EPOCH 1000 Series
Ultrasonic Flaw Detectors
User's Manual

910-269-EN [U8778322] — Rev. D
November 2014

This instruction manual contains essential information on how to use this Olympus product safely and effectively. Before using this product, thoroughly review this instruction manual. Use the product as instructed.

Keep this instruction manual in a safe, accessible location.

Olympus Scientific Solutions Americas, 48 Woerd Avenue, Waltham, MA 02453, USA

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This document was prepared with particular attention to usage to ensure the accuracy of the information contained therein, and corresponds to the version of the product manufactured prior to the date appearing on the title page. There could, however, be some differences between the manual and the product if the product was modified thereafter.

The information contained in this document is subject to change without notice.

Part number: 910-269-EN [U8778322]
Rev. D
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Abbreviations

2-D	two dimensional
3-D	three-dimensional
AC	alternating current
AVG	average voltage gain
AWS	American Welding Society
BEA	back wall echo attenuator
BIP	beam index point
BYP	bypass
CAL	calibration
CL	centerline
CSC	curved surface correction
DAC	distance amplitude correction
DGS	distance gain size
DIR	direction
DT	distance travelled
EFUP	environment-friendly use period
ERS	equivalent reflector size
ESC	escape
FBH	flat-bottom hole
FSH	full-screen height
GND	ground
ID	identifier
IF	interface gate
IIW	International Institute of Welding

IN	increment
IP	ingress protection
JIS	Japanese Industrial Standard
LCD	liquid crystal display
LOS	loss of signal
LW	longitudinal wave
MEM	memory
NDT	nondestructive testing
OS	overshoot
P/R	pulser/receiver
PA	phased array
PK	peak
PN	part number
PRF	pulse repetition frequency
SDH	side-drilled hole
TOF	time-of-flight
TRIG	trigonometry
TVG	time-varied gain
USB	universal serial bus
UT	ultrasonic technology
VGA	video graphics adapter

Labels and Symbols

Safety-related labels and symbols are attached to the instrument at the location shown in Figure i-1 on page 1. If any or all of the labels or symbols are missing or illegible, please contact Olympus.

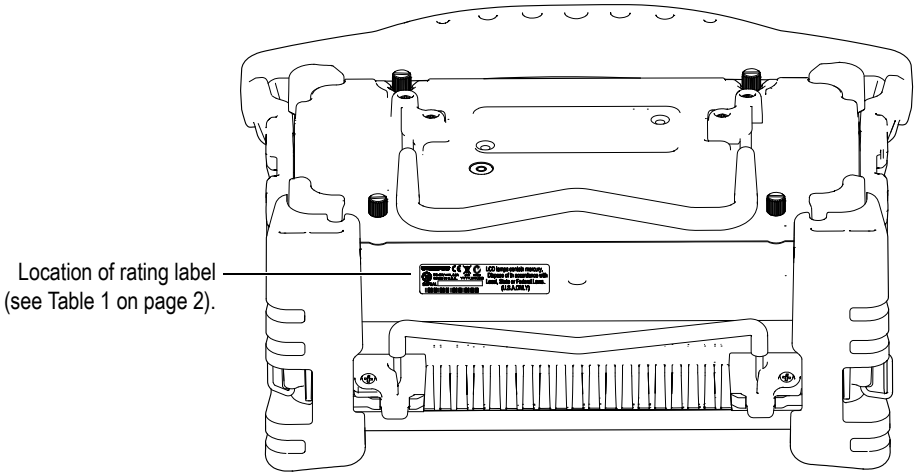


Figure i-1 Label location

Table 1 Content of the rating label

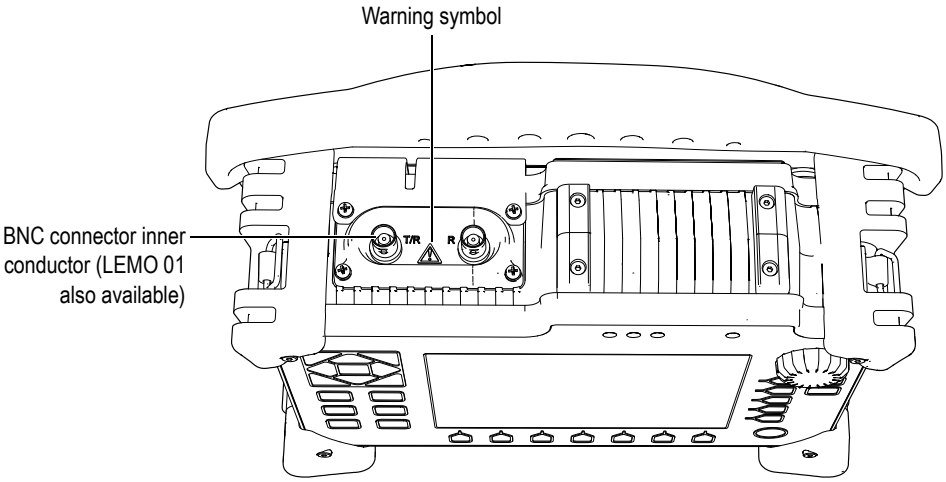
	Content
CE	The CE marking is a declaration that this product conforms to all the applicable directives of the European Community. See the *Declaration of Conformity* for details. Contact your Olympus representative for more information.
	The WEEE symbol indicates that the product must not be disposed of as unsorted municipal waste, but should be collected separately.
15	The China RoHS mark indicates the product's Environment-Friendly Use Period (EFUP). The EFUP is defined as the number of years for which listed controlled substances will not leak or chemically deteriorate while in the product. The EFUP for the EPOCH 1000 has been determined to be 15 years. **Note**: The Environment-Friendly Use Period (EFUP) is not meant to be interpreted as the period assuring functionality and product performance.
⎓	The direct current symbol.

Table 1 Content of the rating label *(continued)*

SERIAL	The serial number is a nine (9) digit number in the following format: **yynnnddmm** where: **yy** Production year **nnn** Unit number manufactured that day **dd** Production day **mm** Production Month For example, the 080011612 serial number indicates that the first unit (001) was produced on the December 16, 2008.

CAUTION

To avoid the risk of electric shock, do not touch the inner conductor of the BNC (or LEMO) connectors. Up to 475 V can be present on the inner conductor. The warning symbol between the Transmit/Receive (T/R) and the Receive (R) BNC connectors shown in the figure below warns of this electric shock risk.



Important Information — Please Read Before Use

Intended Use

The EPOCH 1000 is designed to perform nondestructive inspections on industrial and commercial materials.

WARNING

Do not use the EPOCH 1000 for any purpose other than its intended use.

Instruction Manual

This instruction manual contains essential information on how to use this Olympus product safely and effectively. Before using this product, thoroughly review this instruction manual. Use the product as instructed.

Keep this instruction manual in a safe, accessible location.

IMPORTANT

Some of the details of components illustrated in this manual may differ from the components installed on your instrument. However, the operating principles remain the same.

Instrument Compatibility

Only use EPOCH 1000 Series instruments with the following ancillary equipment:

- Rechargeable lithium-ion (Li-ion) battery pack (PN: EPXT-BAT-L)
- Optional standalone external battery charger (PN: EPXT-EC)
- Charger/adaptor (PN: EP-MCA)

CAUTION

Always use equipment and accessories that meet Olympus specifications. Using incompatible equipment could cause equipment malfunction and/or damage, or human injury.

