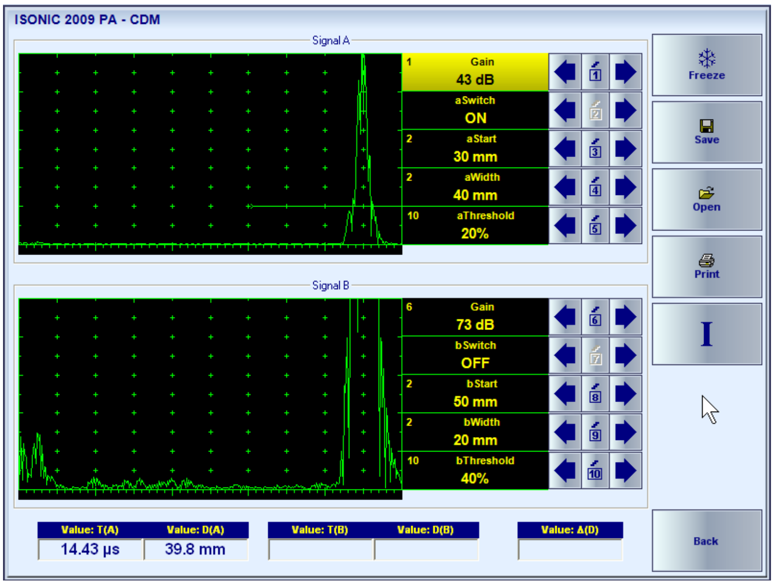
Continue holding of PA Probe in the position of receiving back wall echo and click on [I] or press **Shift** + **Enter** to proceed to the next **CDM Setup – Step 2** screen:

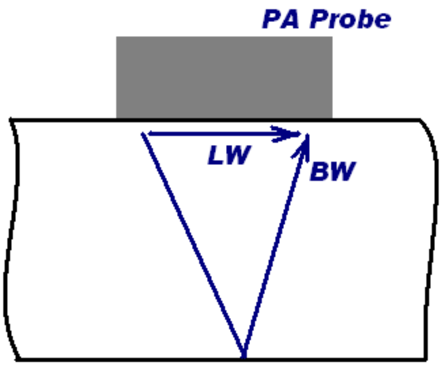
- load just saved ***.prs** file – for that purpose click on [Open] or press **F12** then click on [Current Pulser Receiver]
- increase **Gain** by **30 dB**
- set **aSwitch** to **OFF**

On completion continue holding of PA Probe in the position of receiving back wall echo and click on [I] or press **Shift** + **Enter** to proceed to the **CDM** screen. **CDM** screen is used for precise measurements of crack depth upon tip of the crack has been localized. So at that stage it is necessary to pass through **CDM** screen to the next one allowing localizing tip of crack easily – so simply click on [I] or press **Shift** + **Enter**





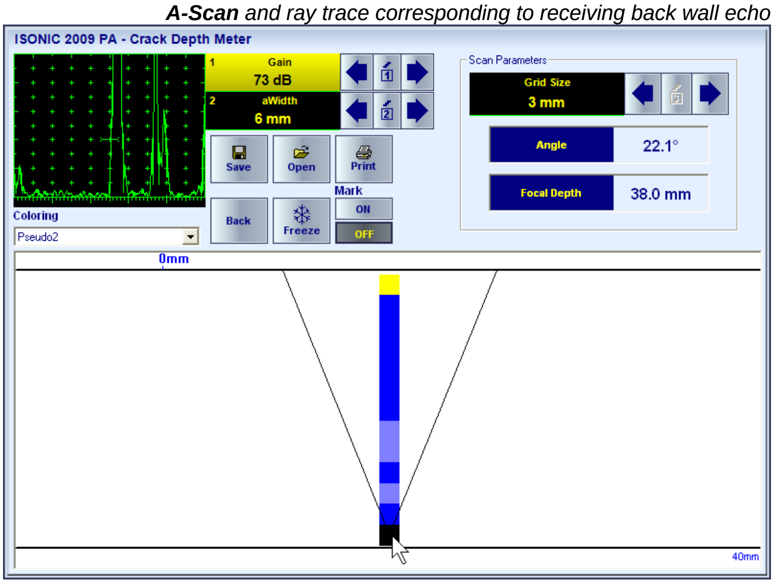




The **ISONIC 2009 Crack Depth Meter** screen becomes active. At this stage **ISONIC 2009 UPA Scope** instrument divides narrow area under the centerline of PA probe into a number of grids and implements several focal laws to insonify each grid. For every focal law (every greed):

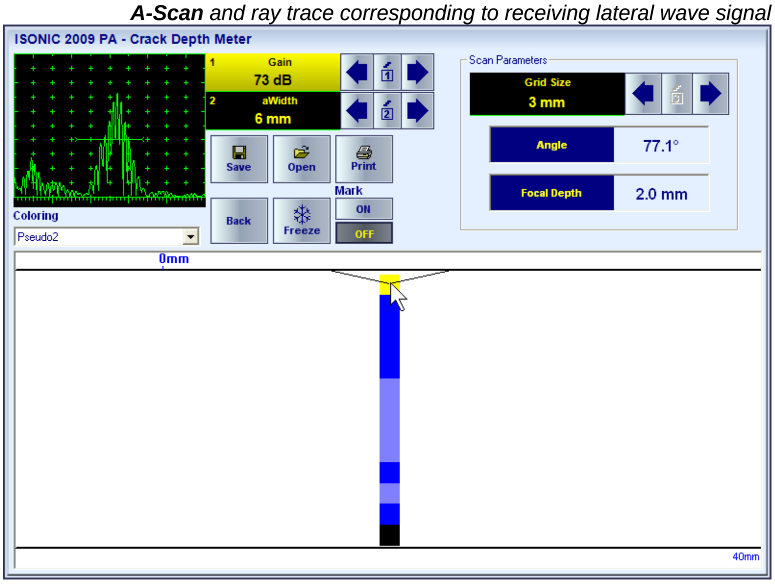
- emitting aperture generates longitudinal wave focused into the center of certain greed
- receiving aperture is focused to the center of the greed for longitudinal wave signal
- **A-Scan** range is calibrated automatically by such a way that the signal from possible obstacle located at the center of the greed will be situated at 50% of **A-Scan** width
- **Gate A** position is calibrated automatically to cover possible signal
- **B-Scan** image is formed through filling grids with color corresponding to signal amplitude within the **Gate A**

__A-Scan__ and ray trace corresponding to receiving back wall echo



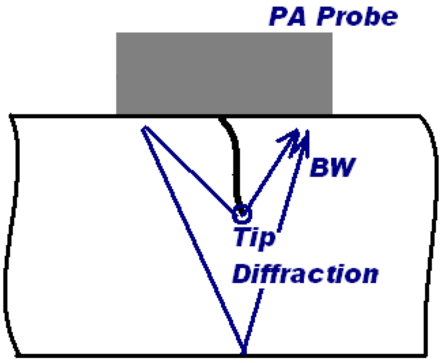
A-Scans for each focal law may be observed / marked along with implemented ray trace through manipulating cursor over the grids composing **B-Scan** – use  control

__A-Scan__ and ray trace corresponding to receiving lateral wave signal

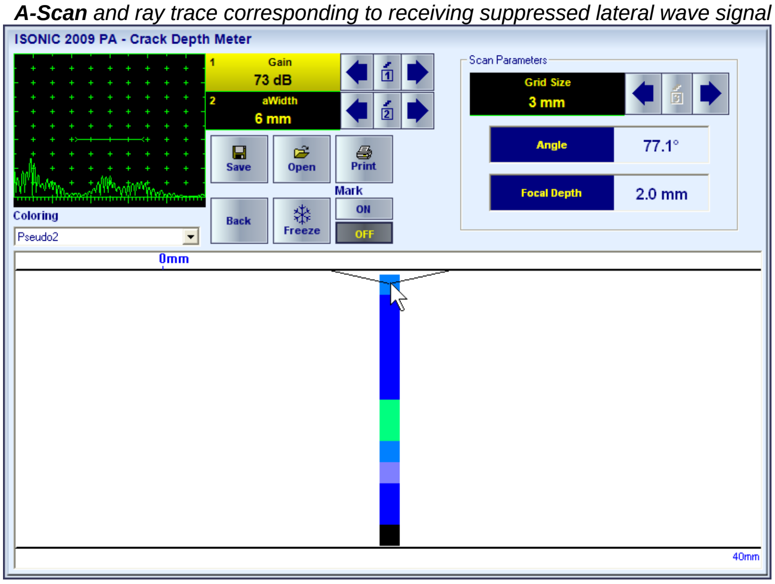


Whilst probe it placed over the area with no defect on the **B-Scan** there are clearly distinguished grids corresponding to receiving of back wall echo and lateral wave signals

On placing probe above crack to be sized at rectangle to the crack direction on outer surface lateral wave signal will be suppressed significantly whilst crack's tip diffraction signal will be received and corresponding grids will be distinguished clearly on the **B-Scan**



A-Scan and ray trace corresponding to receiving suppressed lateral wave signal

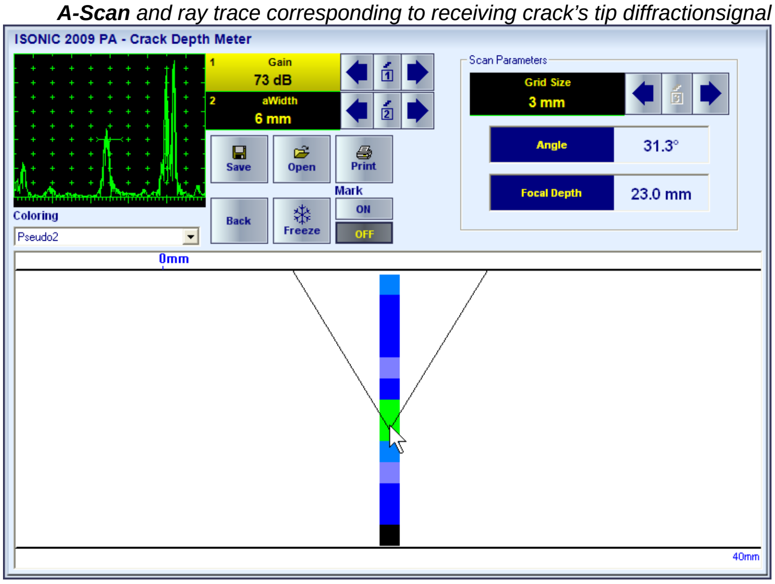


Place cursor over the grid representing crack's tip diffraction signal and maximize it through back and forward manipulation of PA Probe at rectangle to the crack line. On reaching maximized crack's tip diffraction signal mark the corresponding grid and take readings from

Angle	31.3°
Focal Depth	23.0 mm

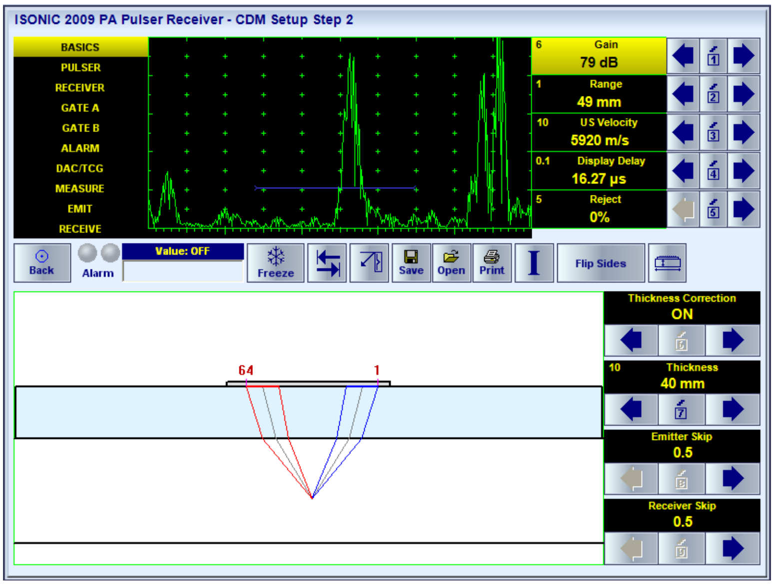
To size crack depth precisely remember readings as **A0** and **FD0** then click on Back or press or press **Esc** – this will return to **CDM** screen then click on Back or press or press **Esc** again – this will return to **CDM Setup – Step 2** screen

A-Scan and ray trace corresponding to receiving crack's tip diffractionsignal



ⓘ

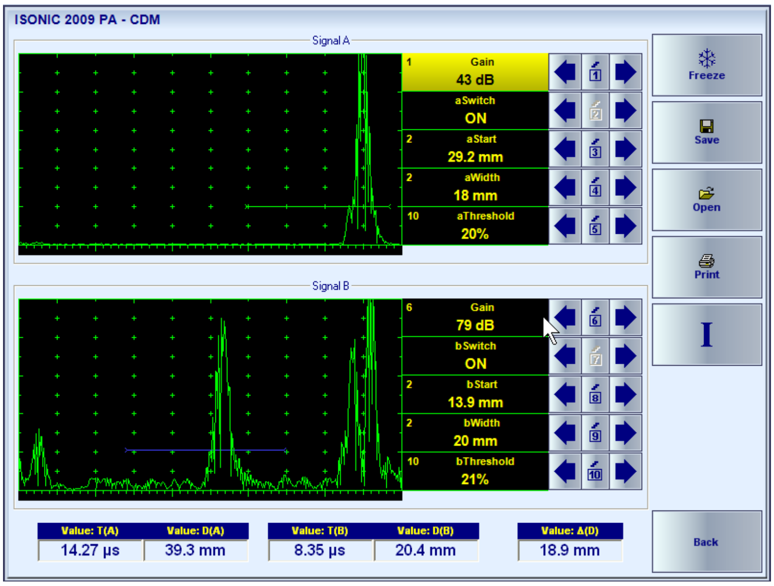
Other procedures in the **Crack Depth Meter** screen such as storing **B-Scan** into a file / upload from a file, Freeze / Unfreeze, etc are identical to already described – refer to paragraph 5.3.4.1.3 of this Operating Manual



Whilst in **CDM Setup – Step 2** screen:

- Set **EMIT Incidence Angle** to **A0**
- Set **EMIT Focal Depth** to **FD0**
- Set **RECEIVE Incidence Angle** to **A0**
- Set **RECEIVE Focal Depth** to **FD0**
- maximize crack's tip diffraction signal through back and forward manipulation of PA Probe at rectangle to the crack line
- set **bSwitch** to ON then cover crack's tip diffraction signal by **Gate B**

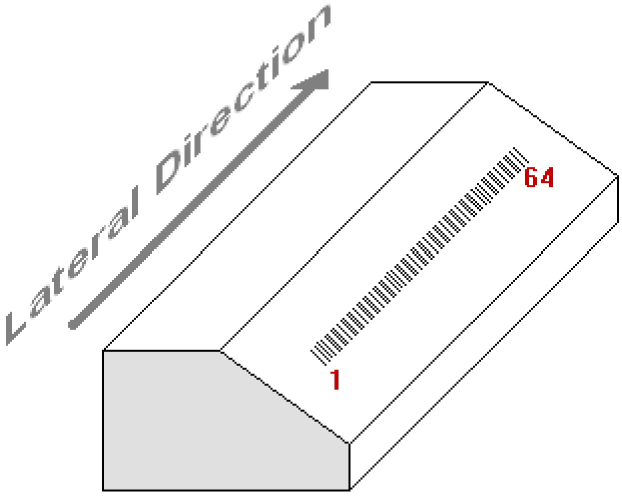
On completion click on **I** or press **Shift** + **Enter** – on the **CDM** screen it will be indicated:



- two **A-Scans** for focal laws – one for the receiving of back echo; second – for the receiving of the maximized crack's tip diffraction signal
- 5 digital readouts as below:

T(A)	**-**	**time of flight for back wall echo**
D(A)	**-**	**measured wall thickness**
T(B)	**-**	**time of flight for crack's tip diffraction signal**
D(B)	**-**	**measured crack depth**
Δ(D)	**-**	**remaining wall thickness under the crack's tip**

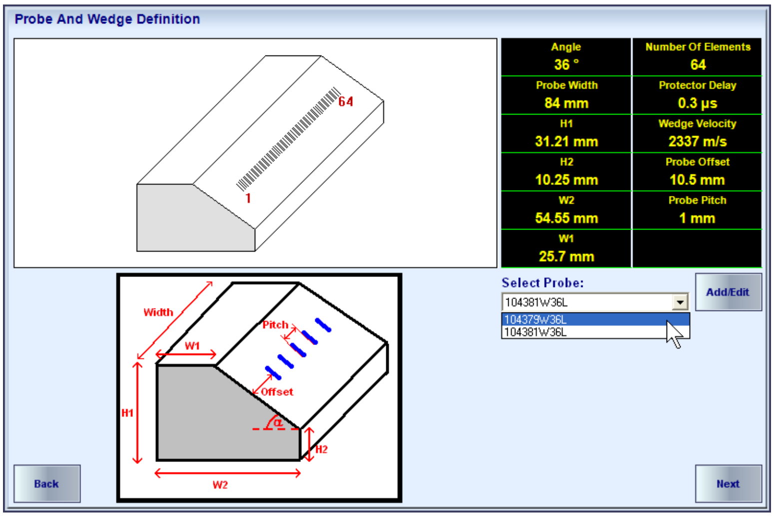
5.5.2.3. Lateral Scanning Optional Inspection SW Package



LATERAL SCANNING optional SW package of **ISONIC 2009 UPA Scope** instrument relates to the inspection of various objects with use of wedged linear array probes providing generating and receiving of either guided, surface, or shear waves. Linear arrays are situated on the wedge laterally so that incidence angle is fixed being defined by wedge geometry only. On the other hand it is possible swiveling of ultrasonic beam in the material electronically through controlling azimuth direction for emitting / receiving aperture. Also if the aperture size is less than total number of elements of linear array then it is possible to perform linear scanning of the material in lateral direction electronically

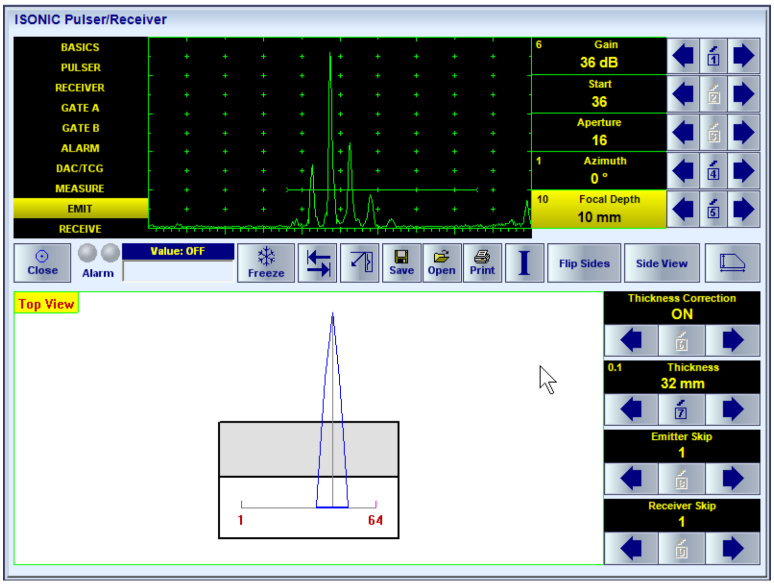
5.5.2.3.1. Probe selection

On start it is necessary to define new wedged linear array probe or select an existing one in the instrument's database – this procedure is identical to the described in the paragraph 5.3.1 of this Operating Manual. On completion click on  or press **Shift** + **Enter**



5.5.2.3.2. ISONIC PA Pulser Receiver

To control **ISONIC PA Pulser Receiver** refer to paragraph 5.5.3 of this Operating Manual and notes below

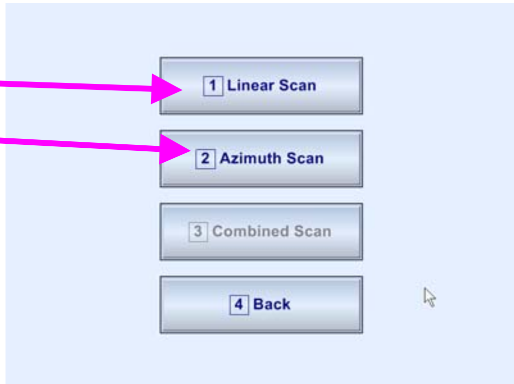


- **Azimuth** is setting to control swiveling of ultrasonic beam
- **Top**, **Side**, and **End** views of probe placed onto material and ultrasonic beam in the material may be selected for viewing through click on the Top View, Side View, End View button (caption of the button is varying depending on the next available view)

5.5.2.3.3. Modes of Lateral Scanning and Imaging

There are two modes of lateral scanning possible:

- Linear – click on
- Azimuth – click on



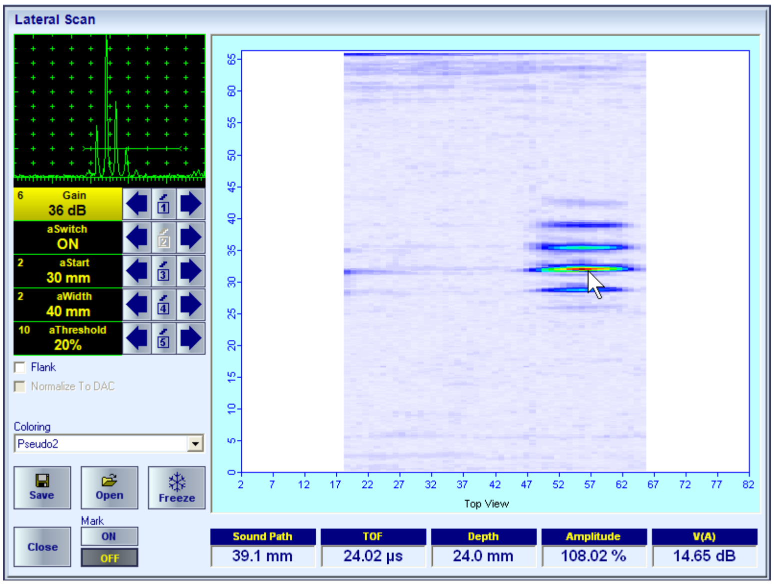
Linear scanning at fixed swiveling angle (azimuth) is performed through electronic shift of predetermined aperture within entire linear array comprising more elements than aperture size

Azimuth scanning is through varying of swiveling angle (azimuth) in a certain range whilst the aperture is fixed