Repair and Modification

The EPOCH 1000 does not contain any user-serviceable parts. Opening the instrument might void the warranty.

CAUTION

In order to prevent human injury and/or equipment damage, do not disassemble, modify, or attempt to repair the instrument.

Safety Symbols

The following safety symbols might appear on the instrument and in the instruction manual:

General warning symbol

This symbol is used to alert the user to potential hazards. All safety messages that follow this symbol shall be obeyed to avoid possible harm or material damage.

High voltage warning symbol

This symbol is used to alert the user to potential electric shock hazards greater than 1000 volts. All safety messages that follow this symbol shall be obeyed to avoid possible harm.

Safety Signal Words

The following safety symbols might appear in the documentation of the instrument:

DANGER

The DANGER signal word indicates an imminently hazardous situation. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, will result in death or serious personal injury. Do not proceed beyond a DANGER signal word until the indicated conditions are fully understood and met.

WARNING

The WARNING signal word indicates a potentially hazardous situation. It calls attention to a procedure, practice, or the like, which, if not correctly performed or adhered to, could result in death or serious personal injury. Do not proceed beyond a WARNING signal word until the indicated conditions are fully understood and met.

CAUTION

The CAUTION signal word indicates a potentially hazardous situation. It calls attention to an operating procedure, practice, or the like, which, if not correctly performed or adhered to, may result in minor or moderate personal injury, material damage, particularly to the product, destruction of part or all of the product, or loss of data. Do not proceed beyond a CAUTION signal word until the indicated conditions are fully understood and met.

Note Signal Words

The following safety symbols could appear in the documentation of the instrument:

IMPORTANT

The IMPORTANT signal word calls attention to a note that provides important information, or information essential to the completion of a task.

NOTE

The NOTE signal word calls attention to an operating procedure, practice, or the like, which requires special attention. A note also denotes related parenthetical information that is useful, but not imperative.

TIP

The TIP signal word calls attention to a type of note that helps you apply the techniques and procedures described in the manual to your specific needs, or provides hints on how to effectively use the capabilities of the product.

Safety

Before turning on the instrument, verify that the correct safety precautions have been taken (see the following warnings). In addition, note the external markings on the instrument, which are described under “Safety Symbols.”

Warnings

WARNING

General Warnings

- Carefully read the instructions contained in this instruction manual prior to turning on the instrument.
- Keep this instruction manual in a safe place for further reference.
- Follow the installation and operation procedures.
- It is imperative to respect the safety warnings on the instrument and in this instruction manual.
- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment could be impaired.
- Do not install substitute parts or perform any unauthorized modification to the instrument.
- Service instructions, when applicable, are for trained service personnel. To avoid the risk of electric shock, do not perform any work on the instrument unless qualified to do so. For any problem or question regarding this instrument, contact Olympus or an authorized Olympus representative.
- Do not allow metallic or foreign objects to enter the device through connectors or any other openings. Otherwise, a malfunction or electric shock may result.

WARNING

Electrical Warnings

- Before operating this instrument using mains electricity, you must connect the protective earth terminal of the instrument to the protective conductor (mains) of the power cord. The mains plug shall only be inserted into a socket outlet provided with a protective earth contact. Never negate the protective action by using an extension cord (power cable) without a protective conductor (grounding).

- Only use fuses with the required rated current, voltage, and specified type (normal-blow, slow-blow, quick-acting, etc.). Do not use repaired fuses or short-circuited fuse holders. Doing so could cause electric shock or create a fire hazard.
- If there is any possibility that the ground protection could be impaired, you must make the instrument inoperative and secure it against any unintended operation.
- The instrument must only be connected to a power source corresponding to the type indicated on the rating label.

CAUTION

If a non-approved power supply cord not dedicated to Olympus products is used, Olympus will not be able to ensure the electrical safety of the equipment.

Battery Precautions

CAUTION

- Before disposing of a battery, check your local laws, rules, and regulations, and follow them accordingly.
- Transportation of lithium-ion batteries is regulated by the United Nations under the United Nations Recommendations on the Transport of Dangerous Goods. It is expected that governments, intergovernmental organizations, and other international organizations shall conform to the principles laid down in these regulations, thus contributing to worldwide harmonization in this field. These international organizations include the International Civil Aviation organization (ICAO), the International Air Transport Association (IATA), the International Maritime Organization (IMO), the US Department of Transportation (USDOT), and others. Please contact the transporter and confirm current regulations before transportation of lithium-ion batteries.
- For California (USA) only:

  The CR battery contains perchlorate material, and special handling may be required. Refer to http://www.dtsc.ca.gov/hazardouswaste/perchlorate.
- Do not open, crush, or perforate batteries; doing so could cause injury.
- Do not incinerate batteries. Keep batteries away from fire and other sources of extreme heat. Exposing batteries to extreme heat (over 80 °C) could result in an explosion or personal injury.

- Do not drop, hit, or otherwise abuse a battery, as doing so could expose the cell contents, which are corrosive and explosive.
- Do not short-circuit the battery terminals. A short circuit could cause injury and severe damage to a battery making it unusable.
- Do not expose a battery to moisture or rain; doing so could cause an electric shock.
- Only use the EPOCH 1000 unit or an external charger approved by Olympus to charge the batteries.
- Only use batteries supplied by Olympus.
- Do not store batteries that have less than 40 % remaining charge. Recharge batteries to between 40 % and 80 % capacity before storing them.
- During storage, keep the battery charge between 40 % and 80 %.
- Do not leave batteries in the EPOCH 1000 unit during instrument storage.

Equipment Disposal

Before disposing of the EPOCH 1000, check your local laws, rules, and regulations, and follow them accordingly.

CE (European Community)

This device complies with the requirements of both directive 2004/108/EC concerning electromagnetic compatibility and directive 2006/95/EC concerning low voltage. The CE marking indicates compliance with the above directives.

WEEE Directive

In accordance with European Directive 2012/19/EU on Waste Electrical and Electronic Equipment (WEEE), this symbol indicates that the product must not be disposed of as unsorted municipal waste, but should be collected separately. Refer to your local Olympus distributor for return and/or collection systems available in your country.

China RoHS

China RoHS is the term used by industry generally to describe legislation implemented by the Ministry of Information Industry (MII) in the People's Republic of China for the control of pollution by electronic information products (EIP).

The China RoHS mark indicates the product's Environment-Friendly Use Period (EFUP). The EFUP is defined as the number of years for which listed controlled substances will not leak or chemically deteriorate while in the product. The EFUP for the EPOCH 1000 has been determined to be 15 years.

Note: The Environment-Friendly Use Period (EFUP) is not meant to be interpreted as the period assuring functionality and product performance.

EMC Directive Compliance

This equipment generates and uses radio-frequency energy and, if not installed and used properly (that is, in strict accordance with the manufacturer's instructions), may cause interference. The EPOCH 1000 has been tested and found to comply with the limits for an industrial device in accordance with the specifications of the EMC directive.