5.5.2.3.4. Linear Scan

It is recommended to perform *Gain per Shot Correction* prior to Linear Scan – the procedure is identical to the described in the paragraph 5.3.4.1.2 of this Operating Manual

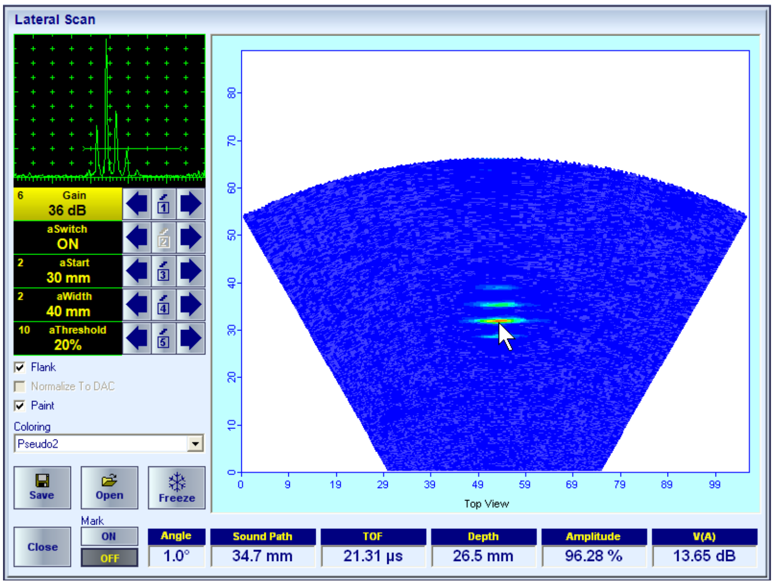
Whilst **Linear Scan** screen is active **ISONIC 2009 UPA Scope** produces the **CB-Scan** image is produced. Control of the instrument is the same as it is described in the paragraph 5.3.4.1.3 of this Operating Manual



5.5.2.3.5. Azimuth Scan

It is recommended to perform *Gain per Swiveling Angle Correction* prior to Linear Scan – the procedure is identical to the described in the paragraph 5.3.4.1.2 of this Operating Manual

Whilst **Linear Scan** screen is active **ISONIC 2009 UPA Scope** produces the **CB-Scan** image is produced. Control of the instrument is the same as it is described in the paragraph 5.3.4.1.3 of this Operating Manual

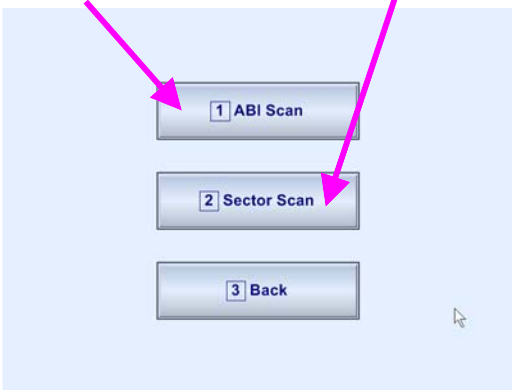


Movie illustrating operating of **ISONIC 2009 UPA Scope** whilst running **Lateral Scanning** SW is available for viewing / download at **http://www.sonotronndt.com/PDF/OM2009/LATERAL.wmv**

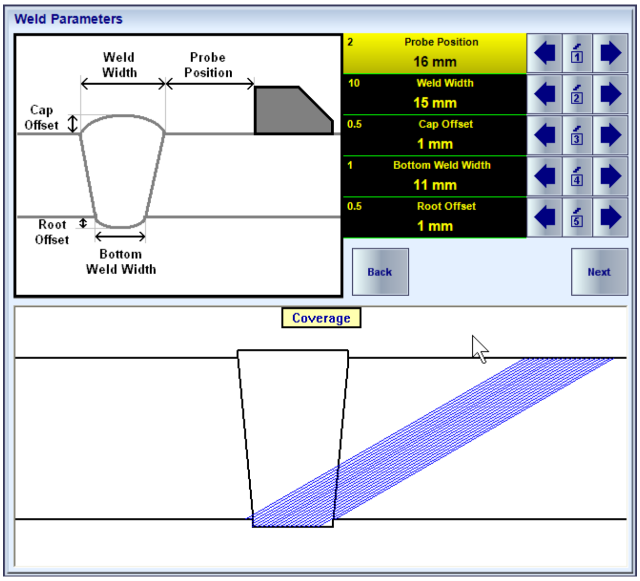
5.5.2.4. EXPERT – Optional Inspection SW Package For Welds

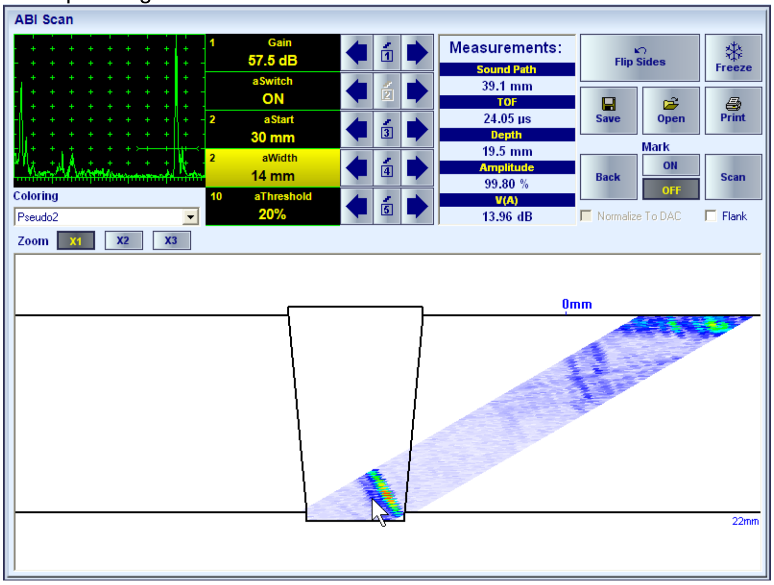
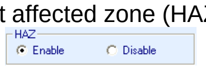
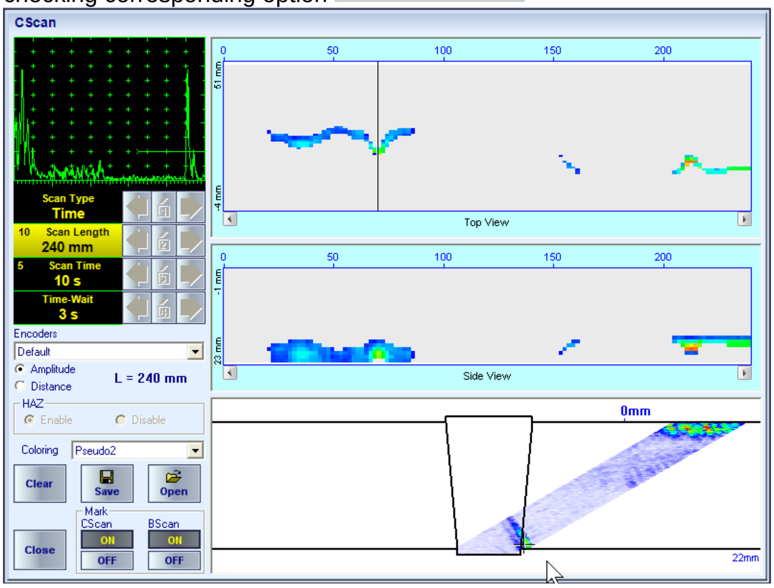
EXPERT optional SW package of **ISONIC 2009 UPA Scope** instrument is dedicated to the inspection of welds having planar cross section. It is applicable to planar and circumferential butt welds, corner welds, nozzles, tee welds, and the like. On start it is necessary to define new wedged linear array probe or select an existing one in the instrument's database – this procedure is identical to the described in the paragraph 5.3.1 of this Operating Manual. Next step is selection of the way to insonify cross section of the weld – there are 2 ways available:

B-Scan and **Sector Scan** (**S-Scan**)



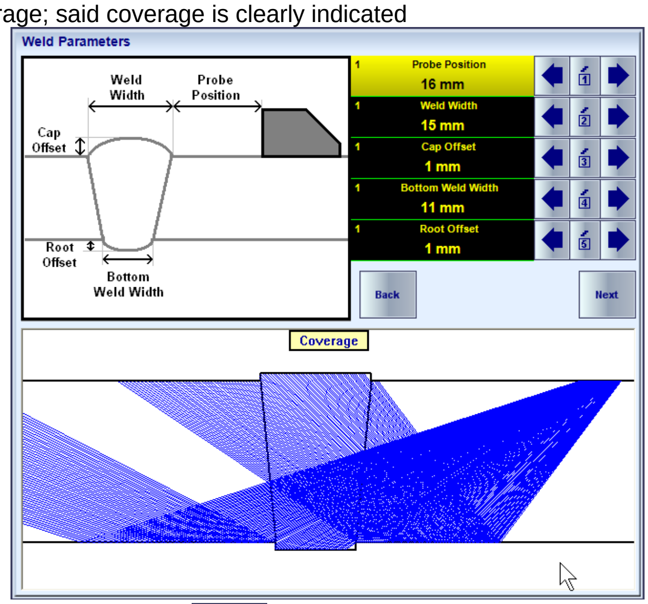
5.5.2.4.1. B-Scan

#	Task	Instruction
1	Calibration of **ISONIC PA Pulser Receiver**	Refer to paragraph 5.3.4.1.1 of this Operating Manual
2	Calibration of **Gain Per Shot Correction**	Refer to paragraph 5.3.4.1.2 of this Operating Manual
3	Weld definition and selection of probe position	There is a number for parameters characterizing weld geometry to be keyed in. Then probe position to be selected to provide necessary coverage; said coverage is clearly indicated  On completion click on [Next] or press **Shift** + **Enter** to proceed with **TTGI B-Scan** For more instructions on weld cross section geometry settings refer to paragraph 5.5.2.4.3 of this Operating Manual

#	Task	Instruction
4	**TTGI B-Scan**	**TTGI B-Scan** represents actual coverage of the material. To control instrument in that screen refer to paragraphs 5.3.4.1.3 and 5.3.4.1.4 of this Operating Manual 
5	**3D** data recording through linear scanning (**C-Scan**, **Top** and **Side Views**)	To control instrument in that screen refer to paragraph 5.3.4.1.5 of this Operating Manual. In addition it is necessary to define the region of interest as either including heat affected zone (HAZ) or not through checking corresponding option  

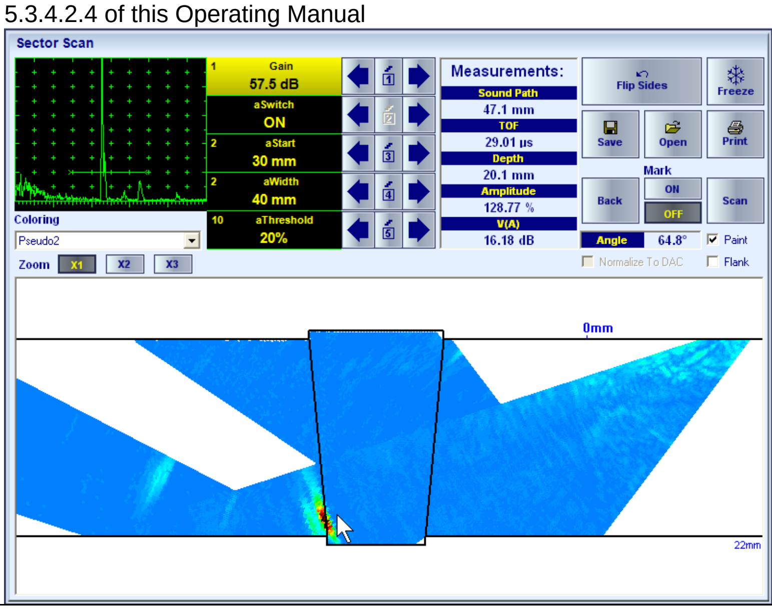
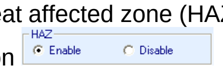
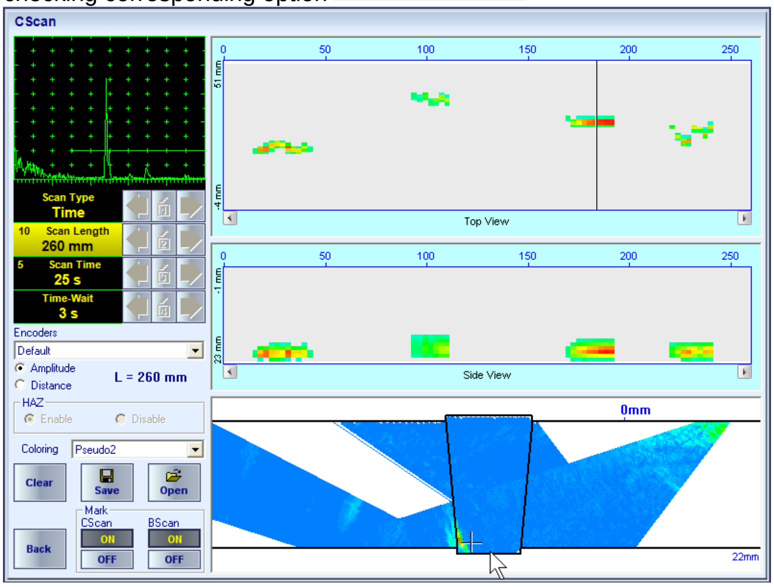
5.5.2.4.2. Sector-Scan

<table>
<tr><th>#</th><th>Task</th><th>Instruction</th></tr>
<tr><td>1</td><td>Calibration of ISONIC PA Pulser Receiver</td><td>Refer to paragraph 5.3.4.2.1 of this Operating Manual</td></tr>
<tr><td>2</td><td>Calibration of Gain Per Angle Correction</td><td>Refer to paragraph 5.3.4.2.2 of this Operating Manual</td></tr>
<tr><td>3</td><td>Weld definition and selection of probe position</td><td>There is a number for parameters characterizing weld geometry to be keyed in. Then probe position to be selected to provide necessary coverage; said coverage is clearly indicated



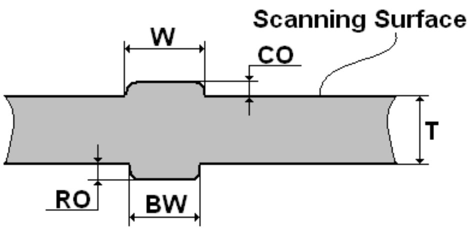
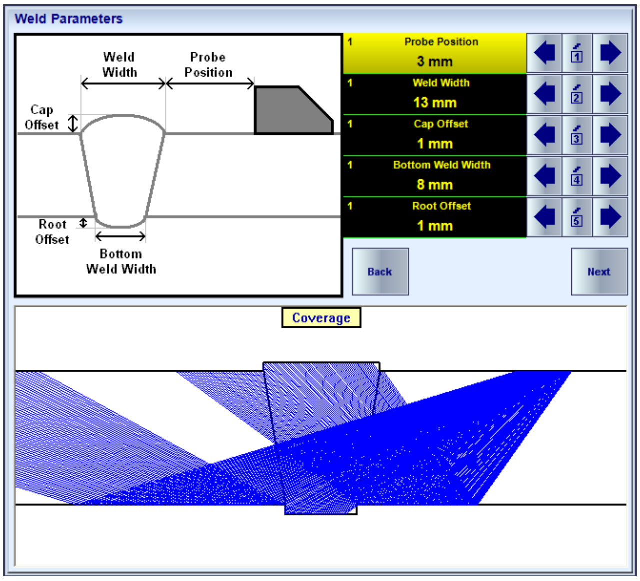
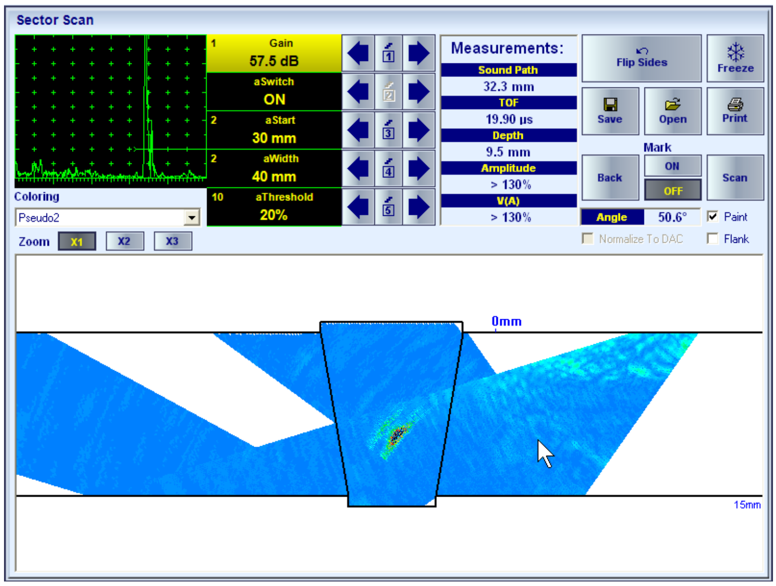
On completion click on 

or press Shift + Enter to proceed with TTGI Sector-Scan
For more instructions on weld cross section geometry settings refer to paragraph 5.5.2.4.3 of this Operating Manual</td></tr>
</table>

#	Task	Instruction
4	**TTGI Sector-Scan**	**TTGI Sector-Scan** represents actual coverage of the material. To control instrument in that screen refer to paragraphs 5.3.4.2.3 and 5.3.4.2.4 of this Operating Manual 
5	**3D** data recording through linear scanning (**C-Scan**, **Top** and **Side Views**)	To control instrument in that screen refer to paragraph 5.3.4.2.5 of this Operating Manual. In addition it is necessary to define the region of interest as either including heat affected zone (HAZ) or not through checking corresponding option  

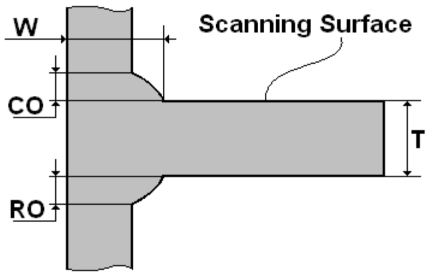
5.5.2.4.3. Weld Cross Section Geometry Settings

EXPERT SW option is suitable for the inspection of welds of various geometries. To provide the required coverage and imaging the weld parameters to be entered accordingly, typical examples are presented below

Weld Geometry and Probe Placement	Coverage and TTGI Cross Sectional View
Butt weld, all possible types of preparation  Required geometry settings: **Thickness = T** **Weld Width = W** **Bottom Weld Width = BW** **Cap Offset = CO** **Root Offset = RO**	 

<table>
<tr><th>Weld Geometry and Probe Placement</th><th>Coverage and TTGI Cross Sectional View</th></tr>
<tr><td>

Tee-weld, scanning above web



Required geometry settings:

Thickness = T

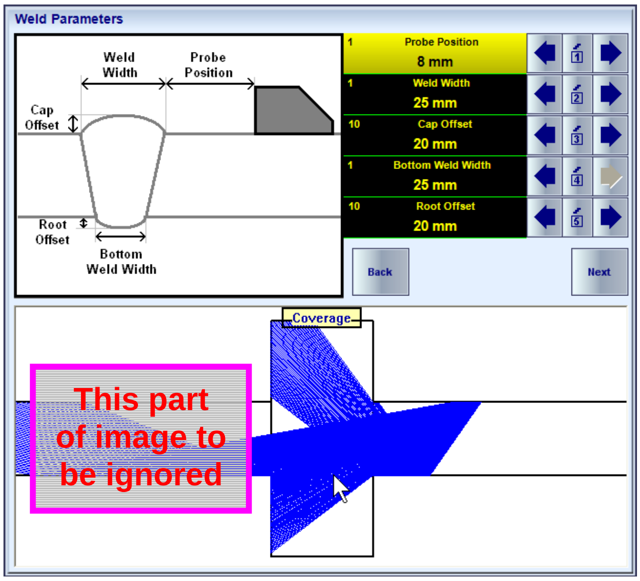
Weld Width = W

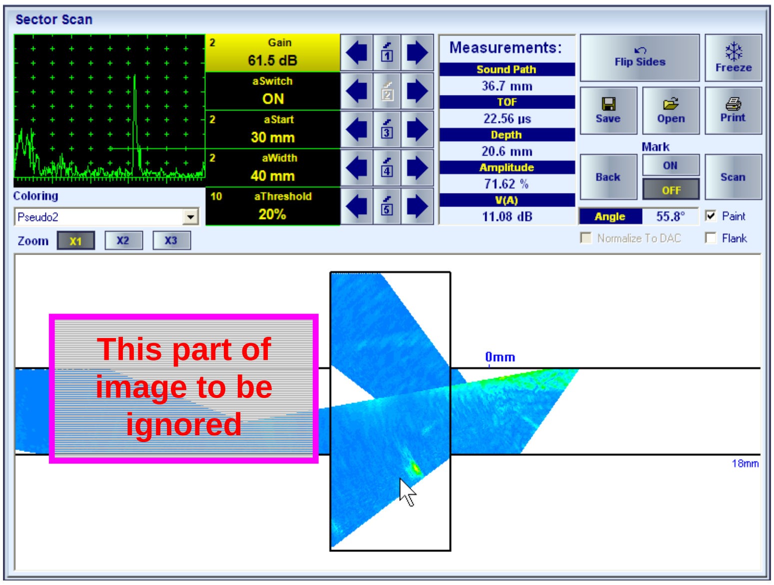
Bottom Weld Width = W

Cap Offset ≥ CO

Root Offset ≥ RO

</td><td>

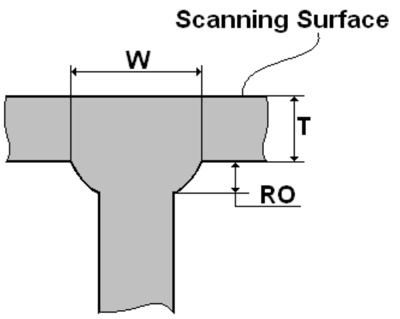




</td></tr>
</table>

Weld Geometry and Probe Placement	Coverage and TTGI Cross Sectional View

Tee-weld, scanning above outer surface of the flange



Required geometry settings:

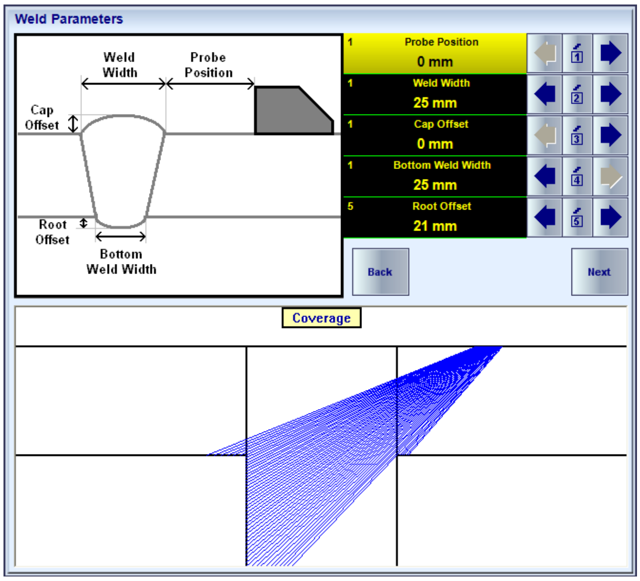
Thickness = T

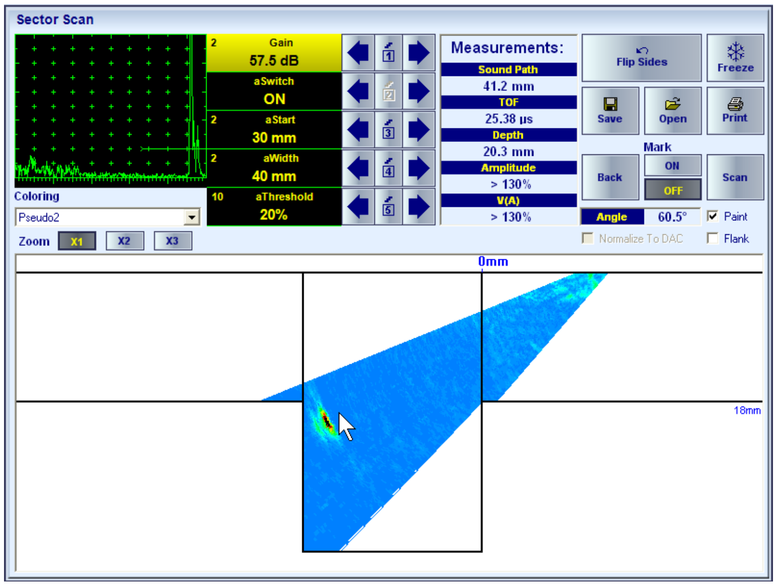
Weld Width = W

Bottom Weld Width = W

Cap Offset = 0

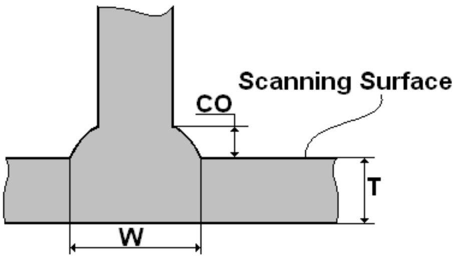
Root Offset ≥ RO





<table>
<tr><th>Weld Geometry and Probe Placement</th><th>Coverage and TTGI Cross Sectional View</th></tr>
<tr><td>

Tee-weld, scanning above inner surface of the flange



Required geometry settings:

Thickness = T

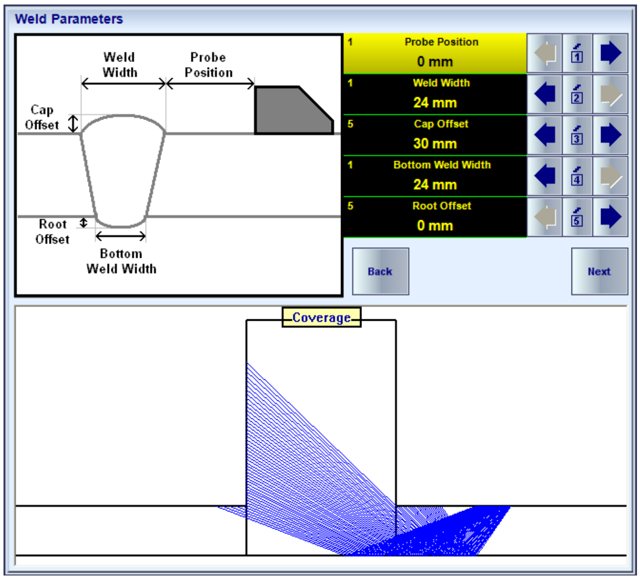
Weld Width = W

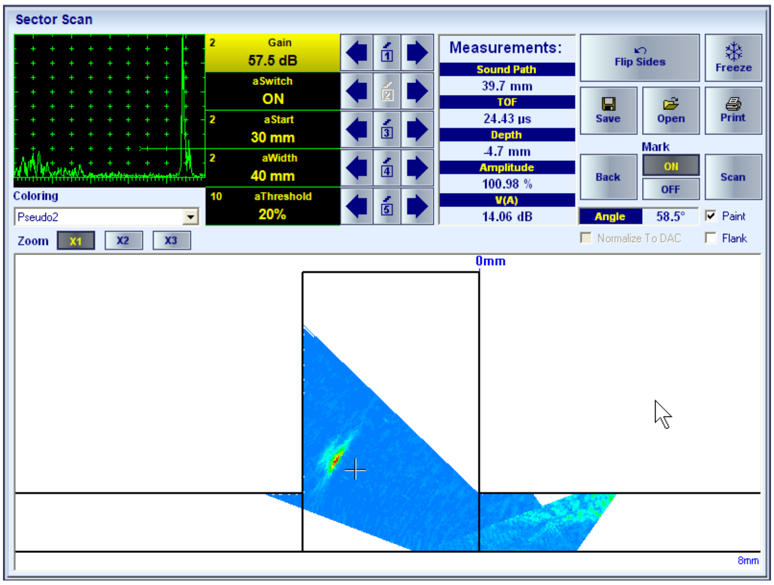
Bottom Weld Width = W

Cap Offset ≥ CO

Root Offset = 0

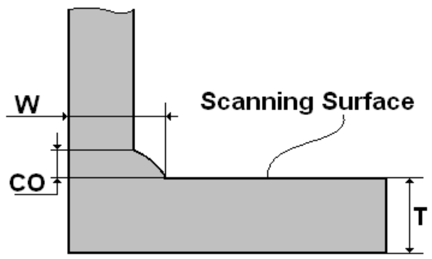
</td><td>





</td></tr>
</table>

<table>
<tr><th>Weld Geometry and Probe Placement</th><th>Coverage and TTGI Cross Sectional View</th></tr>
<tr><td>
Corner / Nozzle weld



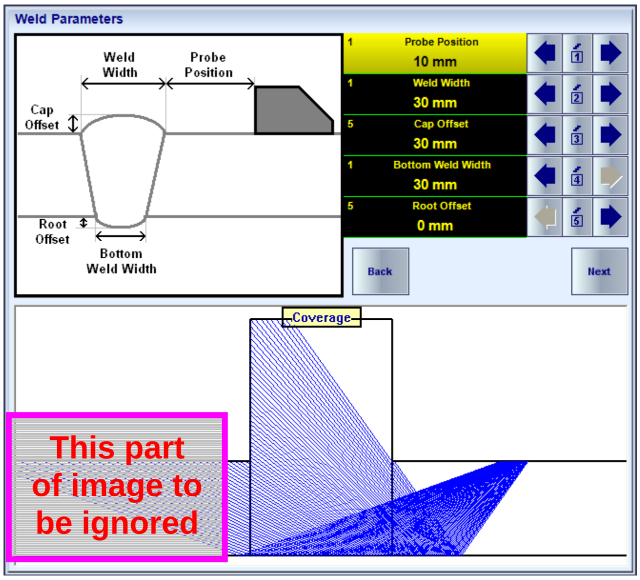
Required geometry settings:

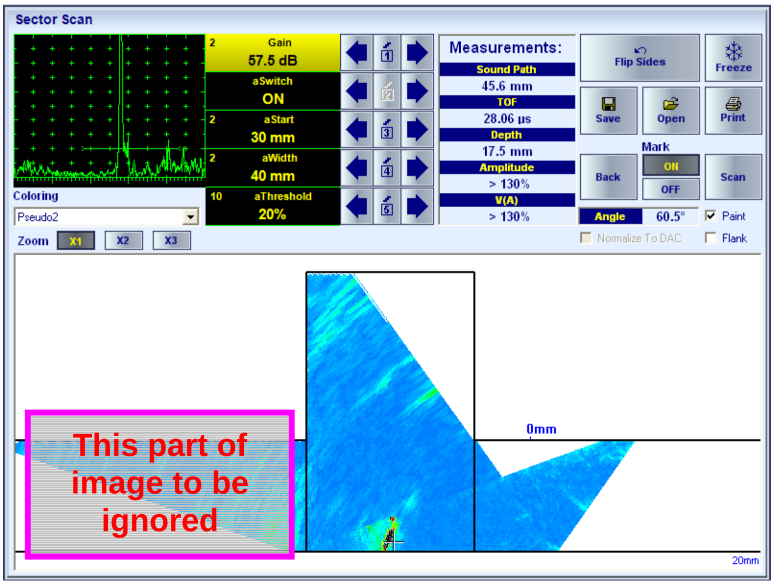
Thickness = T

Weld Width = W

Bottom Weld Width = W

Cap Offset ≥ CO

Root Offset = 0
</td><td>


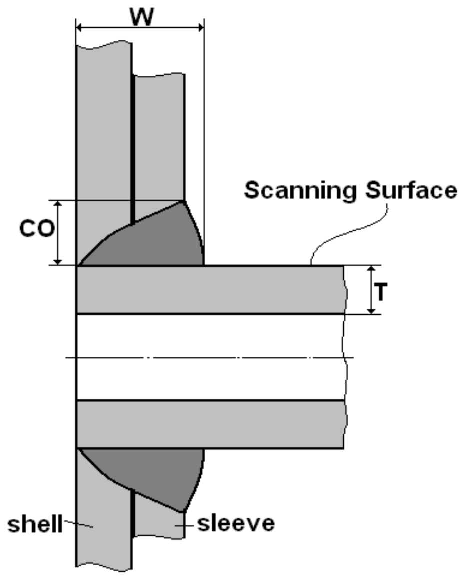


</td></tr>
</table>

Weld Geometry and Probe Placement

Coverage and TTGI Cross Sectional View

Nozzle weld into shell through sleeve



Required geometry settings:

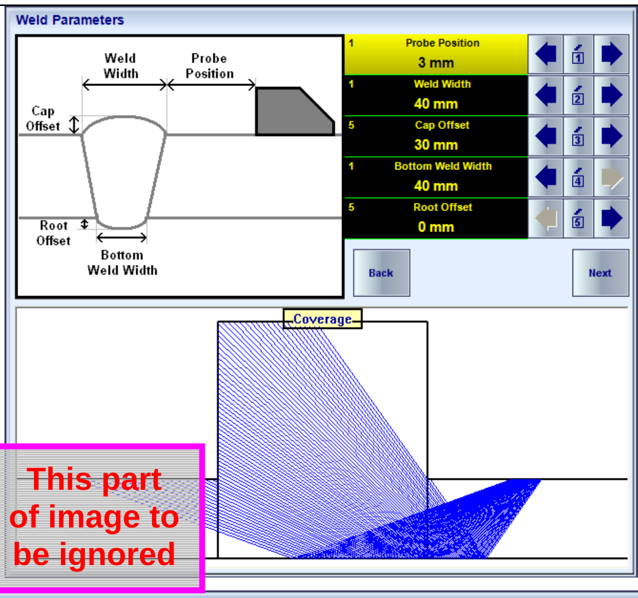
Thickness = T

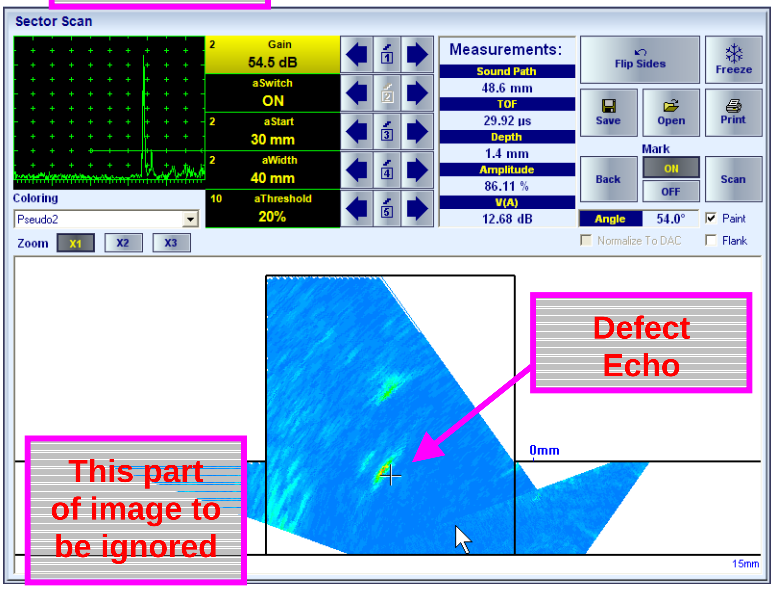
Weld Width = W

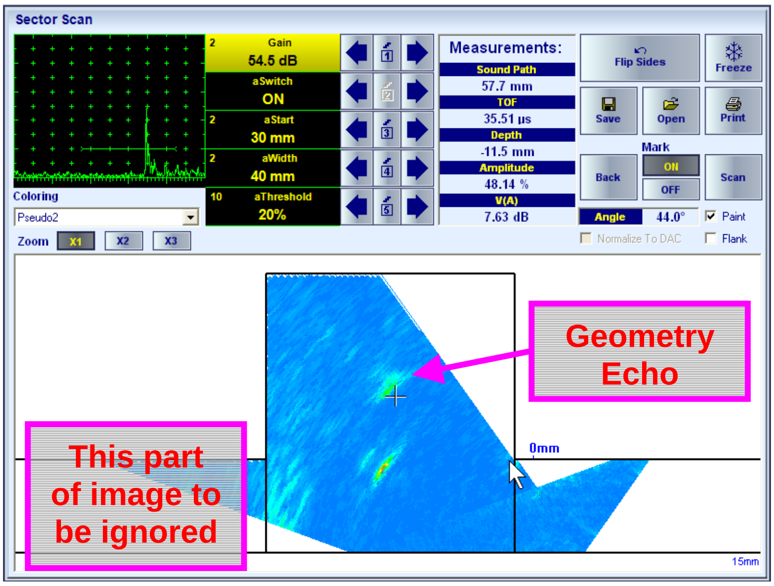
Bottom Weld Width = W

Cap Offset ≥ CO

Root Offset = 0

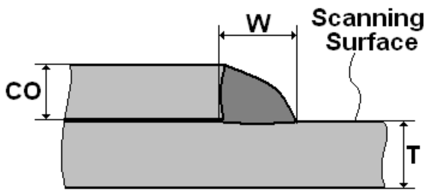






Weld Geometry and Probe Placement	Coverage and TTGI Cross Sectional View

Lap joint



Required geometry settings:

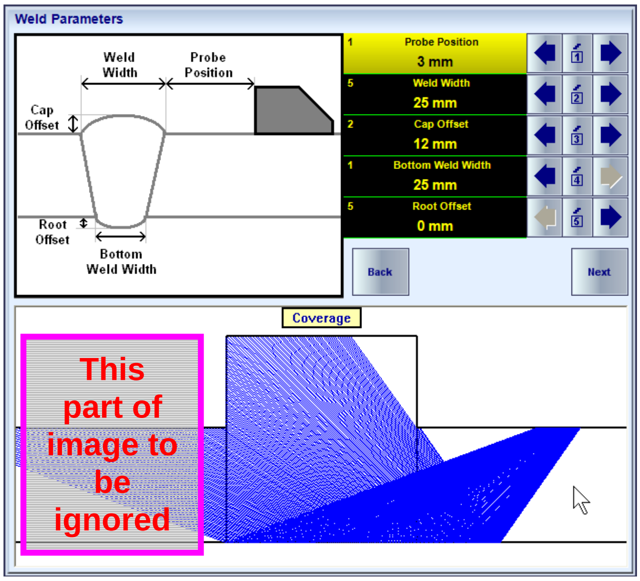
Thickness = T

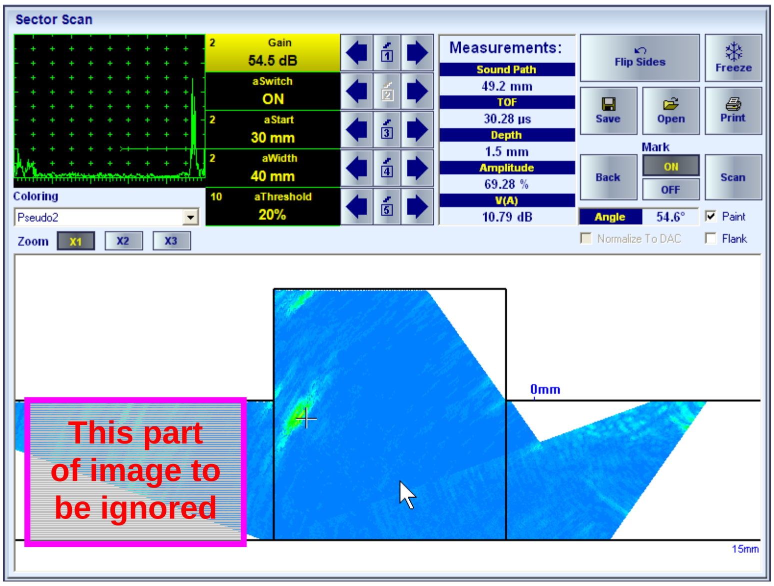
Weld Width ≥ W

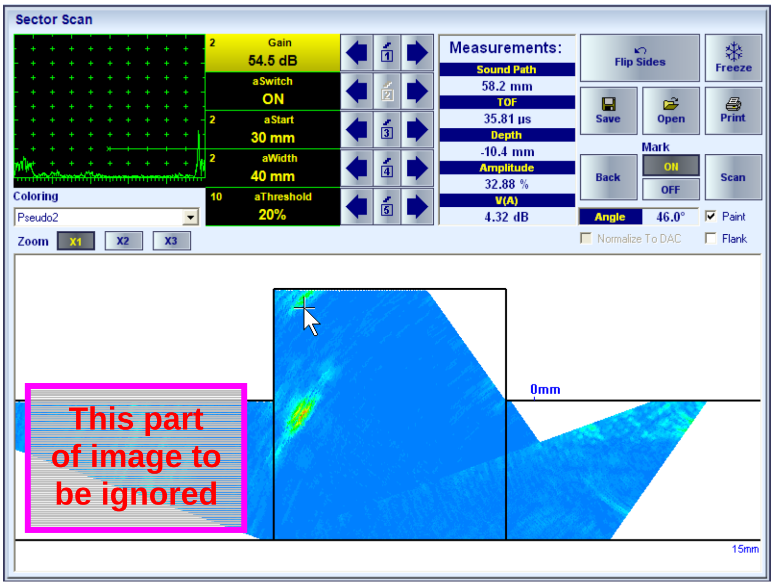
Bottom Weld Width = Weld Width

Cap Offset = CO

Root Offset = 0

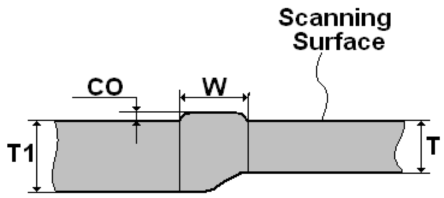






Weld Geometry and Probe Placement	Coverage and TTGI Cross Sectional View

Butt weld between two parts with different thickness of parent material



Required geometry settings:

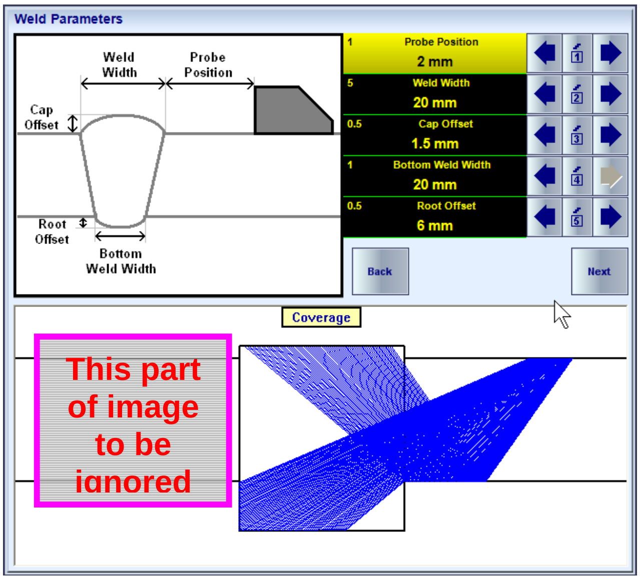
Thickness = T

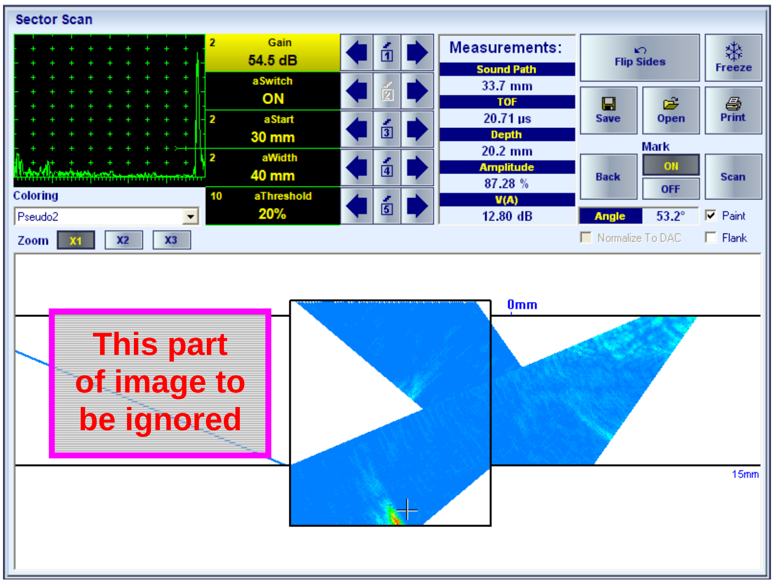
Weld Width = W

Bottom Weld Width = Weld Width

Cap Offset = CO

Root Offset = T1 - T





5.5.2.5. EXPERT CU – Optional Inspection SW Package For Tubular Objects, Rods, and Welds

EXPERT CU optional SW package of **ISONIC 2009 UPA Scope** instrument is dedicated to the inspection of:

- tubular objects
- rods
- welded joints of several types such as:
  - longitudinal welds in pipes, pressure vessels, and the like
  - butt welds between spherical shape components
  - TKY welds