FCC (USA) Compliance

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference.
2. This device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, might cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case you will be required to correct the interference at your own expense.

ICES-001 (Canada) Compliance

This Class A digital apparatus complies with Canadian ICES-001.

Cet appareil numérique de la classe A est conforme à la norme NMB-001 du Canada.

Warranty Information

Olympus guarantees your Olympus product to be free from defects in materials and workmanship for a specific period, and in accordance with conditions specified in the *Olympus Scientific Solutions Americas Inc. Terms and Conditions* available at http://www.olympus-ims.com/en/terms/.

The Olympus warranty only covers equipment that has been used in a proper manner, as described in this instruction manual, and that has not been subjected to excessive abuse, attempted unauthorized repair, or modification.

Inspect materials thoroughly on receipt for evidence of external or internal damage that might have occurred during shipment. Immediately notify the carrier making the delivery of any damage, because the carrier is normally liable for damage during shipment. Retain packing materials, waybills, and other shipping documentation needed in order to file a damage claim. After notifying the carrier, contact Olympus for assistance with the damage claim and equipment replacement, if necessary.

This instruction manual explains the proper operation of your Olympus product. The information contained herein is intended solely as a teaching aid, and shall not be used in any particular application without independent testing and/or verification by the operator or the supervisor. Such independent verification of procedures becomes increasingly important as the criticality of the application increases. For this reason, Olympus makes no warranty, expressed or implied, that the techniques, examples, or procedures described herein are consistent with industry standards, nor that they meet the requirements of any particular application.

Olympus reserves the right to modify any product without incurring the responsibility for modifying previously manufactured products.

Technical Support

Olympus is firmly committed to providing the highest level of customer service and product support. If you experience any difficulties when using our product, or if it fails to operate as described in the documentation, first consult the user's manual, and then, if you are still in need of assistance, contact our After-Sales Service. To locate the nearest service center, visit the Service Centers page at: http://www.olympus-ims.com.

Preface

Product Description

The EPOCH 1000, EPOCH 1000*iR*, and EPOCH 1000*i* are portable ultrasonic nondestructive testing (NDT) instruments used to detect flaw conditions in welds, pipes, and many other structural and industrial materials. These instruments may be used with a variety of conventional ultrasonic transducers and/or phased array probes in indoor and outdoor environments. EPOCH 1000 Series instruments offer advanced conventional ultrasonic performance as well as basic phased array imaging capabilities. All three instrument models (EPOCH 1000/1000*iR*/1000*i*) feature a large dynamic range, superior measurement resolution, an intuitive user interface, and a full VGA resolution (640 × 480 pixels) color liquid-crystal display with transflective technology for superior visibility.

EPOCH 1000 Series instruments feature many performance, durability, and operational enhancements when compared to previous EPOCH flaw detectors, including:

- Casing designed to meet the requirements of IP66 environmental rating
- Color liquid-crystal display (LCD) with full VGA resolution and transflective technology
- Compliance with EN12668-1
- A 100 % digital high-dynamic-range receiver design
- Over 30 digital receiver filters
- Maximum 6000 Hz pulse repetition frequency (PRF) for high-speed scanning
- Phased array imaging capabilities
- Dynamic DAC/TVG sizing software
- Onboard DGS/AVG sizing software

- Image and A-scan reference and measurement cursors
- Four programmable analog outputs
- Six programmable alarm outputs
- USB and RS-232 connectivity
- Adjustment knob and navigational arrow keys
- Standard 2 GB CompactFlash card
- VGA output capability

Read through this information completely at least once with your EPOCH 1000/1000*iR*/1000*i* in hand so that you can combine reading the descriptions and examples with the actual use of the instrument.

EPOCH 1000 Series Models

The EPOCH 1000 Series offers three instrument configuration levels to suit many inspection needs:

EPOCH 1000 Advanced UT

An advanced conventional ultrasonic flaw detector that can be upgraded with phased array imaging at an authorized Olympus service center.

EPOCH 1000*iR* Advanced UT + Phased Array Ready

Provides the same ultrasonic flaw detection capabilities as the EPOCH 1000 with the benefit of upgrading to phased array with simple field-remote activation.

EPOCH 1000*i* Advanced UT + Phased Array Built-In

Comes standard with the same advanced ultrasonic flaw detection capabilities as the EPOCH 1000 as well as the benefits of a built-in phased array imaging package.

About This Document

This document is the user's manual for the EPOCH 1000/1000*iR*/1000*i*. This manual describes routine tasks for operating the EPOCH 1000 Series. These tasks include:

- Operating the power supply
- Managing basic operations
- Adjusting the pulser and receiver

- Managing special functions
- Input and Output features
- Using the gates and reference cursors
- Calibrating the EPOCH 1000/1000*iR*/1000*i*
- Managing the data logger and data communication features
- Using software options

Audience

This document is intended for operators of the EPOCH 1000/1000*iR*/1000*i*. Olympus recommends that all operators have a thorough understanding of the principles and limitations of ultrasonic non destructive testing. Olympus assumes no responsibility for incorrect operational procedure or interpretation of test results. We recommend that all operators seek adequate training prior to using this equipment.

While the EPOCH 1000/1000*iR*/1000*i* is a continuously self-calibrating instrument, you must determine regulatory requirements. Olympus offers calibration and documentation services. Contact Olympus or your local representative with any special requests.

Typographical Conventions

Table 2 on page 17 presents the typographical conventions employed in this document.

Table 2 Typographic conventions

Convention	Description
Bold	Used when referring to the label of a user interface element, including menu items, buttons, toolbar names, options, and tabs.
[BOLD]	Used when referring to an instrument front panel key.

Table 2 Typographic conventions *(continued)*

Convention	Description
[2ND F], BOLD	Used when referring to the secondary function of an instrument front panel key. **[BOLD]** is the primary function of the key. **(BOLD)** is the secondary function of the key, appearing above the direct-access keypad key. The comma means to sequentially press and release the two keys.
ALL UPPERCASE	Used to refer to computer keyboard keys
SMALL CAPS	Used to refer to marking on the instrument for connector names for example.
Italics	Used to refer to document titles.
<n>	Used to represent a variable.

1. EPOCH 1000 Series Hardware Features

The EPOCH 1000 Series has many physical features that are either completely new or improved compared to previous EPOCH flaw detector instruments. It is important for you to be familiar with the use and maintenance of these items.

1.1 Hardware Overview

Figure 1-1 on page 20 shows an EPOCH 1000 Series instrument and identifies its main components.