5.5.2.5.1. Circumferential Insonification

Whilst running **EXPERT CU** insonification of object under test is performed circumferentially. For that purpose linear array probes equipped with contoured wedges are suitable, the exemplary list of probes is present below

#	*Item*	*Order Code (Part ##)*	*Note*
1	**PA-2M8E1P** - LINEAR ARRAY Frequency: **2 MHz** Pitch Size: **1 mm** Number of Elements: **8** Elevation: **9 mm**	S 4922104376	Mark on the probe 104376
2	**PA-4M16E0.5P** - LINEAR ARRAY Frequency: **4 MHz** Pitch Size: **0.5 mm** Number of Elements: **16** Elevation: **9 mm**	S 4922104377	Mark on the probe 104377
3	**VKPA-8/16** - 36° wedge (55° central angle for shear wave in low carbon steel) for S 4922104376 and S 4922104377 probes	S 4922104378	Suitable for OD ≥ 1000 mm Linear array probes equipped with that wedge are defined in the instrument database as □ 104378W36 □ 104377W36
4	**VKPA-8/16 CU XXX** - 36° wedge (55° central angle for shear wave in low carbon steel) - circumferentially contoured for XXX mm OD /// for S 4922104376 and S 4922104377 probes	S 4922104378 CUC XXX	Suitable for OD < 1000 mm Linear array probes equipped with that wedge are defined in the instrument database as □ 104378W36CUCxxx □ 104377W36 CUCxxx whereas xxx is OD expressed in mm
5	**PA-5M32E0.5P** - LINEAR ARRAY Frequency: **5 MHz** Pitch Size: **0.5 mm** Number of Elements: **32** Width (Elevation): **10 mm**	S 4922104379	Mark on the probe 104379
6	**PA-5M16E1P** - LINEAR ARRAY Frequency: **5 MHz** Pitch Size: **1 mm** Number of Elements: **16** Elevation: **10 mm**	S4922105503	Mark on the probe 105503
7	**PA-7.5M32E0.5P** - LINEAR ARRAY Frequency: **7.5 MHz** Pitch Size: **0.5 mm** Number of Elements: **32** Elevation: **10 mm**	S 4944109464	Mark on the probe 109464
8	**VKPA-32** - 36° wedge (55° central angle for shear wave in low carbon steel) for S 4922104379, S4922105503, and S 4944109464 probes	S 4922104380	Suitable for OD ≥ 1000 mm Linear array probes equipped with that wedge are defined in the instrument database as □ 104379W36 □ 105503W36 □ 109464W36
9	**VKPA-32 CUC XXX** - 36° wedge (55° central angle for shear wave in low carbon steel) - circumferentially contoured for XXX mm OD /// for S 4922104379, S4922105503, and S 4944109464 probes	S 4922104380 CUC XXX	Suitable for OD < 1000 mm Linear array probes equipped with that wedge are defined in the instrument database as □ 104379W36CUCxxx □ 105503W36CUCxxx □ 109464W36CUCxxx whereas xxx is OD expressed in mm

#	*Item*	*Order Code (Part ##)*	*Note*
10	**PA-5M64E1P** - LINEAR ARRAY Frequency: **5 MHz** Pitch Size: **1 mm** Number of Elements: **64** Width: **10 mm**	S 4922104381	Mark on the probe 104381
11	**VKPA-64** - 36° wedge (55° central angle for shear wave in low carbon steel) for S 4922104381 probe	S 4922705119	Suitable for OD ≥ 1200 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 104381W36
12	**VKPA-64 CUC XXXX** - 36° wedge - 36° wedge (55° central angle for shear wave in low carbon steel) - circumferentially contoured for XXXX mm OD /// for S 4922104381 probe	S 4922705119 CUC XXXX	Suitable for OD < 1200 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 104381W36CUCxxxx whereas xxxx is OD expressed in mm
13	**PA-2.25M16E1P** - LINEAR ARRAY Frequency: **2.25 MHz** Pitch Size: **1 mm** Number of Elements: **16** Elevation: **13 mm**	S 4922105504	Mark on the probe 105504
14	**VKPA-16/1** - 36° wedge (55° central angle for shear wave in low carbon steel) for S 4922105504 probe	S 4922104679	Suitable for OD ≥ 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 105504W36
15	**VKPA-16/1 CUC XXX** - 36° wedge (55° central angle for shear wave in low carbon steel) - circumferentially contoured for XXX mm OD /// for S 4922105504 probe	S 4922104679 CU XXX	Suitable for OD < 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 105504W36CUCxxx whereas xxx is OD expressed in mm
16	**PA-2.25M16E1.5P** - LINEAR ARRAY Frequency: **2.25 MHz** Pitch Size: **1.5 mm** Number of Elements: **16** Elevation: **19 mm**	S 4922105505	Mark on the probe 105505
17	**VKPA-16/1.5** - 36° wedge (55° central angle for shear wave in low carbon steel) for S 4922105505 probe	S 4922104680	Suitable for OD ≥ 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 105505W36
18	**VKPA-16/1.5 CUC XXX** - 36° wedge (55° central angle for shear wave in low carbon steel) - circumferentially contoured for XXX mm OD /// for S 4922105505 probe	S 4922104680 CUC XXX	Suitable for OD < 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 105505W36CUCxxx whereas xxx is OD expressed in mm
19	**PA-1.5M16E1P** - LINEAR ARRAY Frequency: **1.5 MHz** Pitch Size: **1 mm** Number of Elements: **16** Elevation: **12 mm**	S 4922107553	Mark on the probe 107553
20	**VPKA-38-16-1-21** - 38° wedge (59° central angle for shear wave in low carbon steel) for S 4922107553 probe	S 4944262021	Suitable for OD ≥ 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 107553W39-21
21	**VPKA-38-16-1-12** - 38° wedge (59° central angle for shear wave in low carbon steel) for S 4922107553 probe	S 4944262012	Suitable for OD ≥ 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 107553W39-12
22	**VPKA-38-16-1-21 CUC XXX** - 38° wedge (59° central angle for shear wave in low carbon steel) - circumferentially contoured for XXX mm OD /// for S 4922107553 probe	S 4944262021 CUC XXX	Suitable for OD < 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 107553W39-21CUCxxx whereas xxx is OD expressed in mm
23	**VPKA-38-16-1-12 CUC XXX** - 38° wedge (59° central angle for shear wave in low carbon steel) - circumferentially contoured for XXX mm OD /// for S 4922107553 probe	S 4944262012 CUC XXX	Suitable for OD < 1000 mm Linear array probe equipped with that wedge are defined in the instrument database as ☐ 107553W39-12CUCxxx whereas xxx is OD expressed in mm

On start it is necessary to define new wedged linear array probe or select an existing one in the instrument's database – this procedure is identical to the described in the paragraph 5.3.1 of this Operating Manual.

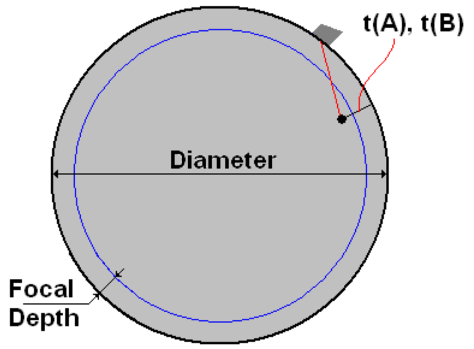
5.5.2.5.2. ISONIC PA Pulser Receiver – Circumferential Insonification

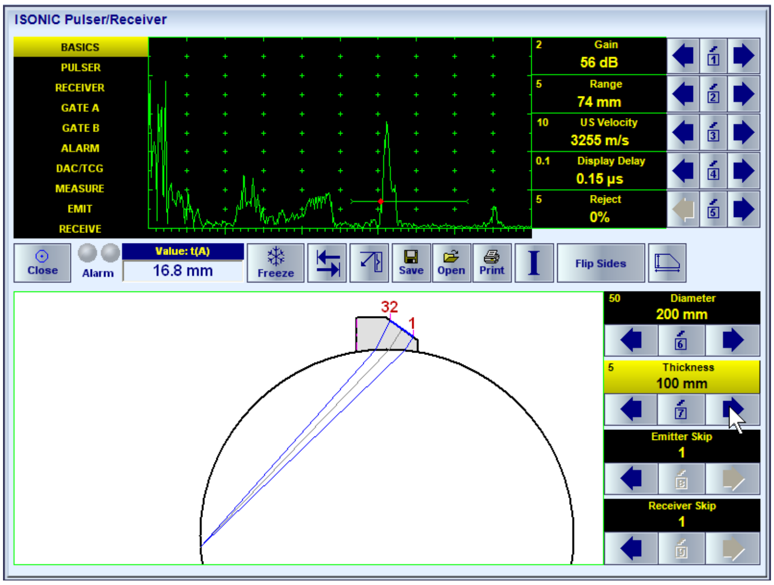
ISONIC PA Pulser Receiver to be calibrated as it is described in the paragraph 5.3.3 of this Operating Manual with considering geometry of object under test – curvature of outer surface and wall thickness

For the inspection of rods key in

Thickness = ½ Diameter

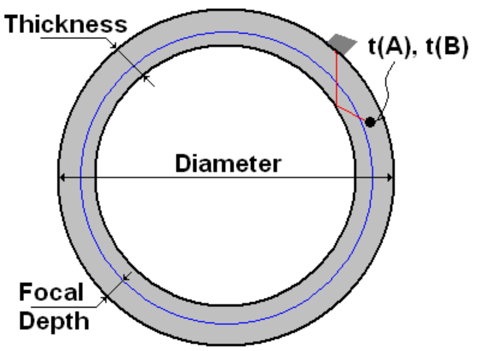
whereas **Diameter** is outside diameter of the rod. In that case **Focal Depth** setting and reflector depth readings **t(A)**, **t(B)** are defined by the instrument automatically according to the sketch below:

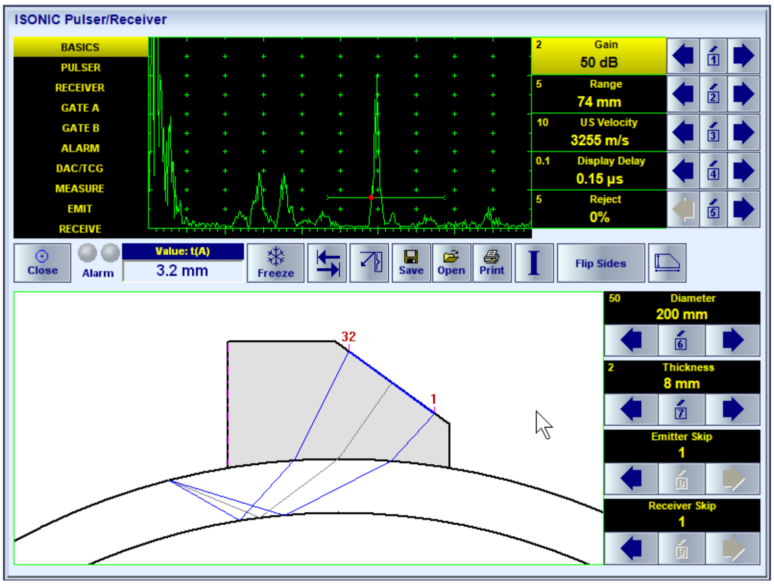




Other settings of **ISONIC PA Pulser Receiver** to be according to paragraph 5.3.4.2.1 of this Operating Manual
Movie illustrating electronic beam steering within the rod is available for viewing / download at
http://www.sonotronndt.com/PDF/OM2009/ROD_SHEAR.wmv

For the inspection of wall of tubular object or weld key in outside diameter value as the **Diameter** and wall thickness value as **Thickness**. In that case **Focal Depth** setting and reflector depth readings **t(A)**, **t(B)** are defined by the instrument automatically according to the sketch below:



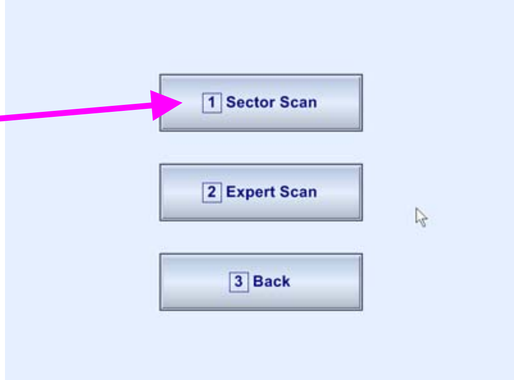


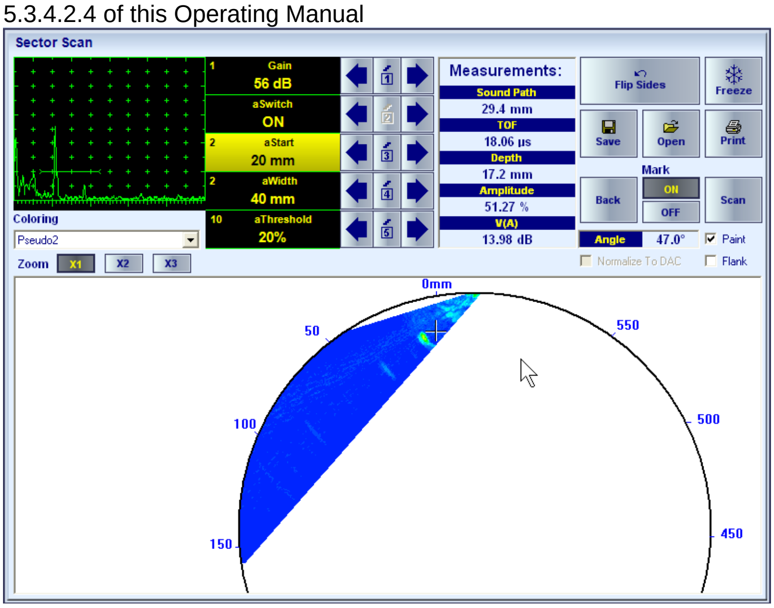
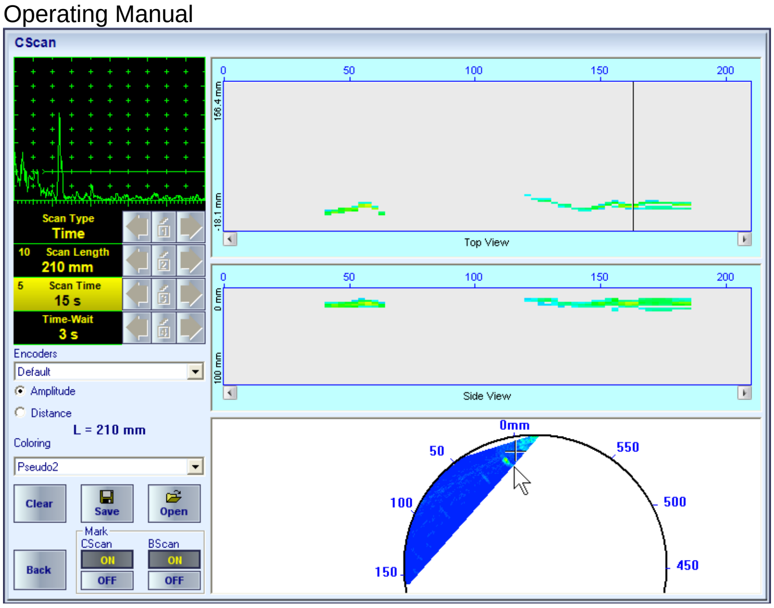
Other settings of **ISONIC PA Pulser Receiver** to be according to paragraph 5.3.4.2.1 of this Operating Manual
Movie illustrating electronic beam steering within the tube wall is available for viewing / download at
http://www.sonotronndt.com/PDF/OM2009/TUBULAR_SHEAR.wmv

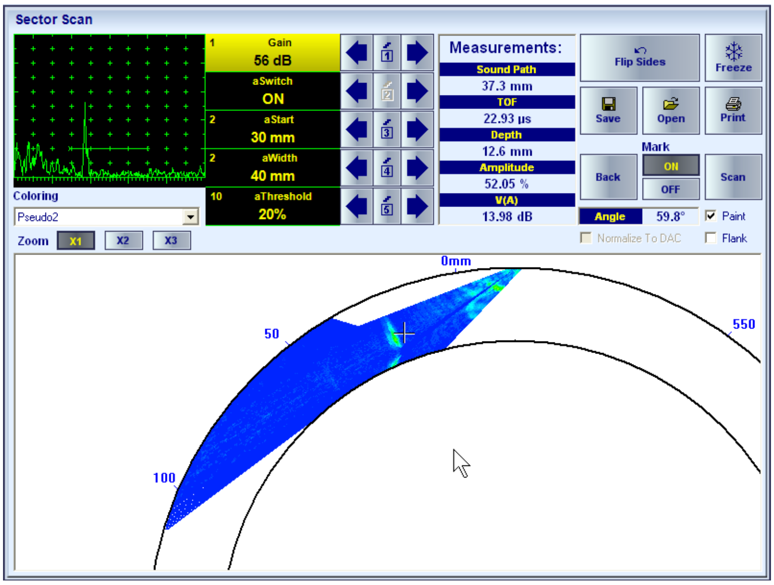
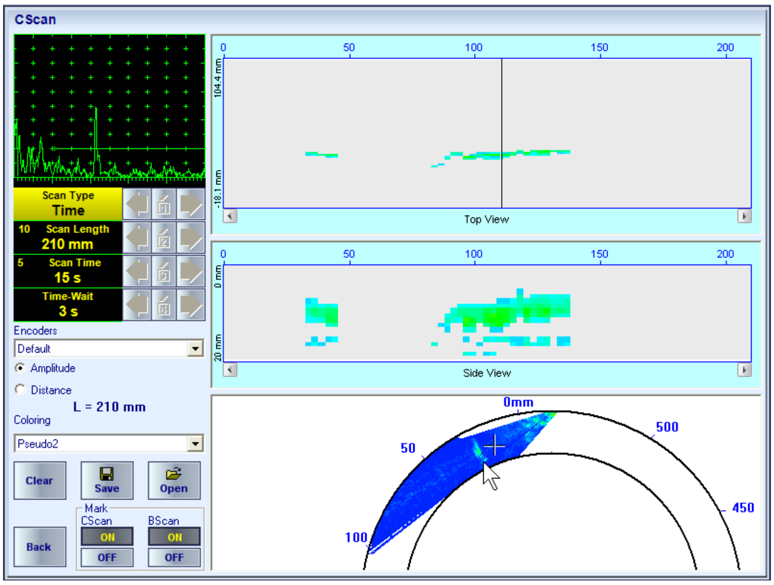
On completion of calibration click on **I** or press **Shift** + **Enter**

5.5.2.5.3. Inspection of Rods and Tube Walls

Click on

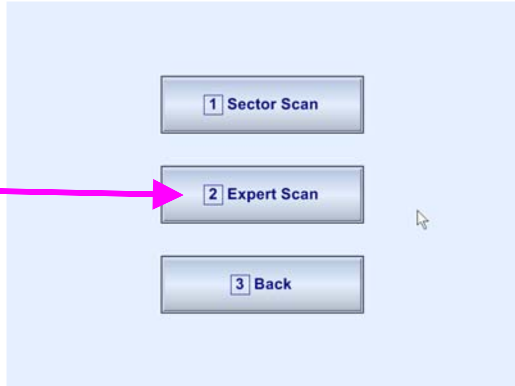


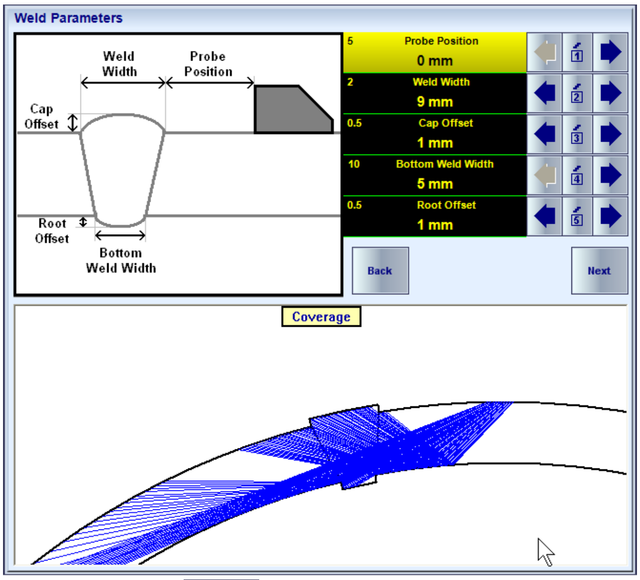
#	Task	Instruction
1	Calibration of **Gain Per Angle Correction**	Refer to paragraph 5.3.4.2.2 of this Operating Manual
2	**TTGI Sector-Scan** - rods	**TTGI Sector-Scan** represents actual coverage of the material. To control instrument in that screen refer to paragraphs 5.3.4.2.3 and 5.3.4.2.4 of this Operating Manual 
3	**3D** data recording through linear scanning (**C-Scan**, **Top** and **Side Views**) - rods	To control instrument in that screen refer to paragraph 5.3.4.2.5 of this Operating Manual 

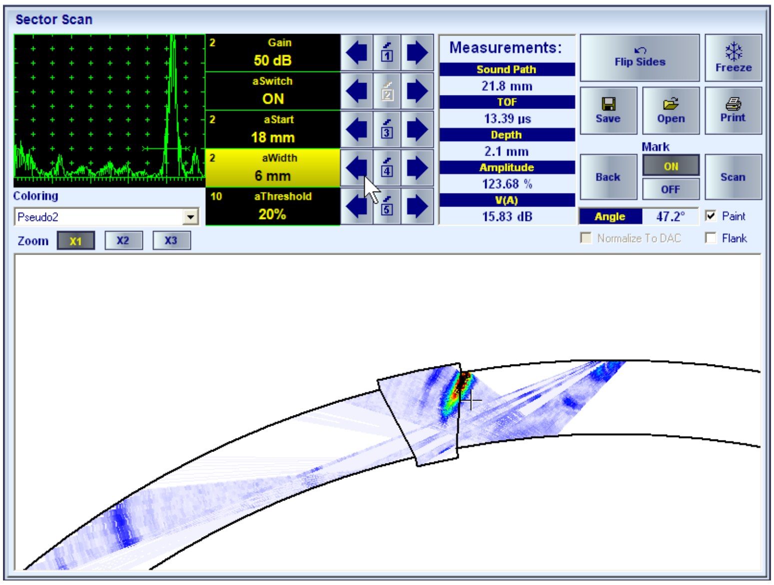
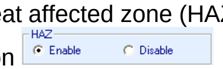
<table>
<tr><th>#</th><th>Task</th><th>Instruction</th></tr>
<tr><td>4</td><td>TTGI Sector-Scan – tube wall</td><td>TTGI Sector-Scan represents actual coverage of the material. To control instrument in that screen refer to paragraphs 5.3.4.2.3 and 5.3.4.2.4 of this Operating Manual