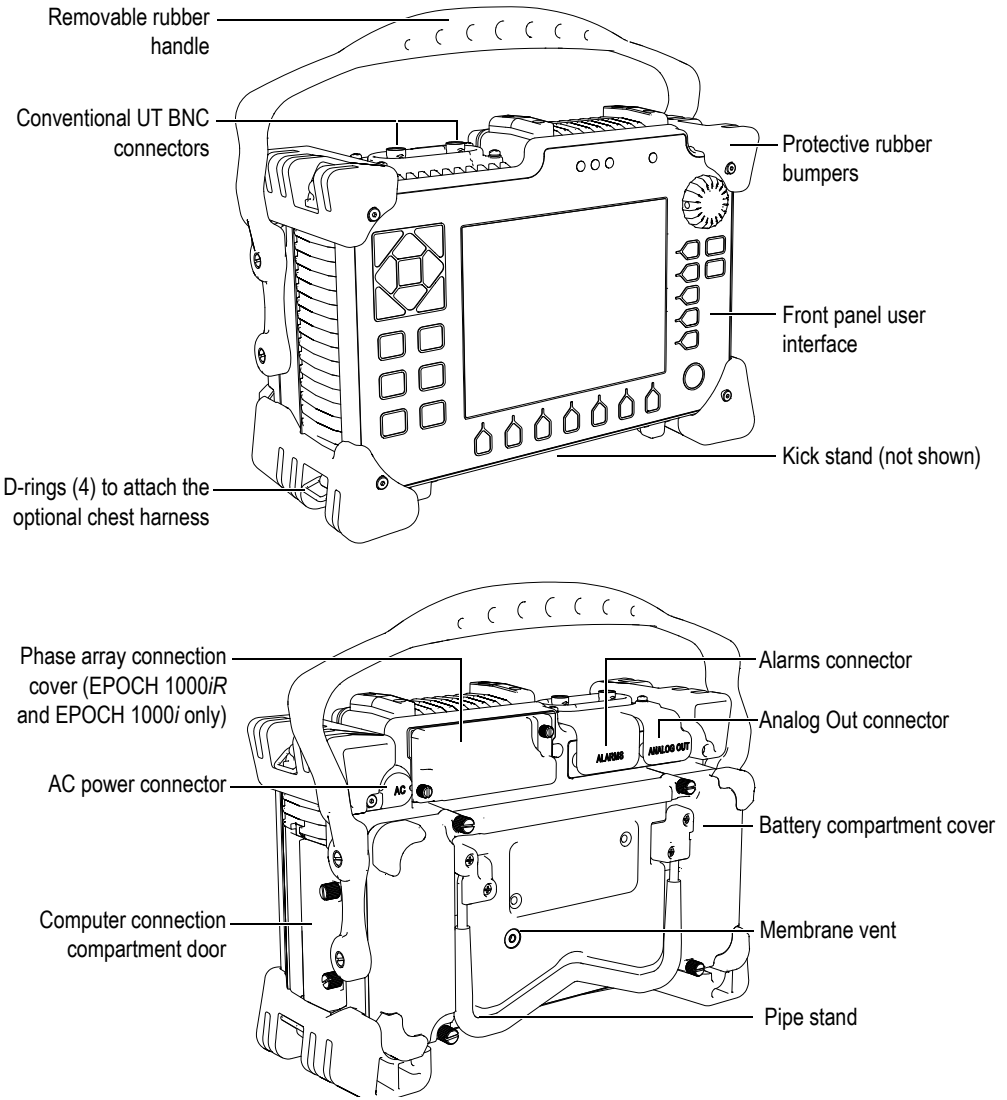


Figure 1-1 Overview of the EPOCH 1000 Series hardware

1.2 Front Panel User Interface

The EPOCH 1000 Series front panel shown in Figure 1-2 on page 21 features a combination of direct-access keys, navigation arrows, dynamic function, and parameter access keys to optimize the usability of the instrument in any mode. The layout of the front panel provides direct access to common inspection parameters, and easy adjustment of values from either side of the instrument without obstructing the view of the display.

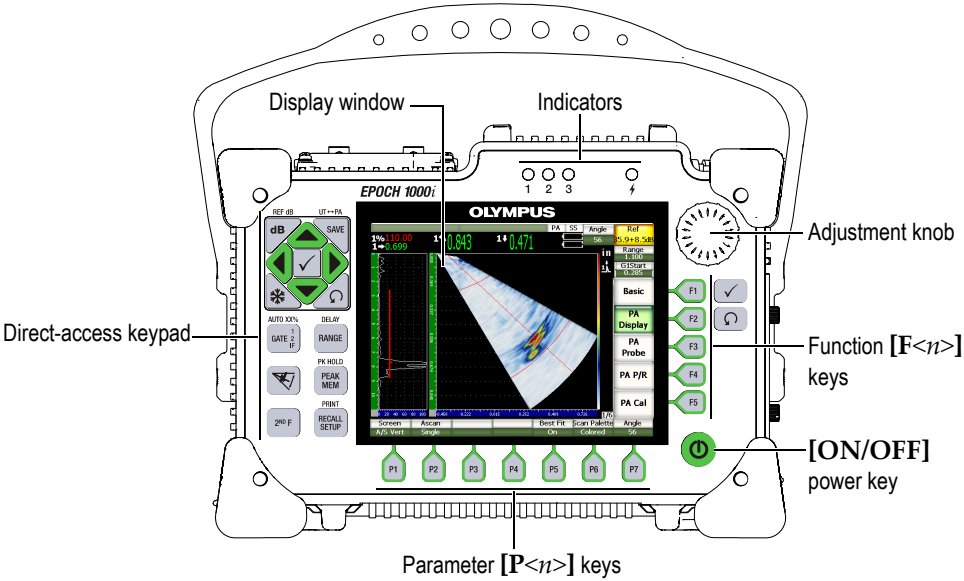


Figure 1-2 The EPOCH 1000 Series hardware user interface elements

The direct-access keypad, on the left side of the front panel, provides keys for direct access to software parameters that are commonly used during inspection (see section "About the Direct-Access Keypad" on page 24 for details).

1.2.1 General Purpose Keys and Knob

The EPOCH 1000 Series provides navigation arrows, **[CHECK]** and **[ESCAPE]** keys, and an adjustment knob (see Figure 1-3 on page 22). They are general purpose keys, regardless of instrument mode or function. The **[CHECK]** and **[ESCAPE]** keys are available on both the left and right side of the EPOCH 1000 Series front panel.

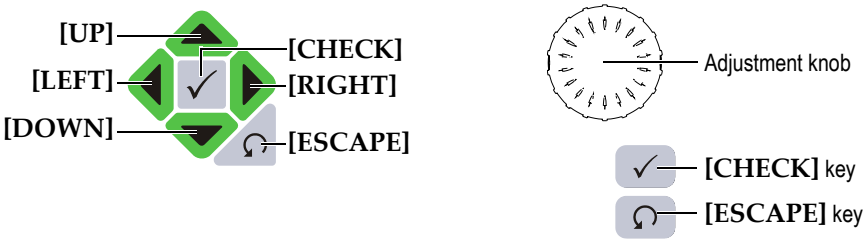


Figure 1-3 General purpose keys and knob

The **[CHECK]** key has four primary functions:

- When a submenu is highlighted, **[CHECK]** selects this submenu and brings the highlighted focus to the first parameter within the submenu.
- When an adjustable parameter is highlighted, **[CHECK]** toggles the parameter adjustment between a coarse and a fine adjustment.
  - Coarse adjustment is active when the parameter title is underlined.
  - Fine adjustment is active when the parameter title is not underlined.
- When a parameter button is highlighted, **[CHECK]** activates that function (example **CAL Zero**).
- When a parameter is highlighted and has two or more selections or states, **[CHECK]** toggles through each available state.