</td></tr>
<tr><td>5</td><td>3D data recording through linear scanning (C-Scan, Top and Side Views) – tube wall</td><td>To control instrument in that screen refer to paragraph 5.3.4.2.5 of this Operating Manual

</td></tr>
</table>

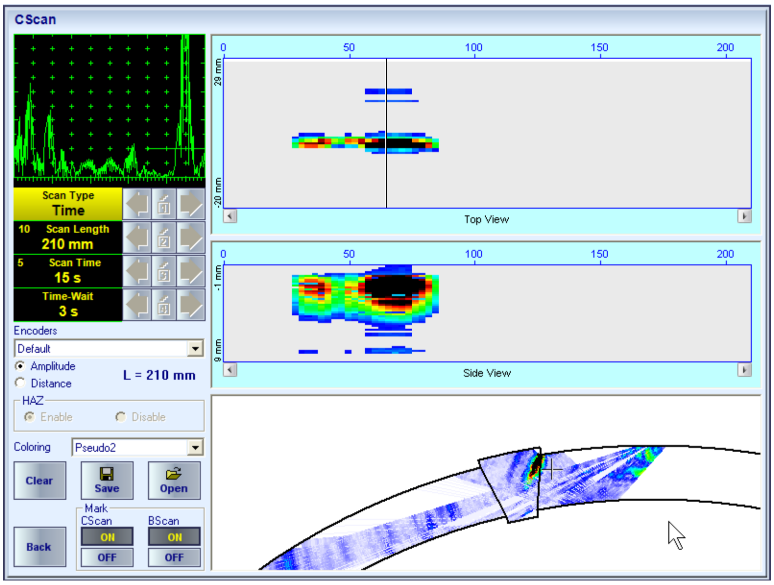
5.5.2.5.4. Inspection of Welds

Click on



#	Task	Instruction
1	Calibration of **Gain Per Angle Correction**	Refer to paragraph 5.3.4.2.2 of this Operating Manual
2	Weld definition and selection of probe position	There is a number for parameters characterizing weld geometry to be keyed in. Then probe position to be selected to provide necessary coverage; said coverage is clearly indicated  On completion click on  or press **Shift + Enter** to proceed with **TTGI Sector-Scan** For more instructions on weld cross section geometry settings refer to paragraphs 5.5.2.4.3 and 5.5.2.5.5 of this Operating Manual

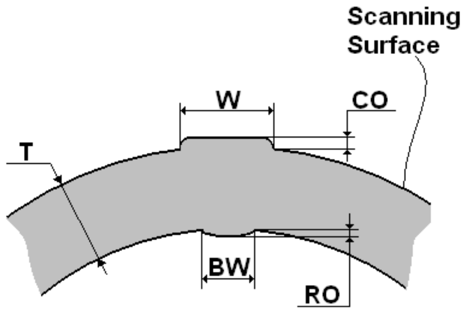
<table>
<tr><th>#</th><th>Task</th><th>Instruction</th></tr>
<tr><td>3</td><td>TTGI Sector-Scan</td><td>TTGI Sector-Scan represents actual coverage of the material. To control instrument in that screen refer to paragraphs 5.3.4.2.3 and 5.3.4.2.4 of this Operating Manual

</td></tr>
<tr><td>4</td><td>3D data recording through linear scanning (C-Scan, Top and Side Views)</td><td>To control instrument in that screen refer to paragraph 5.3.4.2.5 of this Operating Manual. In addition it is necessary to define the region of interest as either including heat affected zone (HAZ) or not through checking corresponding option 


</td></tr>
</table>

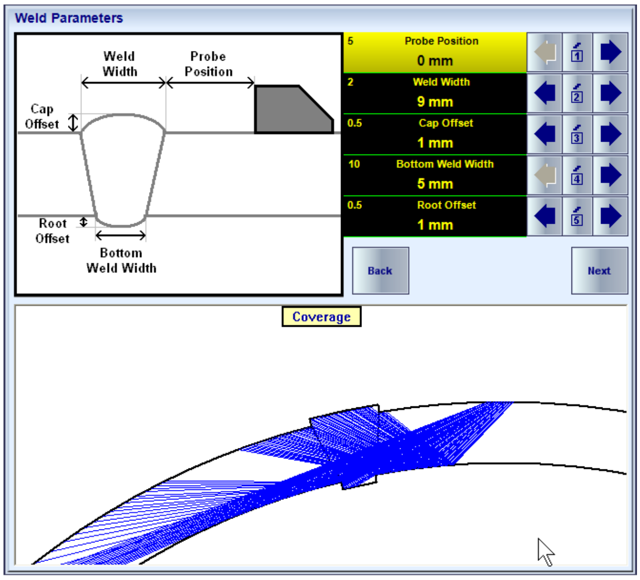
5.5.2.5.5. Weld Cross Section Geometry Settings

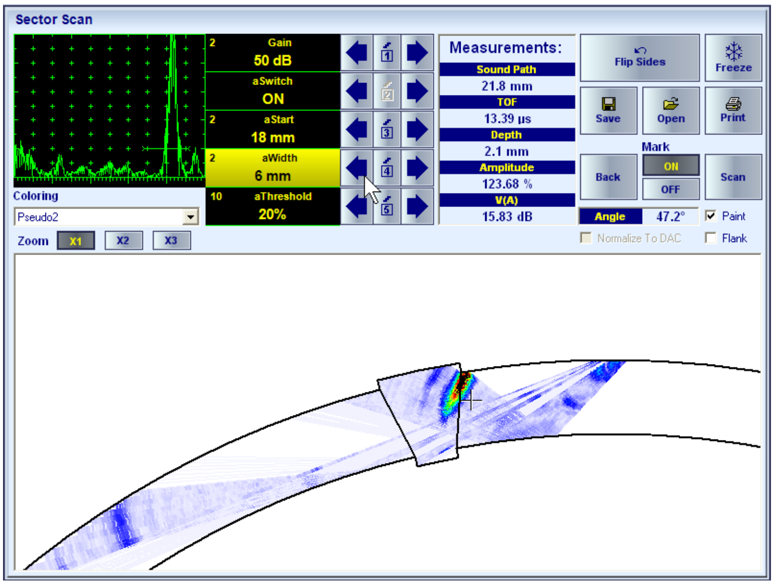
EXPERT CU SW option is suitable for the inspection of welds of various geometries. To provide the required coverage and imaging the weld parameters to be entered accordingly, typical examples are presented below. Also refer to paragraph 5.5.2.4.3 of this Operating Manual

<table>
<tr><th>Weld Geometry and Probe Placement</th><th>Coverage and TTGI Cross Sectional View</th></tr>
<tr><td>
Butt weld, all possible types of preparation

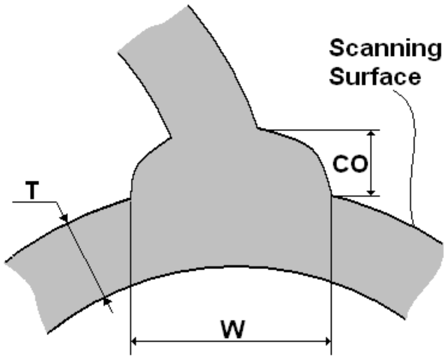
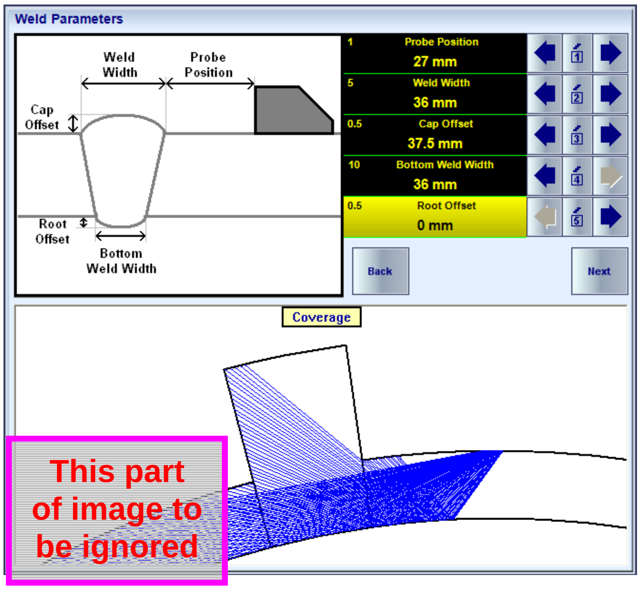
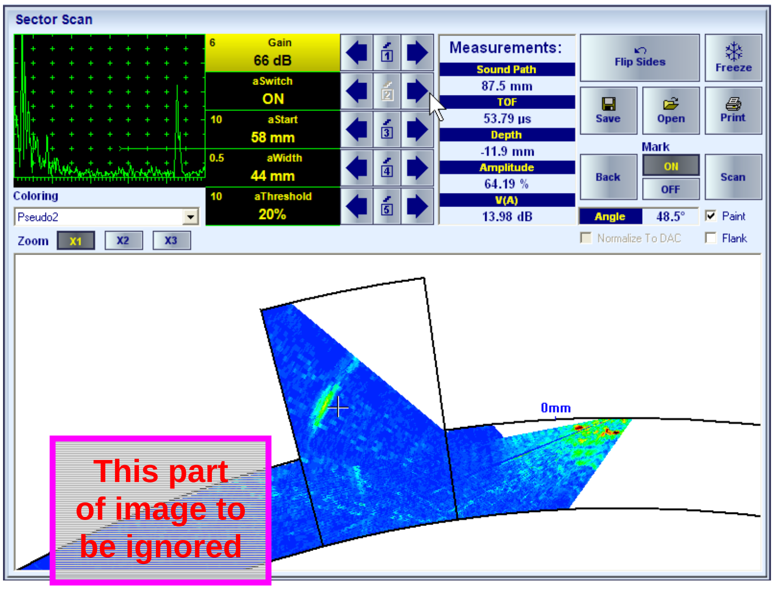


Required geometry settings:

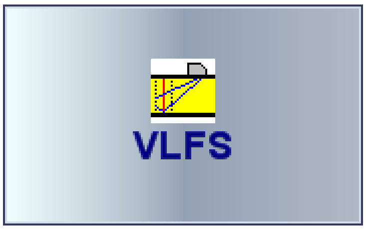
Thickness = T
Weld Width = W
Bottom Weld Width = BW
Cap Offset = CO
Root Offset = RO
</td><td>




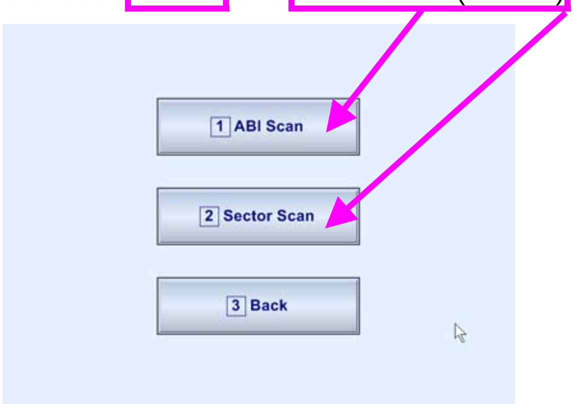
</td></tr>
</table>

Weld Geometry and Probe Placement	Coverage and TTGI Cross Sectional View
TKY weld  Required geometry settings: **Thickness = T** **Weld Width = W** **Bottom Weld Width = Weld Width** **Cap Offset ≥ CO** **Root Offset = 0**	 

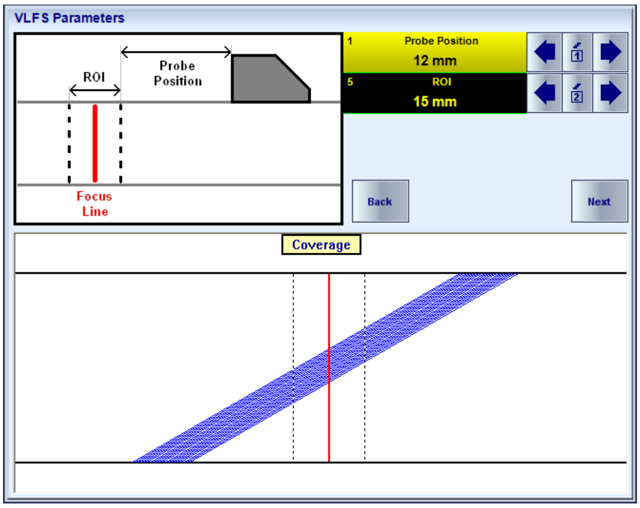
5.5.2.6. VLFS – Optional Inspection SW Package

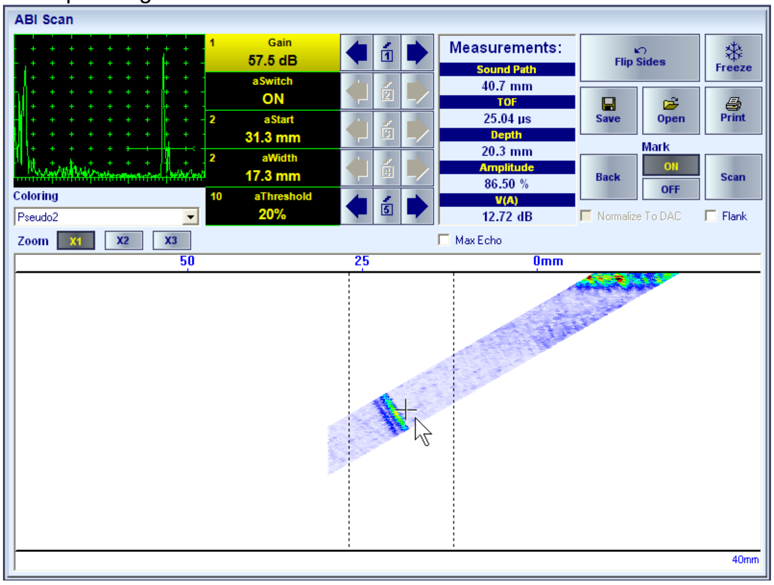
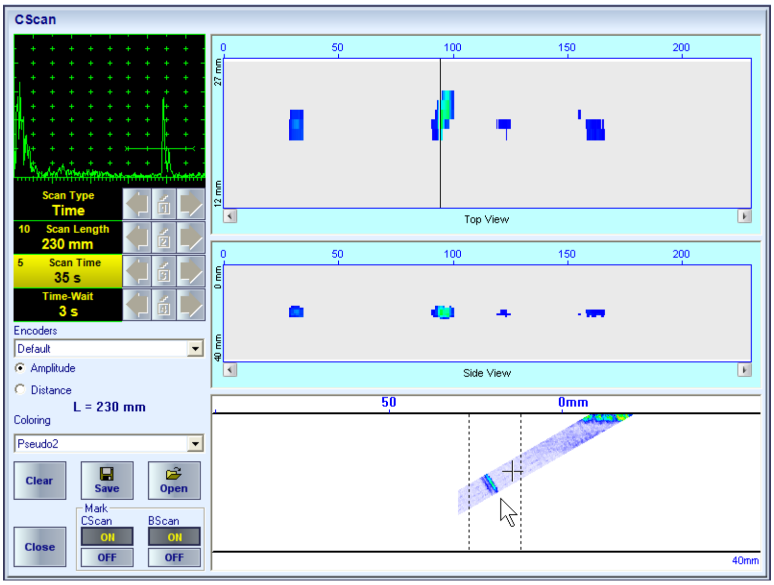


VLFS (**V**ertical **L**ine **F**ocusing **S**can) optional SW package of **ISONIC 2009 UPA Scope** instrument is dedicated to the inspection of ERW seams with planar cross section and the like, for example ERW seams between pipes, rails, etc It is a special feature of VLFS mode of operation that focusing of every beam composing **B-Scan** or **Sector Scan** image of the region of interest (**ROI**) is performed along vertical line.welds having planar cross section. On start it is necessary to define new wedged linear array probe or select an existing one in the instrument's database – this procedure is identical to the described in the paragraph 5.3.1 of this Operating Manual. Next step is selection of the way to insonify **ROI** – there are 2 ways available: **B-Scan** and **Sector Scan** (**S-Scan**)

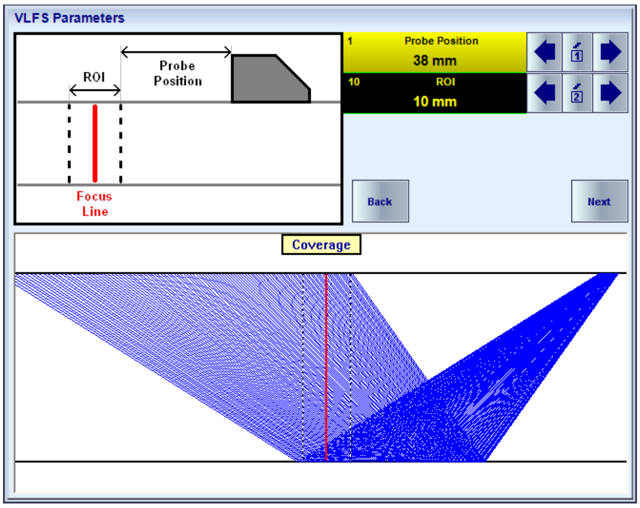


5.5.2.6.1. B-Scan

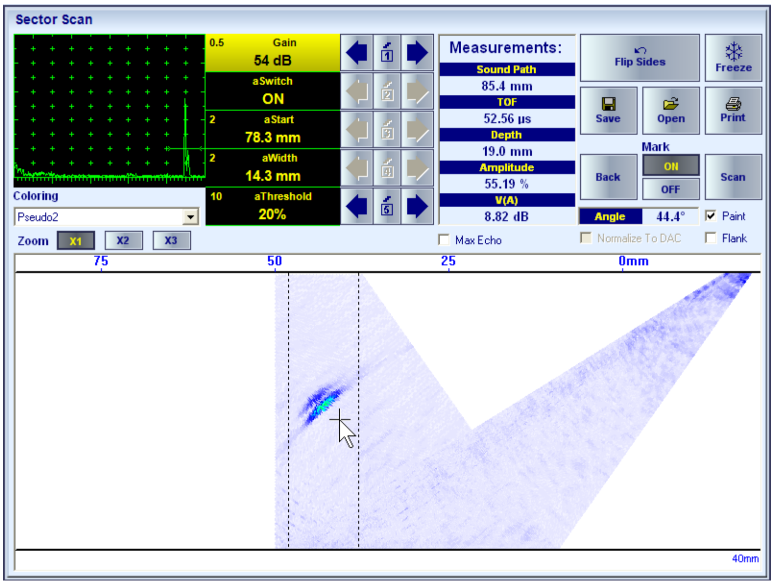
#	Task	Instruction
1	Calibration of **ISONIC PA Pulser Receiver**	Refer to paragraph 5.3.4.1.1 of this Operating Manual
2	Calibration of **Gain Per Shot Correction**	Refer to paragraph 5.3.4.1.2 of this Operating Manual
3	Defining of **ROI** and selection of the **Probe Position**	Width of **ROI** is defined symmetrically for the vertical focused line. Then probe position to be selected to provide necessary coverage of **ROI**, which is clearly indicated  On completion click on Next or press **Shift** + **Enter** to proceed with **TTGI B-Scan**

#	Task	Instruction
4	**TTGI B-Scan**	**TTGI B-Scan** represents actual coverage of the **ROI**. To control instrument in that screen refer to paragraphs 5.3.4.1.3 and 5.3.4.1.4 of this Operating Manual 
5	**3D** data recording through linear scanning (**C-Scan**, **Top** and **Side Views**)	To control instrument in that screen refer to paragraph 5.3.4.1.5 of this Operating Manual 

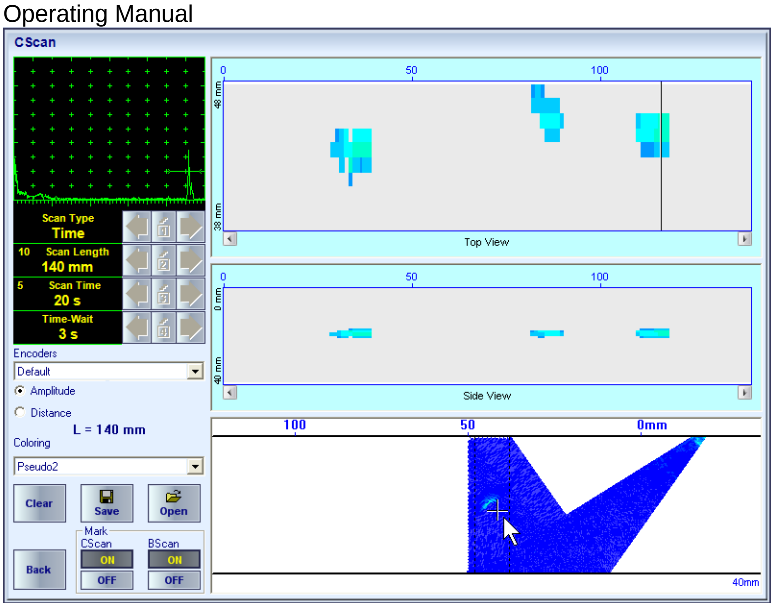
5.5.2.6.2. Sector-Scan

#	Task	Instruction
1	Calibration of **ISONIC PA Pulser Receiver**	Refer to paragraph 5.3.4.2.1 of this Operating Manual
2	Calibration of **Gain Per Angle Correction**	Refer to paragraph 5.3.4.2.2 of this Operating Manual
3	Defining of **ROI** and selection of the **Probe Position**	Width of **ROI** is defined symmetrically for the vertical focused line. Then probe position to be selected to provide necessary coverage of **ROI**, which is clearly indicated  On completion click on  or press **Shift** + **Enter** to proceed with **TTGI B-Scan**

<table>
<tr><th>#</th><th>Task</th><th>Instruction</th></tr>
<tr><td>4</td><td>TTGI Sector-Scan</td><td>TTGI Sector-Scan represents actual coverage of the ROI. To control instrument in that screen refer to paragraphs 5.3.4.2.3 and 5.3.4.2.4 of this Operating Manual

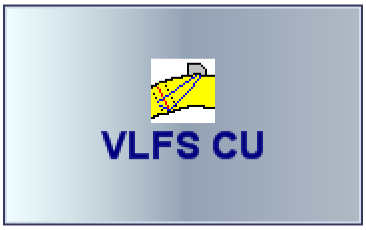


</td></tr>
<tr><td>5</td><td>3D data recording through linear scanning (C-Scan, Top and Side Views)</td><td>To control instrument in that screen refer to paragraph 5.3.4.2.5 of this Operating Manual

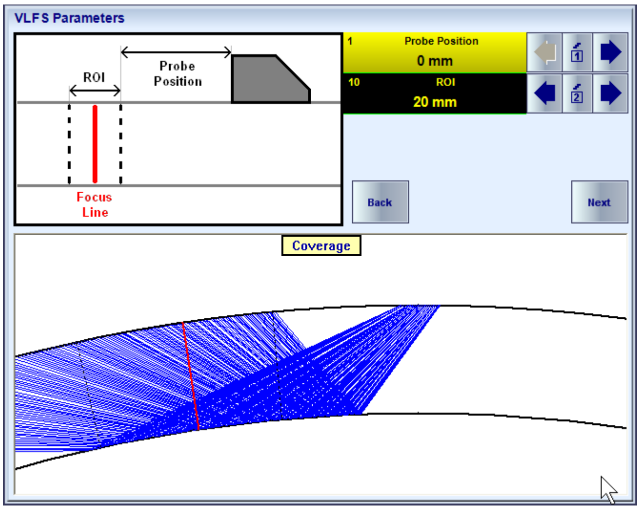


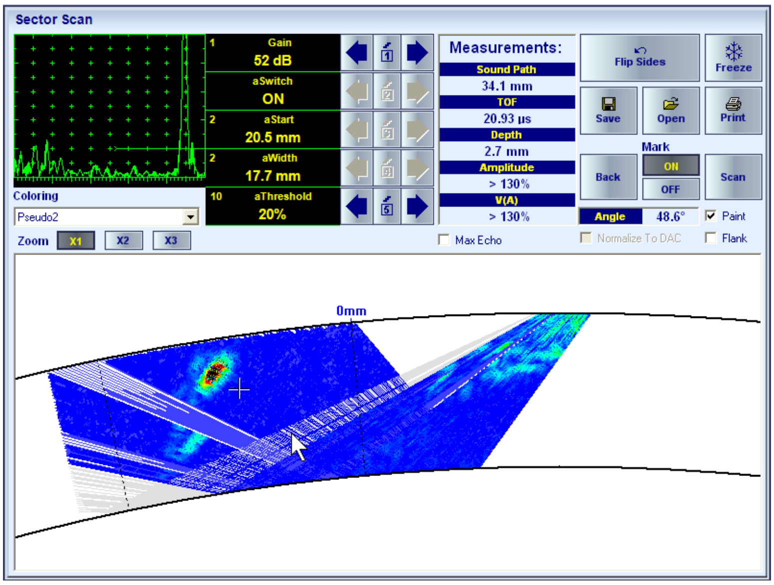
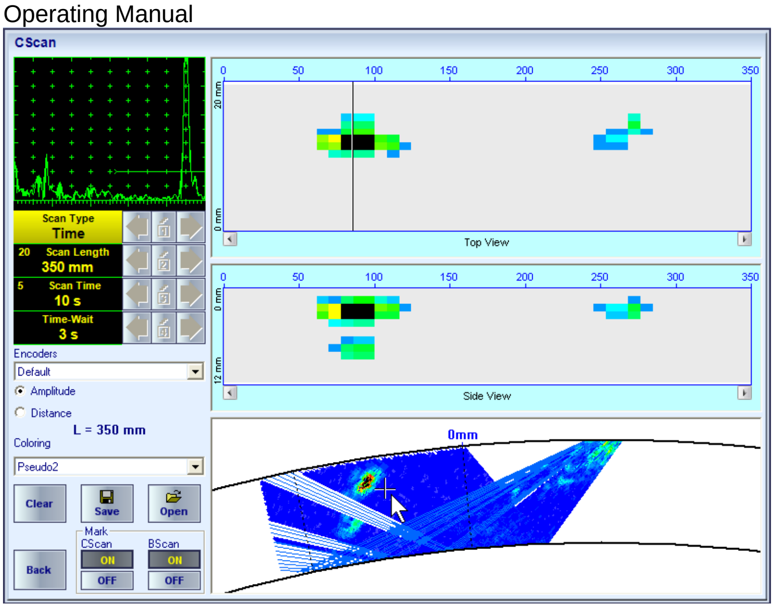
</td></tr>
</table>

5.5.2.7. VLFS CU – Optional Inspection SW Package



VLFS CU (**V**ertical **L**ine **F**ocusing **S**can of **CU**rved objects) optional SW package of **ISONIC 2009 UPA Scope** instrument is dedicated to the inspection of ERW seams with curved cross section and similar objects providing **Sector Scan** imaging of the region of interest (**ROI**). On start it is necessary to define new wedged linear array probe or select an existing one in the instrument's database – refer to paragraphs 5.3.1 and 5.5.2.5.1 of this Operating Manual. Further steps are described below

#	Task	Instruction
1	Calibration of **ISONIC PA Pulser Receiver**	Refer to paragraphs 5.3.4.2.1 and 5.5.2.5.2 of this Operating Manual
2	Calibration of **Gain Per Angle Correction**	Refer to paragraph 5.3.4.2.2 of this Operating Manual
3	Defining of **ROI** and selection of the **Probe Position**	Width of **ROI** is defined symmetrically for the vertical focused line. Then probe position to be selected to provide necessary coverage of **ROI**, which is clearly indicated  On completion click on  or press **Shift** + **Enter** to proceed with **TTGI B-Scan**

#	Task	Instruction
4	**TTGI Sector-Scan**	**TTGI Sector-Scan** represents actual coverage of the **ROI**. To control instrument in that screen refer to paragraphs 5.3.4.2.3 and 5.3.4.2.4 of this Operating Manual 
5	**3D** data recording through linear scanning (**C-Scan**, **Top** and **Side Views**)	To control instrument in that screen refer to paragraph 5.3.4.2.5 of this Operating Manual 

5.5.2.8. Multi-Group – Optional Inspection SW Utility

Multi-Group optional SW package of **ISONIC 2009 UPA Scope** instrument allows implementation of several (up to 5) various insonification schemes simultaneously with use of differently configured groups of elements of wedged linear array probe. Each insonification scheme to be implemented with the same filter settings of **ISONIC PA Pulser Receiver**. Geometry settings (thickness, weld, curvature) if any, probe position, and **USVelocity** in the material as to be identical for all insonification schemes. Calibration for each insonification scheme to be performed in advance and the appropriate **B-Scan** / **Sector-Scan** files either **TTGI** or not to be stored in advance in accordance with procedures described in the paragraphs 5.3.4.1, 5.3.4.2, 5.5.2.4 through 5.5.2.7 of this Operating Manual. Movie illustrating typical composing and implementation of multi-group insonification is available for viewing / download at **http://www.sonotronndt.com/PDF/OM2009/MULTI_GROUP.wmv**

5.5.3. Matrix Array PA Probes

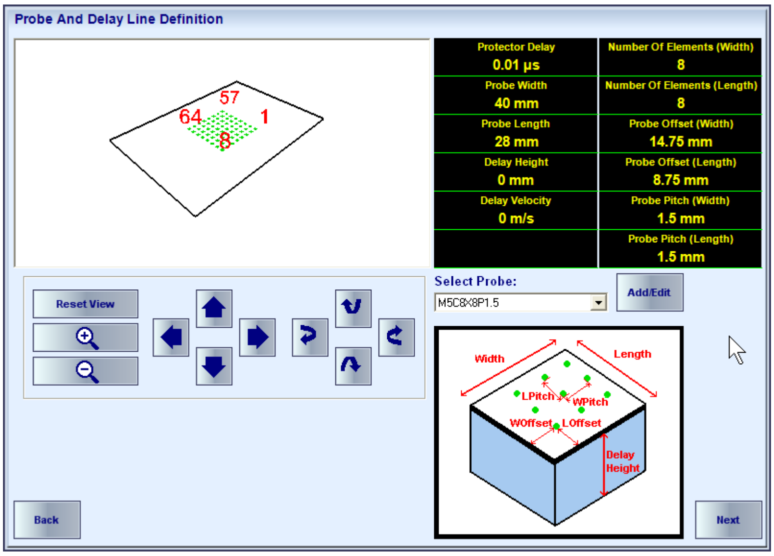
No-multiplexing parallel architecture of **ISONIC 2009 UPA Scope** instrument allows using of up to 64-elements matrix arrays probes. This makes it possible insonifying predefined volume in the object under test and obtaining 3D image of it's interior from fixed probe position without involving mechanical scanning

5.5.3.1. Matrix Delay Line 3D Scan L – Optional Inspection SW Package for Compression Wave Inspection

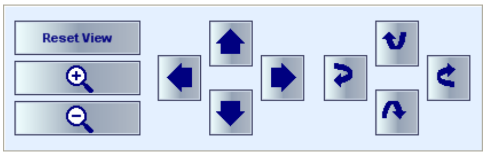
Matrix Delay Line 3D Scan L optional inspection SW package utilizes matrix array probes either equipped with delay line or directly contacted to object under test for compression wave inspection with 3D image data presentation

5.5.3.1.1. Database of Matrix Arrays With / Without Delay Line

It is necessary to define matrix array probe with / without delay line probe or select an existing one in the database first for further operation – refer to paragraph 5.3.1 of this Operating Manual



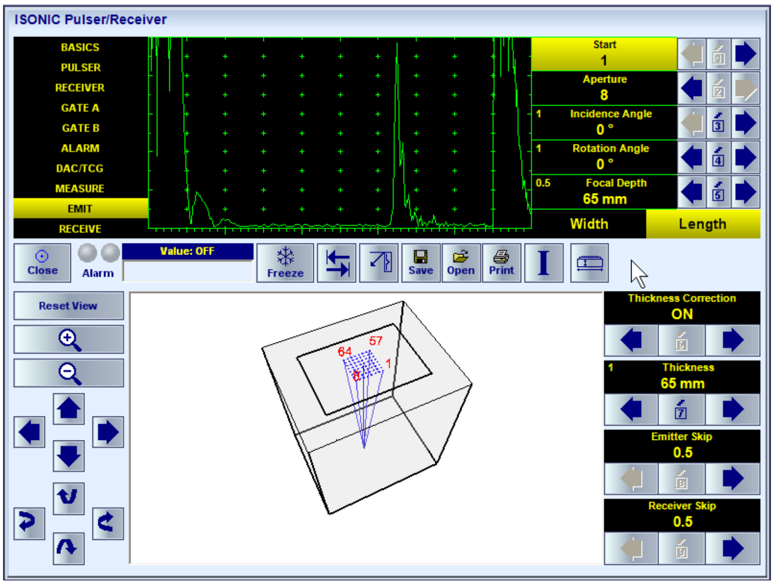
Whilst defining matrix array probe and for further operation 3D graphic presentation is very useful, to optimize 3D viewing use 3D toolbox:



It is also possible to control 3D view by mouse through placing cursor over the image:

- left mouse button press and hold followed by mouse motion allows moving of the imaged object in the desired direction
- right mouse button press and hold followed by mouse motion allows rotating of the imaged object in the desired direction

5.5.3.1.2. ISONIC PA Pulser Receiver for Matrix Arrays With / Without Delay Line



To control **ISONIC PA Pulser Receiver** refer to paragraph 5.5.3 of this Operating Manual and notes below

- **2D** aperture setting – **Start** and **Aperture** setting to be provided for both **Width** and **Length** directions
- **3D** control of ultrasonic beam is performed through use of the following settings:
  - **Incidence Angle**
  - **Rotation Angle**
  - **Focal Depth and Skip OR Focal Distance**

The following settings to be provided **for 3D Scan L** mode of operation:

#	*Parameter or Mode*	*Required Settings*	*Note*
1	**Pulser Mode**	**SINGLE**	
2	**Aperture Width**	**N_W** whereas **N_W** is total ***Number Of Elements*** in the **Width** direction	recommended
3	**Aperture Length**	**N_L** whereas **N_L** is total ***Number Of Elements*** in the **Width** direction	recommended
4	**Incidence Angle**	**0 deg**	Only at the stage of setting **Gain**
5	**Rotation Angle**	**0 deg**	Only at the stage of setting **Gain**
6	**Thickness Correction**	**ON**	
7	**Thickness**	Equal to the actual value of material thickness	
8	**Emitter / Receiver Skip**	**0.5**	
9	**Focal Depth**	In accordance with the inspection procedure	
10	**USVelocity**	Equal to the actual value of ultrasound velocity in the object under test either for shear or longitudinal waves	
11	**Gain**	**Gain** setting to be performed according to inspection procedure providing required echo heights from defects to be detected	
12	**DAC/TCG**	**DAC/TCG** settings to meet requirements of inspection procedure	
13	**Pulse Width, Firing Level**	**Pulse Width** and **Firing Level** settings to optimize signal to noise ratio **Pulse Width** to be around 1/F where F is frequency of PA probe	To synchronize with **Gain** setting – finalize setting of **Pulse Width** and **Firing Level** before setting of the **Gain**
14	**Filter, Low Cut, and High Cut Frequencies**	**Filter** and **Low Cut** and **High Cut** settings to match with frequency of PA probe to optimize signal to noise ratio	To synchronize with **Gain** setting – finalize setting of **Filter, Low Cut, and High Cut** before setting of the **Gain**
15	**Display**	**Display** setting may be either **Full, RF, PosHalf,** or **NegHalf** – follow requirements the inspection procedure	
16	**Surface Alignment**	**ON**	
17	**Range**	**Range** setting is important at the stage of **Gain** and **DAC** setup only providing representation of all reflectors used for **Gain** and **DAC** calibration	

On completing click on  or press **Shift** + **Enter**

5.5.3.1.3. Region of Interest (ROI)

ROI is a part of volume of object under test under matrix array, which is defined through keying in of 3 values:

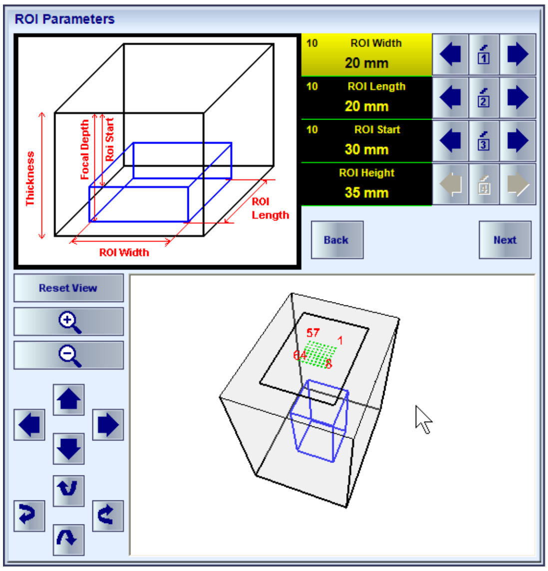
- **ROI Width**
- **ROI Length**
- **ROI Start** (counted as distance from contact surface of the material)

The last setting (**ROI Height**) is defined automatically:

ROI Height = Focal Depth – ROI Start

All dimensions are clearly shown on the sketch

On completion click on **Next** or press **Shift** + **Enter** to proceed with **TTGI 3 D Scan L**

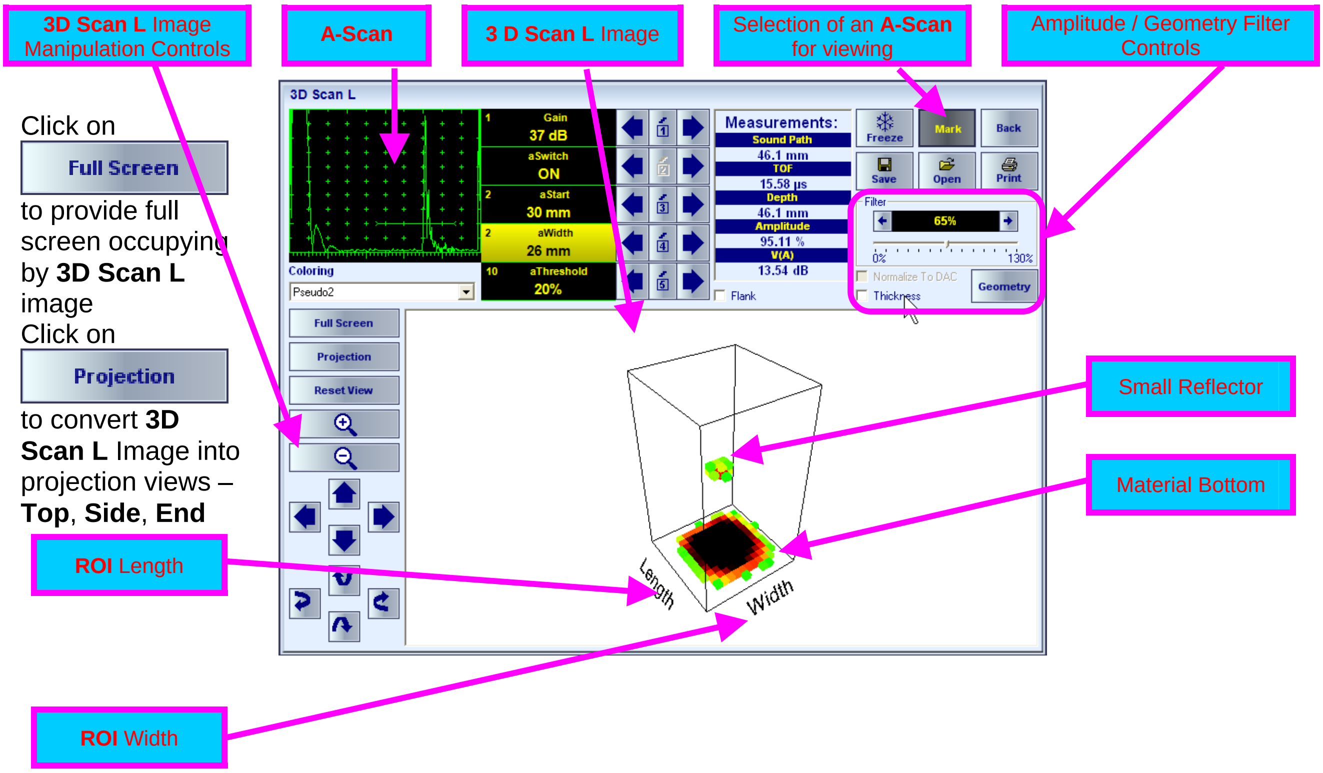


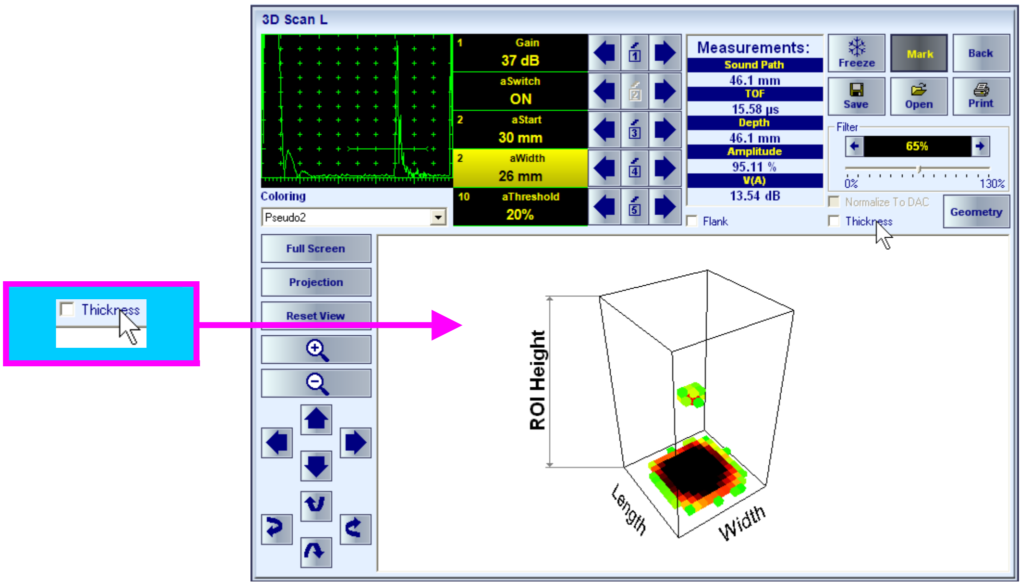
5.5.3.1.4. 3D Scan L Mode of Inspection and Imaging

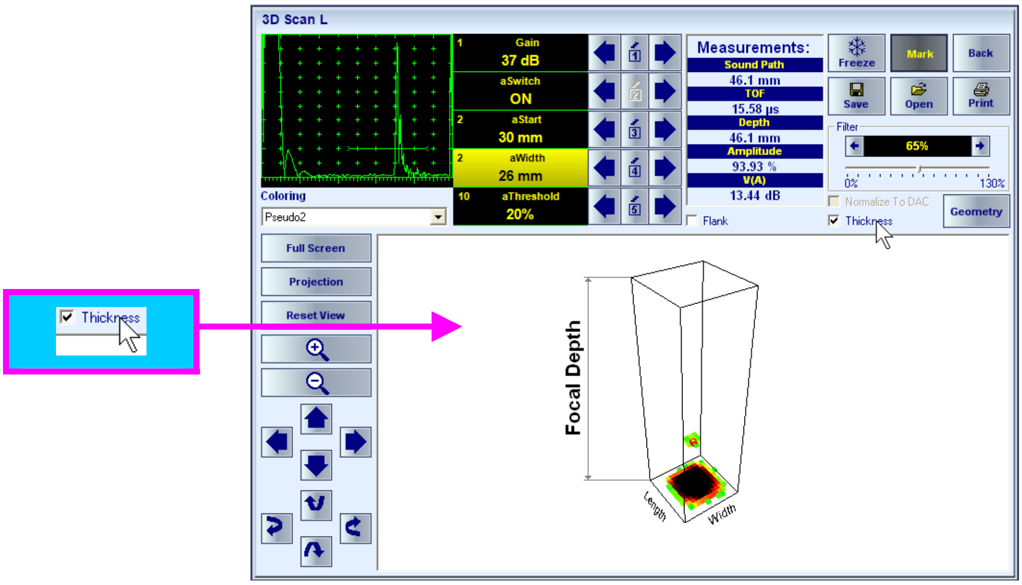
Typical **3D Scan L** screen is shown below. 3D image is provided through rendering of elementary volumes composing **ROI**; color of each elementary volume represents corresponding echo amplitude