The **[ESCAPE]** key has two primary functions:

- When in a setup page, **[ESCAPE]** returns to the live inspection screen.
- When a parameter in the horizontal parameter frame is highlighted, **[ESCAPE]** returns focus to the corresponding submenu. A second press of **[ESCAPE]** returns focus to the first selection of the first submenu (**Basic** or **PA Display**).

1.2.2 Function and Parameter Keys

Adjustment and/or activation of most of the EPOCH 1000 Series software functions are performed via an intuitive menu system. The menu system software buttons appear at all times, vertically on the right side and horizontally at the bottom of the display. Five function keys (**[F1]** through **[F5])** and seven parameter keys (**[P1]** through **[P7]**) are located around the display, allowing you to individually activate a software button. In the example of Figure 1-4 on page 23, pressing **[F2]** chooses the **Pulser** submenu and activates the corresponding functions.

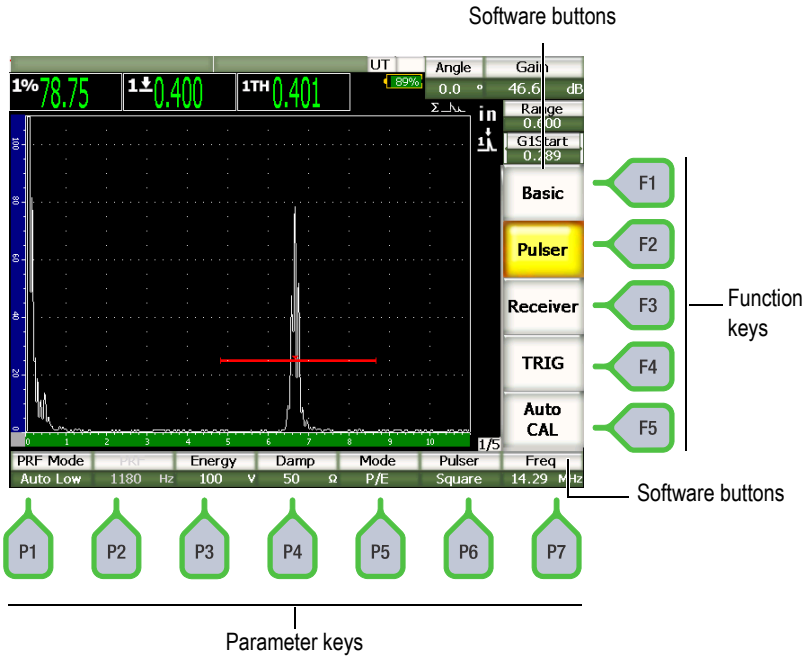


Figure 1-4 [F<*n*>] and [P<*n*>] keys pointing to software buttons

1.2.3 Parameter Adjustment

Software parameter value adjustments, such as **Gain** or **Range**, can be accomplished via two primary methods:

- Use the **[UP]** and **[DOWN]** arrow keys respectively to increase and decrease a parameter value in either coarse or fine steps.
- Turn the adjustment knob clockwise to increase a parameter value, and counterclockwise to decrease a parameter value in either coarse or fine steps.

TIP

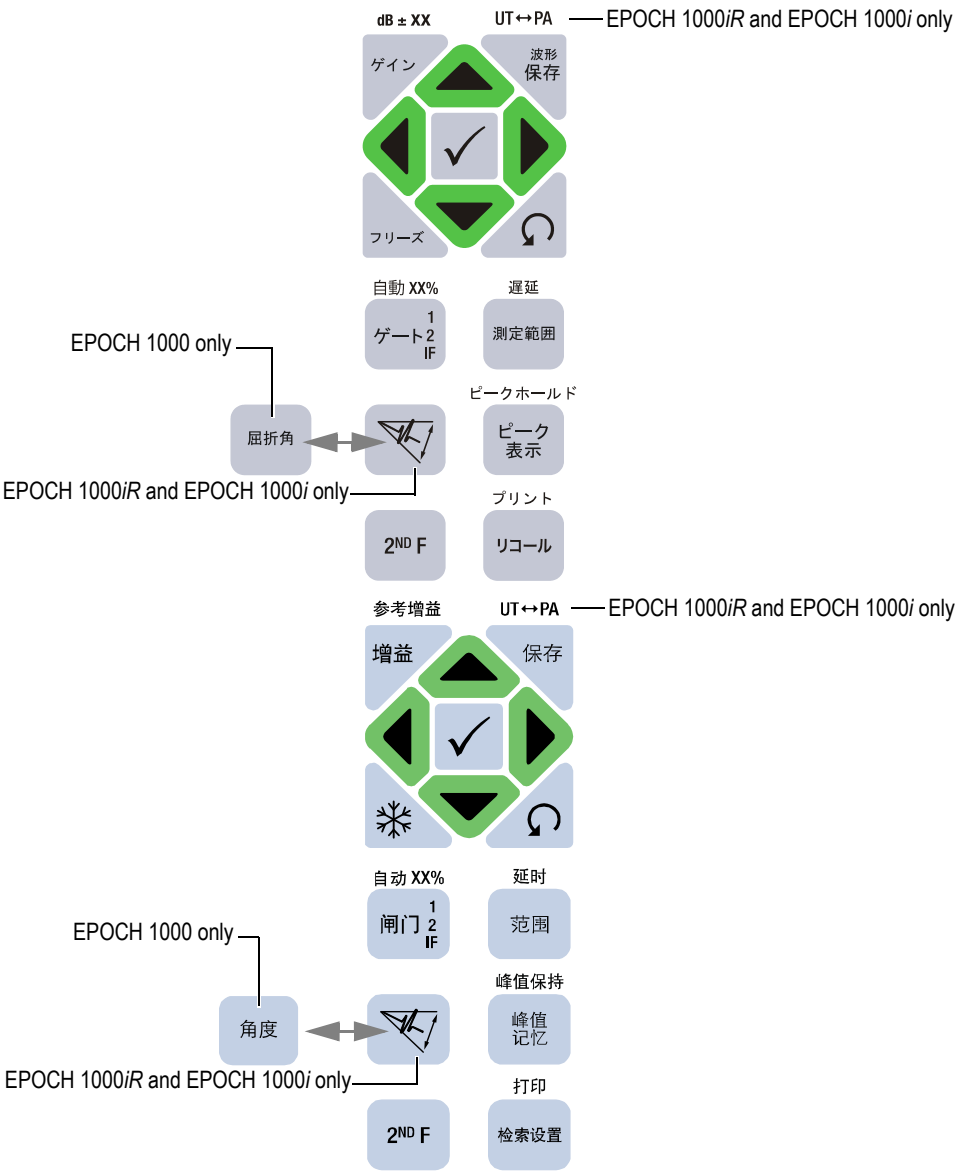
The **[CHECK]** key sets the coarse/fine mode and the **[ESCAPE]** key returns the focus one level up in the menu hierarchy.

1.2.4 About the Direct-Access Keypad

Important, commonly used parameters can be accessed via keys on the instrument's direct-access keypad. Figure 1-5 on page 26 shows the keypad in its EPOCH 1000*iR* and EPOCH 1000*i* configurations and provides indication of the differences for the EPOCH 1000 configuration. There are two differences between the direct-access keypad of conventional only instruments versus conventional with phased array instrument models:

1. The **[ANGLE]** key label (ANGLE), (屈折角)(角度) is replaced by , which illustrates a focal law angle selection.
2. The **(UT-PA)** secondary function is added to allow easy switching between conventional and phased array operational modes.