Click on **Full Screen** to provide full screen occupying by **3D Scan L** image

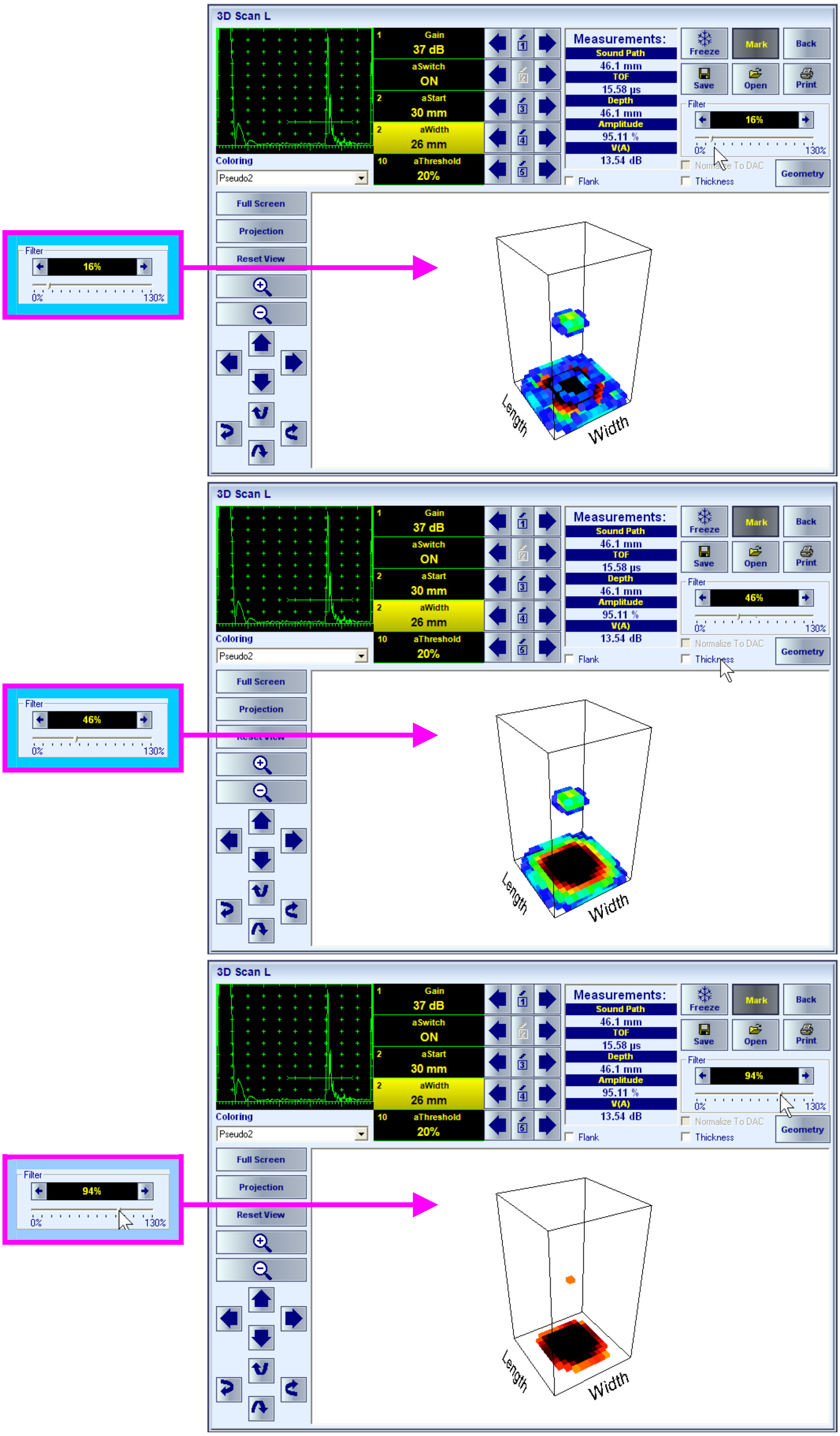
Click on **Projection** to convert **3D Scan L** Image into projection views – **Top**, **Side**, **End**





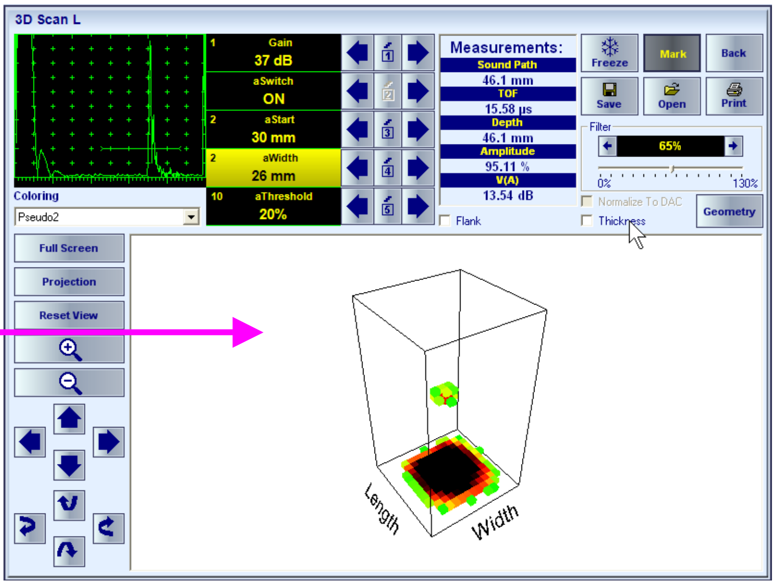


ⓘ Vertical size of **3D Scan L** image depends on status of ☐ Thickness option

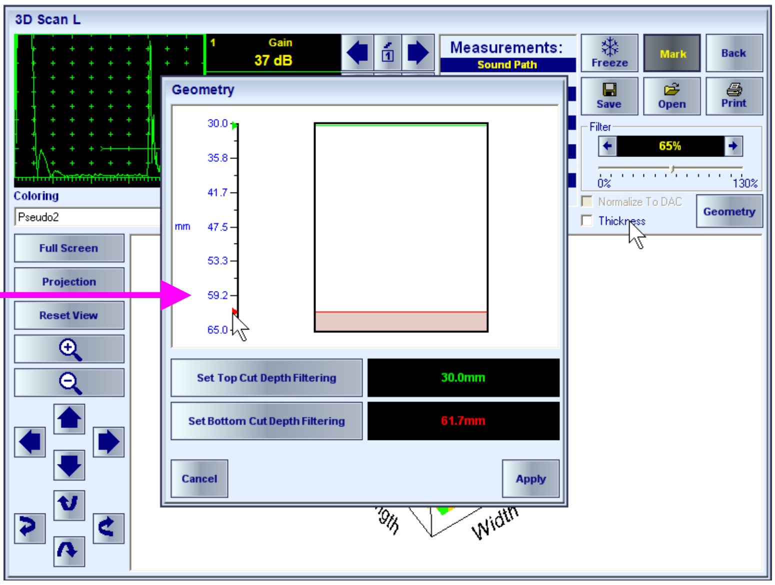


ⓘ Quantity of rendered elementary volumes depends on amplitude **Filter** settings, filtering level may vary between 0 to 130% of **A-Scan** height

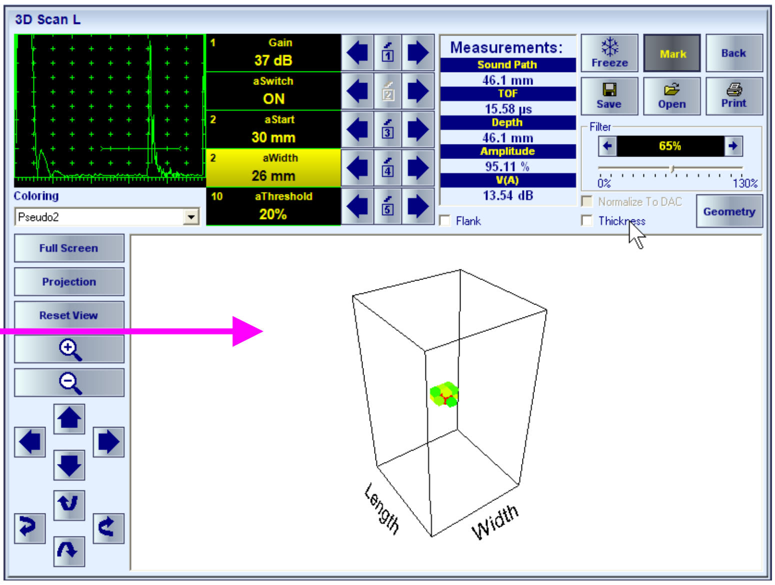
No Geometry Filter



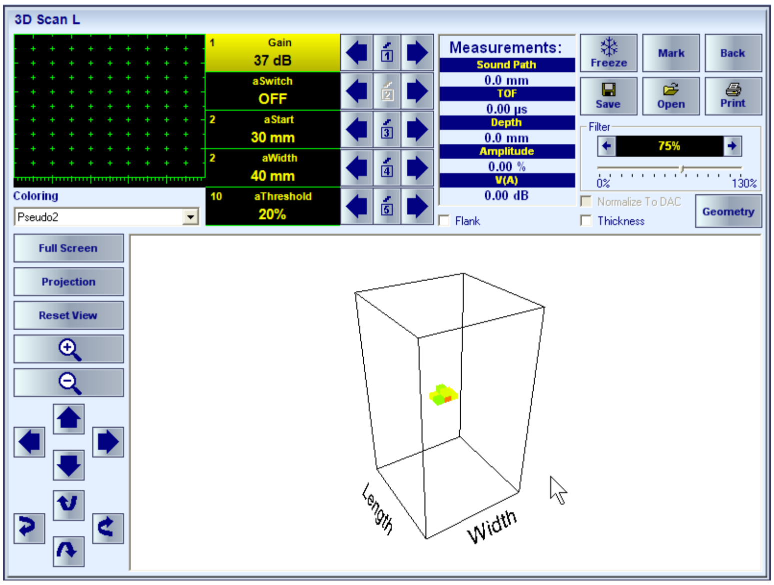
Cutting bottom part of **3 D Scan L** Image

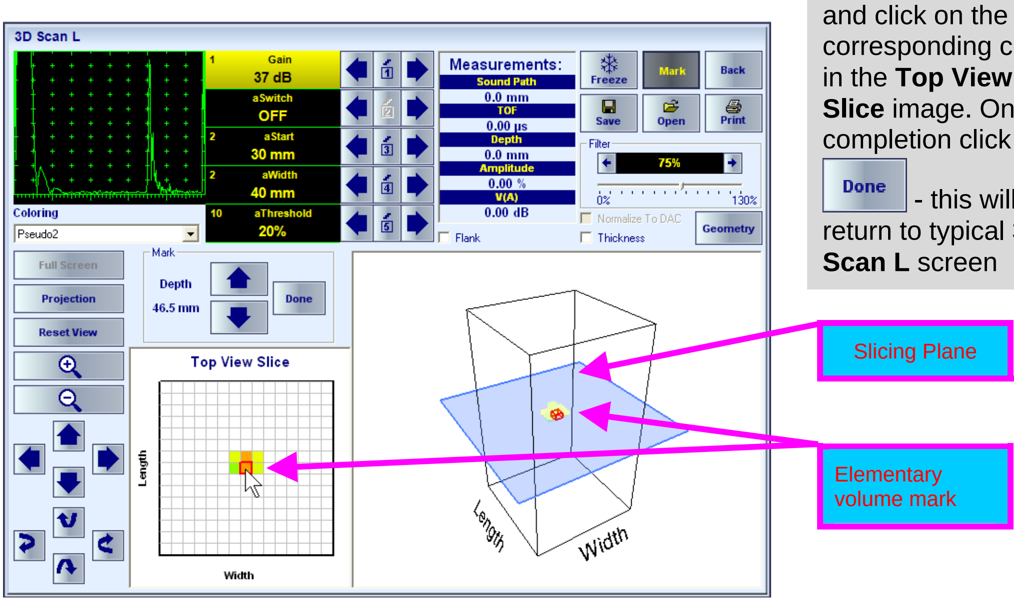


Geometry Filter is Applied



It is possible to apply geometry filter to cut top and bottom part of **3D Scan L** image through dialogue activated by clicking on **Geometry**





ⓘ

To select elementary volume, for reproducing of the corresponding **A-Scan** click on **Mark** then place *slicing plane* into position matching with selected elementary volume using ⬆, ⬇ buttons and click on the corresponding cell in the **Top View Slice** image. On completion click on **Done** - this will return to typical **3D Scan L** screen

Movie illustrating operating of **ISONIC 2009 UPA Scope** whilst running **3D Scan L** SW is available for viewing / download at http://www.sonotronndt.com/PDF/OM2009/3D_SCAN_L.wmv

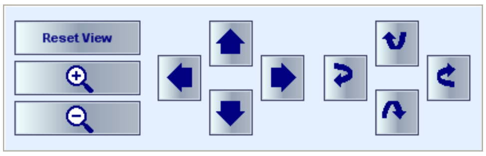
5.5.3.2. Matrix Wedge 3D Scan S – Optional Inspection SW Package for Shear Wave Inspection

Matrix Wedge 3D Scan S optional inspection SW package utilizes wedged matrix array probes for shear wave inspection with 3D image data presentation

5.5.3.2.1. Database of Wedged Matrix Arrays

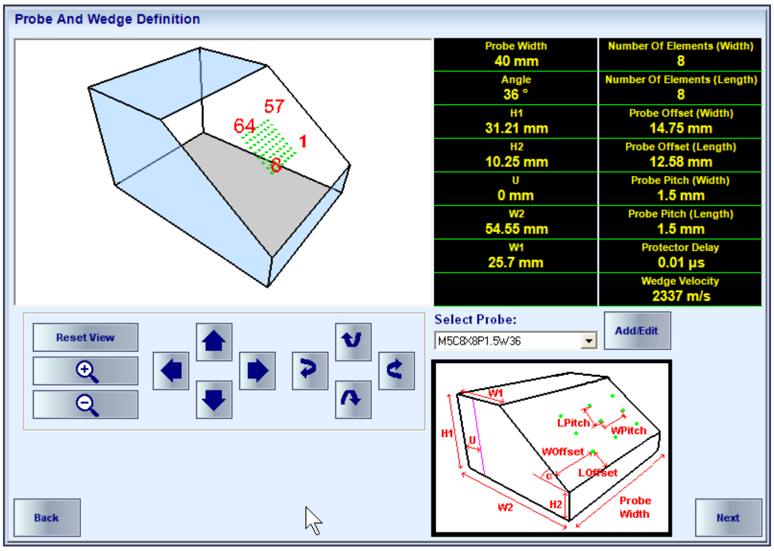
It is necessary to define new wedged matrix array probe or select an existing one in the database first for further operation – refer to paragraph 5.3.1 of this Operating Manual

Whilst defining matrix array probe and for further operation 3D graphic presentation is very useful, to optimize 3D viewing use 3D toolbox:



It is also possible to control 3D view by mouse through placing cursor over the image:

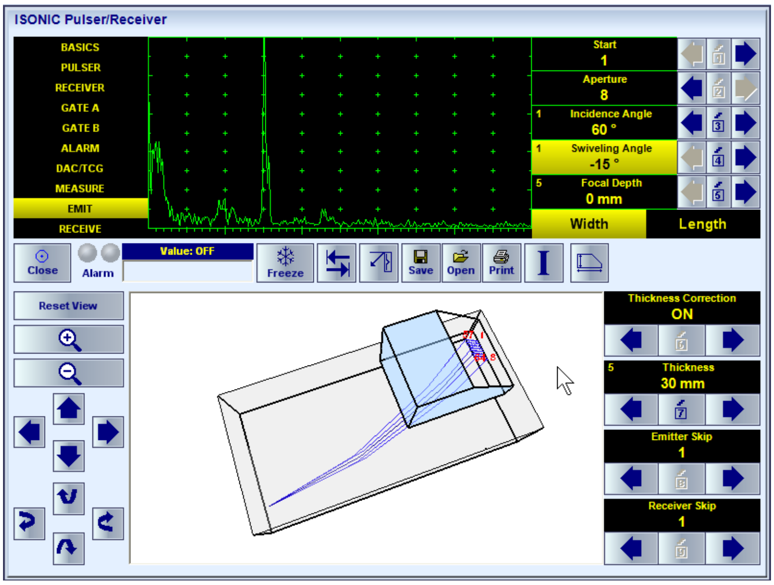
- left mouse button press and hold followed by mouse motion allows moving of the imaged object in the desired direction
- right mouse button press and hold followed by mouse motion allows rotating of the imaged object in the desired direction



5.5.3.2.2. ISONIC PA Pulser Receiver for Wedged Matrix Arrays

To control **ISONIC PA Pulser Receiver** refer to paragraph 5.5.3 of this Operating Manual and notes below

- **2D** aperture setting – **Start** and **Aperture** setting to be provided for both **Width** and **Length** directions
- **3D** control of ultrasonic beam is performed through use of the following settings:
  - **Incidence Angle**
  - **Swiveling Angle**
  - **Focal Depth and Skip OR Focal Distance**



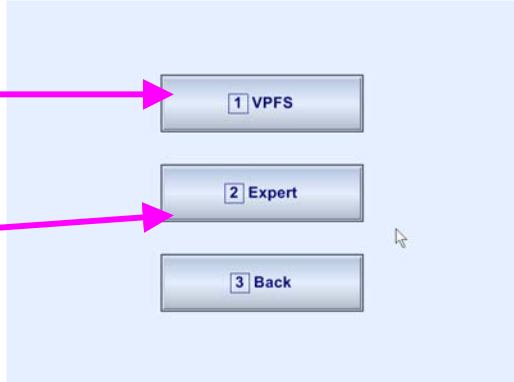
The following settings to be provided **for 3D Scan S** mode of operation:

#	*Parameter or Mode*	*Required Settings*	*Note*
1	**Pulser Mode**	**SINGLE**	
2	**Aperture Width**	$\mathbf{N_W}$ whereas $\mathbf{N_W}$ is total ***Number Of Elements*** in the **Width** direction	recommended
3	**Aperture Length**	$\mathbf{N_L}$ whereas $\mathbf{N_L}$ is total ***Number Of Elements*** in the **Width** direction	recommended
4	**Incidence Angle**	A value within required varying range for incidence angle in accordance with the inspection procedure	Only at the stage of setting **Gain**
5	**Swiveling Angle**	**0 deg**	Only at the stage of setting **Gain**
6	**Thickness Correction**	**ON**	
7	**Thickness**	Equal to the actual value of material thickness	
8	**Emitter / Receiver Skip**	In accordance with the inspection procedure	Only at the stage of setting **Gain**
9	**Focal Depth**	In accordance with the inspection procedure	
10	**USVelocity**	Equal to the actual value of ultrasound velocity in the object under test either for shear or longitudinal waves	
11	**Gain**	**Gain** setting to be performed according to inspection procedure providing required echo heights from defects to be detected	
12	**DAC/TCG**	**DAC/TCG** settings to meet requirements of inspection procedure	
13	**Pulse Width, Firing Level**	**Pulse Width** and **Firing Level** settings to optimize signal to noise ratio **Pulse Width** to be around 1/F where F is frequency of PA probe	To synchronize with **Gain** setting – finalize setting of **Pulse Width** and **Firing Level** before setting of the **Gain**
14	**Filter, Low Cut, and High Cut Frequencies**	**Filter** and **Low Cut** and **High Cut** settings to match with frequency of PA probe to optimize signal to noise ratio	To synchronize with **Gain** setting – finalize setting of **Filter, Low Cut, and High Cut** before setting of the **Gain**
15	**Display**	**Display** setting may be either **Full, RF, PosHalf,** or **NegHalf** – follow requirements the inspection procedure	
16	**Surface Alignment**	**ON**	
17	**Range**	**Range** setting is important at the stage of **Gain** and **DAC** setup only providing representation of all reflectors used for **Gain** and **DAC** calibration	

On completing click on  or press **Shift** + **Enter**

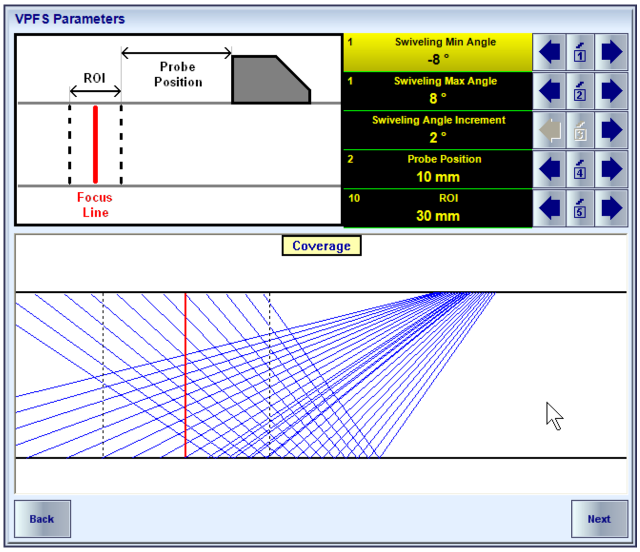
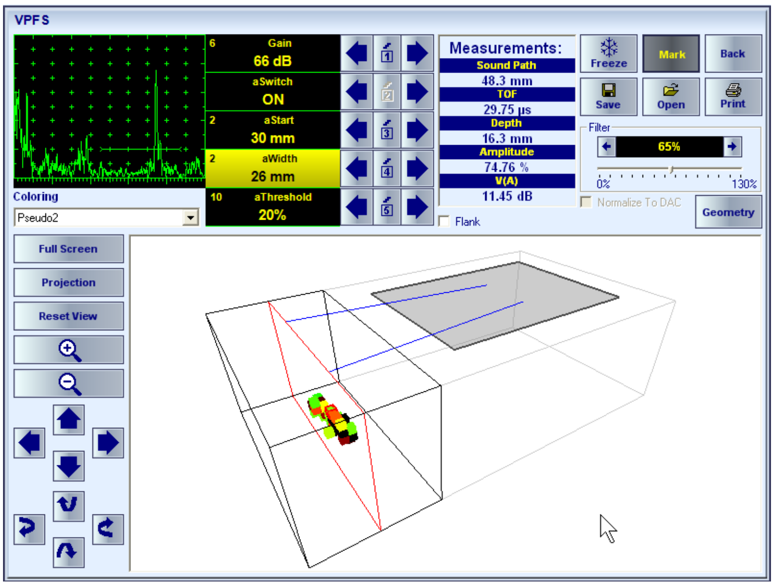
5.5.3.2.3. 3 D Scan S: Scanning Modes

There are two scanning and imaging modes available while running 3D Scan S SW packages:

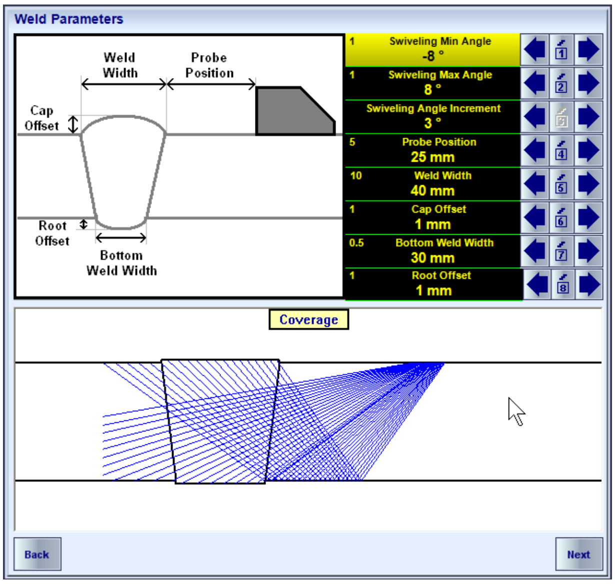
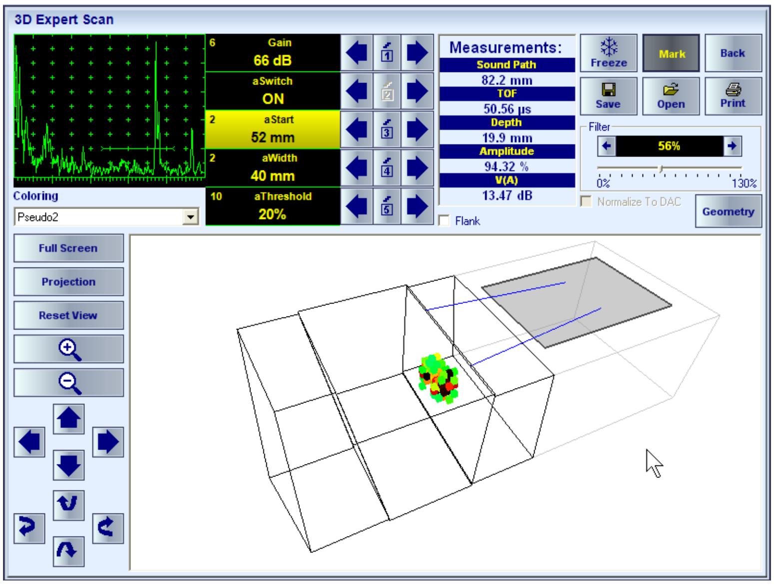


- **V**ertical **P**lane **F**ocusing **S**canning (**VPFS**) – click on
  For that type of scanning focal points for each implemented focal law are situated in the same predetermined vertical plane; such way of insonification is suitable for the inspection of ERW joints and the like
- **EXPERT** – click on
  This type of insonification is suitable for the inspection of butt, corner, nozzle, tee- welds and the like

5.5.3.2.4. 3D Scan S: VPFS – Vertical Plane Focusing Scanning

#	Task	Instruction
1	Width of **ROI** is defined symmetrically for the predetermined vertical focusing plane. Then probe position to be selected to provide necessary coverage of **ROI**, which is clearly indicated. It is also necessary to key in positive and negative limits for beam swiveling angle and increment for varying beam swiveling angle On completion click on  or press **Shift** + **Enter**	
2	**3D Scan S – VPFS** For that screen all procedures are identical to the described in paragraph 5.5.3.1.4 of this Operating Manual	

5.5.3.2.5. 3D Scan S: EXPERT – Inspection of Welds

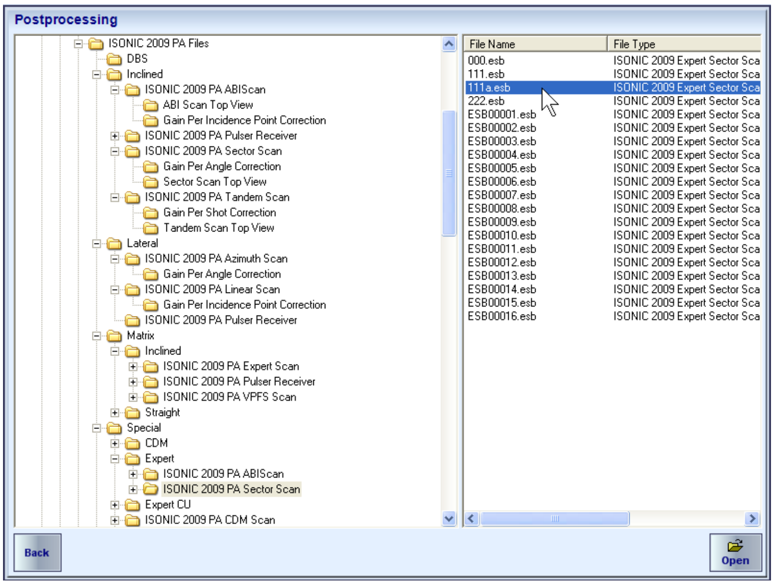
#	Task	Instruction
1	Weld cross section geometry and dimensions to be defined first. Then probe position to be selected to provide necessary coverage of the weld and heat affected zone; the coverage is clearly indicated. It is also necessary to key in positive and negative limits for beam swiveling angle and increment for varying beam swiveling angle On completion click on  or press Shift + Enter	
2	**3D Scan S – EXPERT** For that screen all procedures are identical to the described in paragraph 5.5.3.1.4 of this Operating Manual	

Movie illustrating operating of **ISONIC 2009 UPA Scope** whilst running **3D Scan L** SW is available for viewing / download at **http://www.sonotronndt.com/PDF/OM2009/3D_SCAN_S.wmv**

5.6. Viewing And Processing Of Recorded Files – PA Modality

5.6.1. Posptoroсessing on board ISONIC 2009 UPA Scope

ISONIC 2009 UPA Scope instrument is equipped with comprehensive viewing postprocessing tools for all types of inspection and calibration files. On entering postprocessing mode from **PA Modality Start Menu** (refer to paragraph 5.1 of this Operating Manual) ISONIC 2009 Explorer screen appears. To start postprocessing / viewing of the file double click on it's name



The following typical functions are provided at the postprocessing stage:

File types						
Function	Gain per Angle / Gain per Shot Correction	Parametric file – calibration of ISONIC PA Pulser Receiver	2D Files – B-Scan, Tandem B-Scan, Sector Scan, CB-Scan	Multi-Group Files	3D Files – Top, Side, End Views captured with linear array probes through mechanical scanning	3D Files captured with matrix array probes
Viewing	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Editing	**Y**	**Y** **±6 dB Gain manipulation**	**Y** **±6 dB Gain manipulation**	**Y** **±6 dB Gain manipulation**	**Y** **±6 dB Gain manipulation**	**Y** **±6 dB Gain manipulation**
A-Scan and Gate based signal evaluation	**NA**	**Y**	**Y**	**Y**	**N**	**Y**
Play back of raw data A-Scan	**NA**	**NA**	**Y**	**Y**	**Y**	**Y**
Play Back of Raw data B-Scan, Sector Scan	**NA**	**NA**	**NA**	**NA**	**Y**	**NA**
Measuring projection dimensions of reflectors	**NA**	**NA**	**Y**	**Y**	**Y**	**Y**
Amplitude Filtering	**NA**	**NA**	**Y**	**Y**	**Y**	**Y**
Geometry filtering	**NA**	**NA**	**NA**	**NA**	**Y**	**Y**
Profiling (slicing) in 3 planes	**NA**	**NA**	**NA**	**NA**	**Y**	**Y**
3D presentation of the inspected volume with defects	**NA**	**NA**	**NA**	**NA**	**Y**	**Y**
Y = YES **N** = NO **NA** = Not Applicable						

Postprocessing is implemented through intuitive interface, typical movies explaining various off-line operations are available for viewing / download at:

File Type	Postprocessing Movie Viewing / Download Link
Weld cross section – EXPERT Mode – TTGI Sectro Scan	http://www.sonotronndt.com/PDF/OM2009/TTGI_S_SCAN_BUTT_WELD_PP.wmv
Weld Scanning – EXPERT mode – TTGI Sector Scan and 3D data Capturing	http://www.sonotronndt.com/PDF/OM2009/EXP_PP_BUTT_WELD_SCAN.wmv
B-Scan – composite material	http://www.sonotronndt.com/PDF/OM2009/STRAIGHT_B_SCAN.wmv
Scanning of composite material – B-Scan and 3D Data Capturing	http://www.sonotronndt.com/PDF/OM2009/STRAIGHT_B_SCAN_SC.wmv
Multi - Group	http://www.sonotronndt.com/PDF/OM2009/MGR_PP.wmv
Files created with use of matrix probes	http://www.sonotronndt.com/PDF/OM2009/MATRIX_PP.wmv

5.6.2. Posptorocessing in the PC

5.6.2.1. ISONIC 2009 PP Postprocessing Package

ISONIC 2009 PP Postprocessing Package for office PC provides the same functions as postprocessing SW on board ISONIC 2009 instrument

5.5.2.2. PUZZLE Postrocessing SW Package

PUZZLE postrpocessing allows composing of large 3D data files composed from several B-Scan scanning files. This provide compressing of large area data into one file and further off-line viewing and analysis

6. Conventional PE and TOFD Modalities

To operate conventional channel(s) of **ISONIC 2009 UPA Scope** in conventional PE and TOFD modalities refer to **ISONIC 2008 Operating Manual**. The latest version of this document is available for download at **http://www.sonotronndt.com/pdf/om2008.pdf**

Item	Order Code (Part #)	Note
ISONIC 2009 UPA-Scope – Portable Digital Phased Array Ultrasonic Flaw Detector and Recorder: ***64 channels PA electronics and 1 independent channel for connection of conventional and TOFD probes***	SA 804900	The following chapters of ISONIC 2008 Operating Manual are applicable: **5, 6, 8, 9, 10**
ISONIC 2009 UPA-Scope – Portable Digital Phased Array Ultrasonic Flaw Detector and Recorder: ***64 channels PA electronics and 8 independent channels for connection of conventional and TOFD probes***	SA 804902	The following chapters of ISONIC 2008 Operating Manual are applicable: **5, 6, 7, 8, 9, 10**

7. Incremental Encoders

Various encoders for may be used with **ISONIC 2009 UPA Scope**. For appropriate encoder data cable and connector pin-out contact

- Nearest Sonotron NDT representative

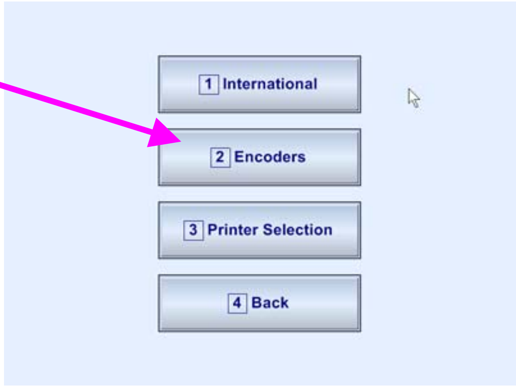
OR

- Directly to Sonotron NDT – e-mail to support@sonotronndt.com with subject **ISONIC 2009 UPA Scope encoder connection**

ⓘ

Improper cable out-coming from custom made encoder for proprietary inspection tasks may lead to warranty exempted damaging ISONIC 2009 UPA Scope instrument

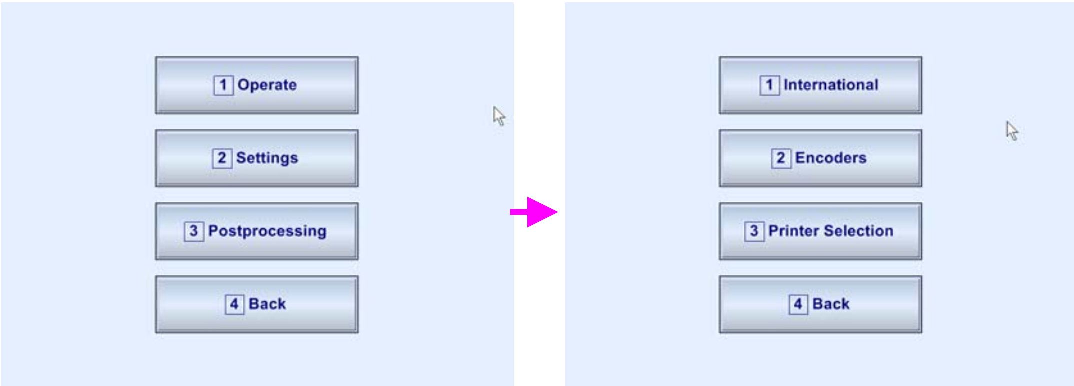
To calibrate / add to database / encoder click on



The proceed according to paragraph 8.4 of **ISONIC 2008 Operating Manual**. The latest version of this document is available for download at http://www.sonotronndt.com/pdf/om2008.pdf

8. Miscellaneous

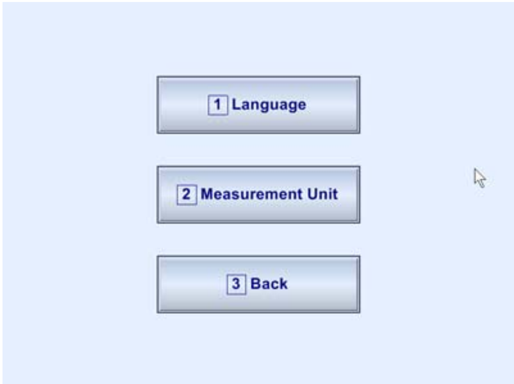
8.1. International Settings



In the PA Modality Start Menu slick on 

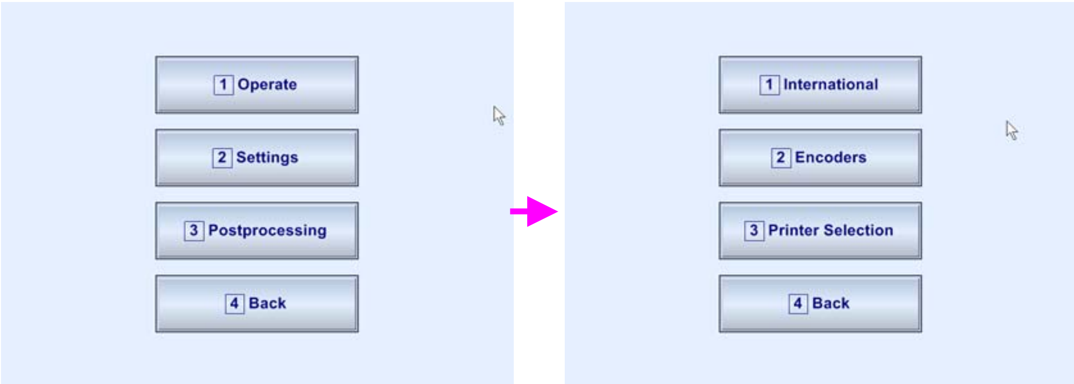
or press **F2** then click on 

or press **F1** :

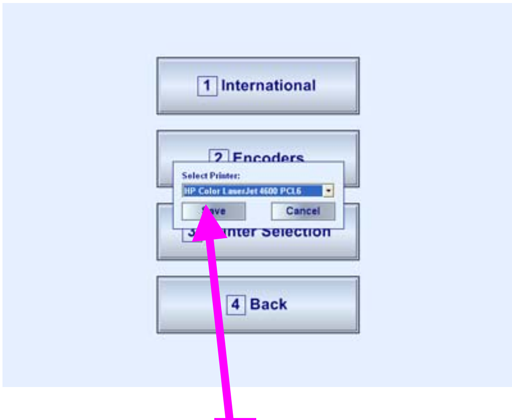


This will allow setting of dialogue language (English, Chinese, Portuguese, etc) and measuring units (metric or imperial)

8.2. Printer Selection



In the PA Modality Start Menu slick on  or press **F2** then click on  or press **F3**:



Select printer among available in the list then click on

8.3. Exit to Windows

In the **ISONIC 2009 UPA-Scope Start Screen** click on 3 Exit To Windows or press **F3** to proceed with Windows XP Embedded settings of **ISONIC 2009 UPA-Scope** instrument. To return to **ISONIC 2009 UPA-Scope Start Screen** double click on icon located in the Windows Desktop

ⓘ

Exit to Windows is required for:

- Connection to network
  - Printing inspection results to network printer
  - Transferring data to / from remote PC
- Installing printer driver(s)
- Quasi-disk management

In order to prevent overloading of **ISONIC 2009 UPA Scope** quasi-disk and memory with data and non **ISONIC 2009 UPA Scope** SW that may affect instrument performance it's not allowed to install non **ISONIC 2009 UPA Scope** SW except drivers noted above. Affecting of instrument performance through installing on non **ISONIC 2009 UPA Scope** SW except drivers noted above is the warranty exemption damage

8.4. Connection to Network

To connect **ISONIC 2009 UPA Scope** to local area network use Ethernet connector (refer to paragraph 4.2 of this Operating Manual). Default factory settings are made for most typical connection to DHCP enabled network with obtaining IP automatically

8.5. External USB Devices

8.5.1. Mouse

Use one of 2 USB Connectors (refer to paragraph 4.2 of this Operating Manual). **ISONIC 2009 UPA Scope** founds and registers external USB mouse automatically through standard Windows routine. Microsoft optical mouse is recommended

8.5.2. Keyboard

Use one of 2 USB Connectors (refer to paragraph 4.2 of this Operating Manual). **ISONIC 2009 UPA Scope** founds and registers USB keyboard automatically through standard Windows routine. Microsoft keyboard is recommended

8.5.3. Memory Stick (Disk on Key)

Use one of 2 USB Connectors (refer to paragraph 4.2 of this Operating Manual). **ISONIC 2009 UPA Scope** running founds and registers USB memory stick (disk on key) automatically through standard Windows routine

8.5.4. Printer

Use one of 2 USB Connectors (refer to paragraph 4.2 of this Operating Manual). Preliminary driver setup is required. To install driver use network connection or USB memory stick (disk on key)

8.6. External VGA screen / VGA projector

Connect to appropriate connector (refer to paragraph 4.2 of this Operating Manual) while at least one of 2 devices either **ISONIC 2009 UPA Scope** or external screen / projector is switched OFF then switch on one or both devices

8.7. SW Upgrade

Refer to **http://www.sonotronndt.com/support.htm** in the Internet

8.8. Charging Battery

Battery of **ISONIC 2009 UPA Scope** may be charged while disconnected from the unit. The special charger is required (refer to Chapter 3 of this Operating Manual). Connect charger to the battery as it is shown below

There is **Charge** LED on the charger. While charging the battery this LED emits solid light. **Charge** LED starts flashing upon charge is completed

ⓘ

If a battery is new and almost completely discharged then "boiling" effect in the electrolyte may start earlier than battery is fully charged. In order to prevent battery charger stops on detecting boiling "boiling" effect:

- If temperature inside battery does not exceed 60^{o}C deg limit then **Charge** LED starts flashing – for such case it is necessary to disconnect charger from mains for few minutes and to connect it to mains again. The normal charging will continue
- If temperature inside battery exceeds 60^{o}C deg limit then **Temp** LED starts flashing – for such case it is necessary to disconnect charger from mains for at least 2 hours and to connect it to mains again. The normal charging will continue

After few charge / discharge cycles battery becomes "trained" and probability of "boiling" effect decreases to almost zero

8.9. Silicon Rubber Jacket

Use tweezers to remove the plastic screw caps from both sides of the handle:

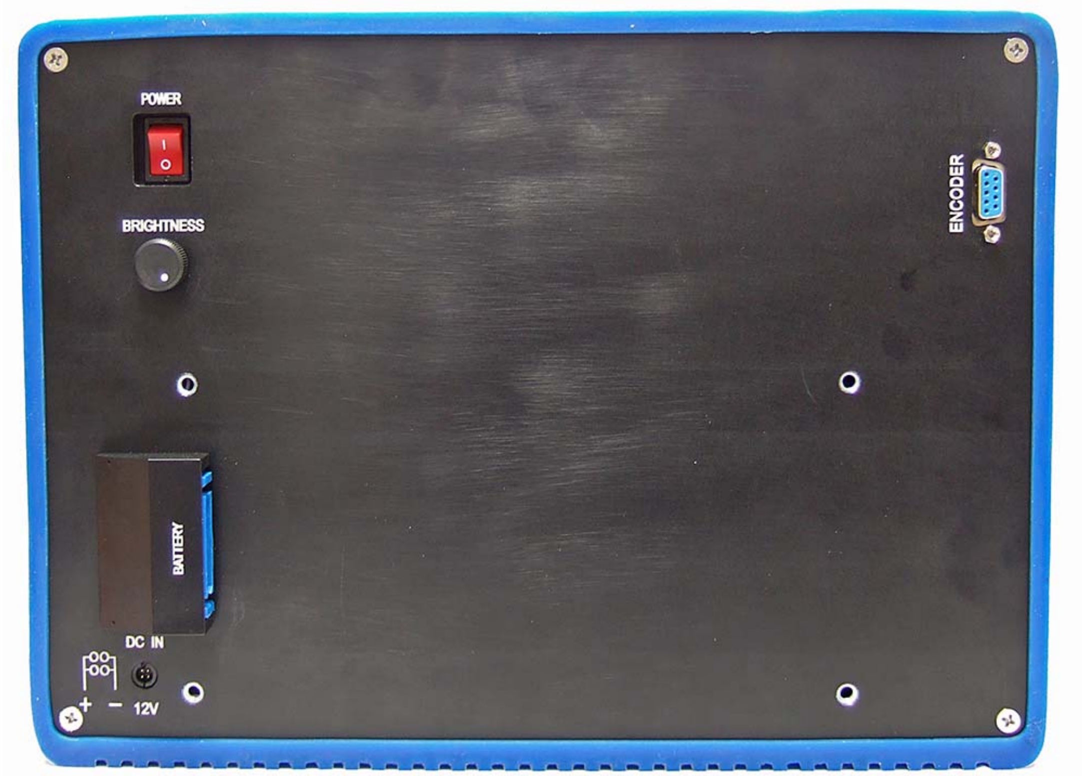
Remove screw and washer from each side of the handle:

Put aside handle and all other parts:

Slip the Silicone Rubber Jacket around the machine:

Make sure the Silicone Rubber Jacket fits properly and covers all edges:

A view from the backside:



Slide the handle back in place (with the metal parts on each side):

Screw-in tightly at on each side of the handle:

Put back the plastic screw caps at each side by pushing them inwards until they lock and click:

DONE!!