The direct-access keypad is available in English, Japanese, Chinese, and International Symbols. In the International version, the text labels of the keys are replaced by pictograms.


dB ± XX
UT↔PA
EPOCH 1000iR and EPOCH 1000i only
ゲイン
波形
保存
フリーズ
自動 XX%
遅延
ゲート 1 2 IF
測定範囲
EPOCH 1000 only
ピークホールド
屈折角
ピーク
表示
EPOCH 1000iR and EPOCH 1000i only
プリント
2ND F
リコール
参考増益
UT↔PA
EPOCH 1000iR and EPOCH 1000i only
増益
保存
自动 XX%
延时
闸门 1 2 IF
范围
EPOCH 1000 only
峰值保持
角度
峰值
记忆
EPOCH 1000iR and EPOCH 1000i only
打印
2ND F
检索设置

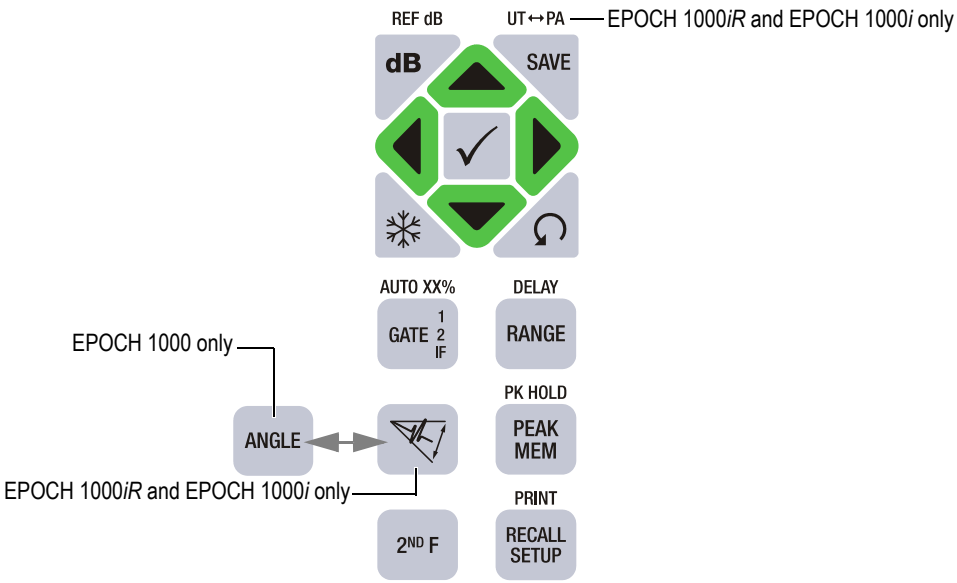


Figure 1-5 The direct-access keypad with model differences

Table 3 on page 27 presents a description of each of the key for the English, Japanese, Chinese, and International versions of the keypad.

Table 3 Keypad key description

English	International/ Japanese/ Chinese	Function
REF dB dB	dB ± XX dB dB ± XX ゲイン 参考増益 増益	**[GAIN]** Adjusts system sensitivity.
		[2nd F], [GAIN] (REF dB) Locks the reference gain level and allows the scanning gain to be used.
UT↔PA SAVE	UT↔PA UT↔PA 波形 保存 UT↔PA 保存	**[SAVE]** Saves to the selected File and ID.
		[2nd F], [SAVE] (UT-PA) [EPOCH 1000*iR* and EPOCH 1000*i* only] Switches back and forth between the conventional (UT) and the phased array (PA) modes.
❄	❄	**[FREEZE]** Freeze holds the displayed waveform until **[FREEZE]** is pressed again.

Table 3 Keypad key description *(continued)*

English	International/ Japanese/ Chinese	Function
AUTO XX% 1 GATE 2 IF	AUTO XX% 1 2 IF 自動 XX% 1 ゲート 2 IF 自动 XX% 1 闸门 2 IF	**[GATE]** Selects gates (1, 2, or IF) on the screen.
		[2nd F], [GATE] (AUTO XX%) Automatically adjusts gated signal to XX% of full-screen height (see “Using the AUTO-XX% Feature” on page 100).
DELAY RANGE	DELAY 遅延 測定範囲 延时 范围	**[RANGE]** Adjusts the instrument’s range according to the sound level setting.
		[2nd F], [RANGE] (DELAY) Displays the delay that does not affect the calibrated zero offset.
		[ANGLE] (EPOCH 1000*iR* and EPOCH 1000*i* only) Enables adjustment of the current focal law (PA mode) or angle (UT mode)
ANGLE	屈折角 角度	**[ANGLE]** (EPOCH 1000 only) Enables adjustment of current angle.

Table 3 Keypad key description *(continued)*

English	International/ Japanese/ Chinese	Function
PK HOLD PEAK MEM	PK HOLD ピークホールド ピーク 表示 峰值保持 峰值 记忆	**[PEAK MEM]** Activates the peak memory function (see “Peak Memory” on page 112).
		[2nd F], [PEAK MEM] (PK HOLD) Activates the peak hold function (see “Peak Hold” on page 114).
2ND F	2ND F	**[2nd F]** Accesses the second function identified above the keypad keys when pressed and released.
PRINT RECALL SETUP	プリント リコール 打印 检索设置	**[RECALL SETUP]** Enables access to quick calibration file recall.
		[2nd F], [RECALL SETUP] (PRINT) Prints reports to compatible printer connected to a USB port.

1.2.5 About Indicators

EPOCH 1000 Series instruments provide one power and three alarm indicator lights (see Figure 1-6 on page 30). The indicators are located on the front panel above the display window (see Figure 1-2 on page 21).

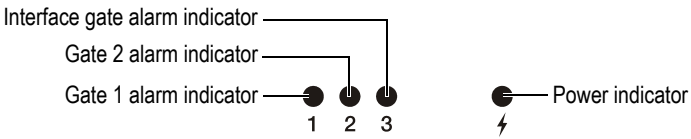


Figure 1-6 Front panel indicator lights

The alarm indicators illuminate in red when the corresponding gate alarm is triggered. Refer to section “Gate Alarms” on page 133 for information on gate alarms.

Refer to Table 5 on page 47 for details on the meaning of the various states of the power indicator.

1.3 USB Keyboard and Mouse Control

You can connect a USB keyboard and a USB mouse to EPOCH 1000 Series instruments and use them to control standard instrument functions. Function control via the USB keyboard and mouse is similar to direct function control via the methods described previously in this document. A USB keyboard can also be used to type characters directly into the alpha-numeric data logger.

Some key control notes are as follows:

- The USB keyboard control enables direct entry of parameter values.
- To accept a directly entered parameter, press the ENTER key on the keyboard.
- The ESC key on a USB keyboard activates the **[ESCAPE]** function.
- The ENTER key on a USB keyboard activates the **[CHECK]** function.
- The wheel on a USB mouse mimics the instrument adjustment knob.

1.4 Connectors

EPOCH 1000 Series instruments provide numerous connections. The following sections describe these connections.

1.4.1 Conventional Transducer Connections

EPOCH 1000 Series instruments are supplied with either BNC or LEMO 01 conventional transducer connectors. The type of conventional transducer connector is chosen at the time of order. If necessary, it is possible to change the type of transducer connection at an authorized Olympus service center for a small charge. Selection of these transducer connections is based on operator preference. Both the BNC and LEMO 01 connectors available are rated to IP67 for use in most inspection environments. The EPOCH 1000 Series is illustrated with BNC connectors in this document.

The conventional transducer connectors are located at the top of the instrument on the left. The two connectors are easily accessible from the front of the instrument (see Figure 1-7 on page 31).

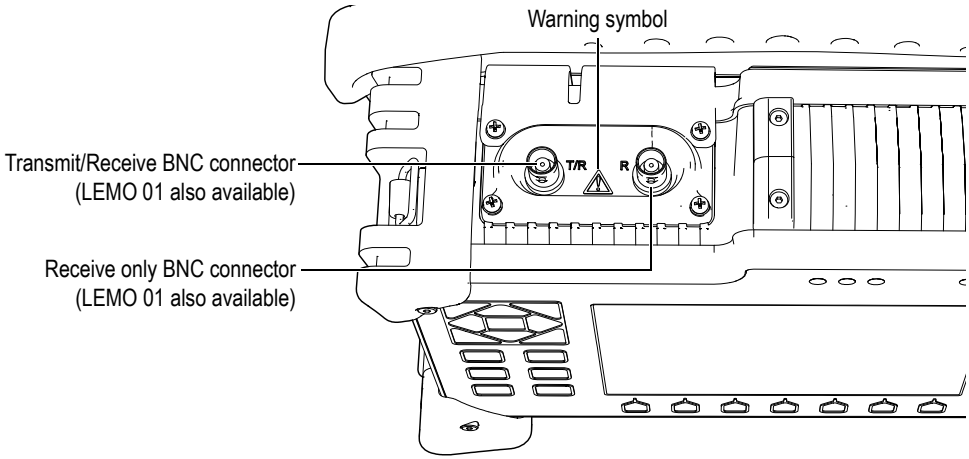


Figure 1-7 Location of the conventional transducer connectors

For single-element transducers, either transducer connector may be used. For some dual transducer and for through-transmission inspections, the transducer connectors are labeled T/R and R. T/R should be used as the transmit channel, and R should be used as the receive channel in these situations.

CAUTION

Do not touch the inner conductor of the BNC (or LEMO) connectors to avoid risks of an electrical shock. Up to 475 V can be present on the inner conductor. The warning symbol between the Transmit/Receive (T/R) and the Receive (R) BNC connectors shown in Figure 1-7 on page 31 indicates this electrical shock risk.

1.4.2 Phased Array Probe Connector (EPOCH 1000*iR*/1000*i* Only)

The EPOCH 1000*iR* and EPOCH 1000*i* come standard with one phased array probe connector located at the back of the instrument (see Figure 1-8 on page 32).

This connector is also used on other Olympus products, including the OmniScan instruments. Any phased array transducer with element count matching the capabilities of the EPOCH 1000 Series may be used with this standard connector. Refer to section “Probe and Wedges Specifications” on page 495 for specifications of compatible PA probes.

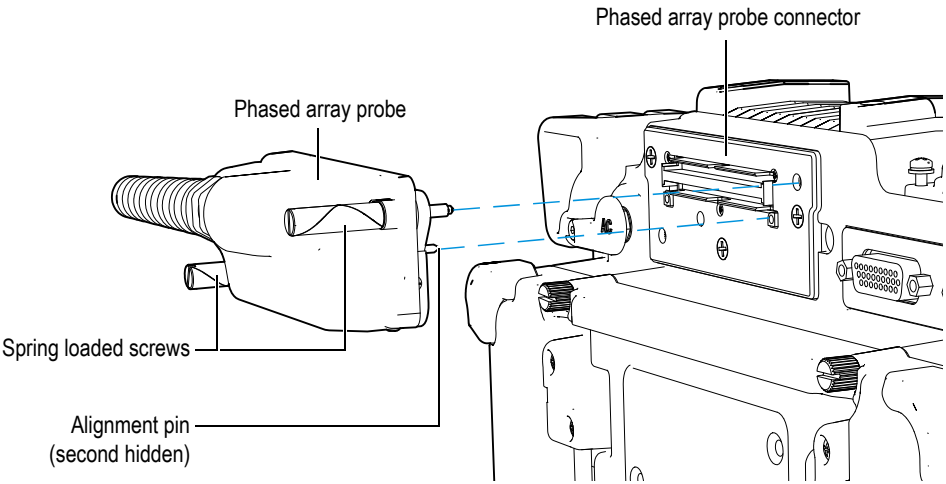


Figure 1-8 The connector for the phased array (PA) probe

The phased array probe connector features two alignment pins to ensure proper connection to any phased array probe (see Figure 1-8 on page 32). Two spring-loaded screws are employed to maintain proper contact of the phased array probe to this connector, and should always be fully engaged before use.

CAUTION

Do not expose the instrument to harsh and wet environments while the phased array connector is not protected by either a phased array probe or the connector cover. This could cause malfunction and/or equipment damage.

To connect a phased array probe

1. Align the two guide pins on the phased array probe with the guide-pin holes on the instrument connector (see Figure 1-8 on page 32).
2. Securely fit the probe onto the instrument connector.
3. Tighten both spring-loaded retention screws on the phased array probe.

Phased Array Connection Cover

The phased array probe connector is not sealed for environmental hazards. When a phased array probe is not connected, proper care should be taken to protect this connector from dust, dirt, liquid, and other potentially damaging substances.

For this purpose, the EPOCH 1000*iR* and EPOCH 1000*i* include a protective cover to protect the phased array probe connector when not in use. The protective cover includes a gasket for environmental seal, and attaches over the phased array probe connector using two thumb screws (see Figure 1-9 on page 34).

When not in use, the phased array connection cover attaches to the battery compartment cover of the EPOCH 1000 Series via two thumb screws. This allows easy transportation of this connection cover and reduces the risk of loss or damage.

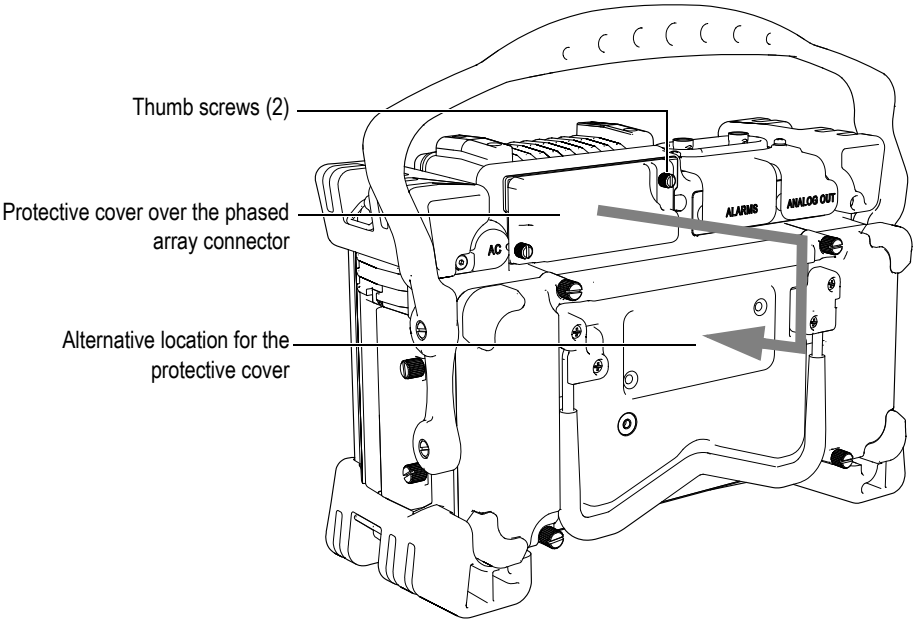


Figure 1-9 Phased array connection cover

1.4.3 Input/Output Connectors

The ALARMS and the ANALOG OUT connectors are located at the back of the instrument, in the upper-right corner (see Figure 1-10 on page 35). A rubber cover protects each connector. The connectors provide analog outputs, digital alarm outputs, a digital input, and encoder outputs. Refer to section “Input/Output Specifications” on page 492 for the complete specifications of the supported I/O signals.

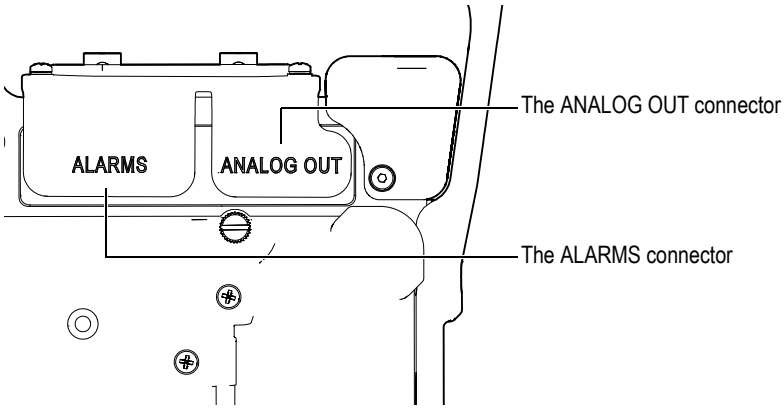


Figure 1-10 The ALARMS and ANALOG OUT connectors

1.4.4 Battery Compartment Connections

The EPOCH 1000 Series battery compartment cover allows you to quickly access the battery and connections without the need for tools. Four thumb screws on the battery compartment cover secure it to the instrument case and ensure the compartment is sealed.

The battery compartment cover also has a small hole in the bottom center area that is covered on the inside by an environmentally sealed membrane vent. This vent is a safety feature that is required in the event that the instrument battery fails and emits gas. This vent must not be punctured.

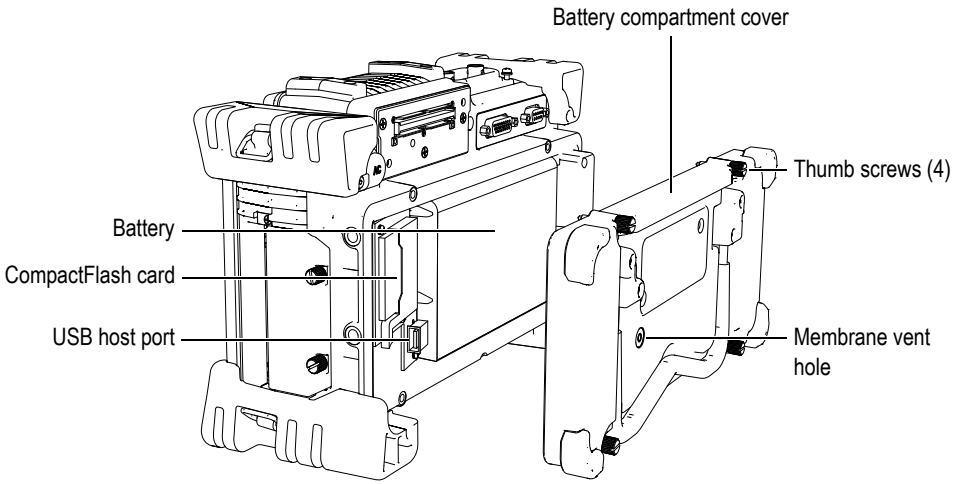


Figure 1-11 The battery compartment cover

The EPOCH 1000 Series accepts one rechargeable lithium-ion battery pack (PN: EPXT-BAT-L) that can be recharged inside the instrument or on the optional external charging base (PN: EPXT-EC).

The battery compartment also contains an auxiliary USB host port and a CompactFlash card port. The EPOCH 1000 Series comes standard with a 2 GB capacity CompactFlash card. This card can be removed for data transfer or replacement.

1.4.5 Computer Connection Compartment

On the right side of the EPOCH 1000 Series instruments, there is a door that covers the computer connection compartment (see Figure 1-12 on page 37). This door has an integral membrane seal to keep liquids away from the unsealed connections behind the door.

Table 4 on page 37 describes connectors available in the computer connection compartment.

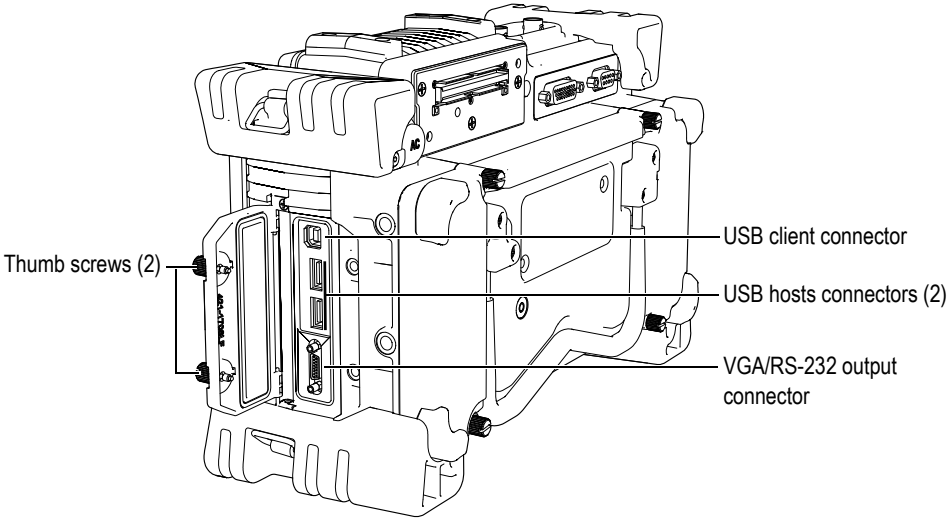


Figure 1-12 The connectors behind the computer connection compartment door

Table 4 Computer connection compartment connectors

Connector	Qty.	Usage
USB client	1	Used to connect the EPOCH 1000 to a computer. The instrument is compatible with the Olympus GageView Pro software (see “Managing Data with GageView Pro Interface Program” on page 98 and “USB Client” on page 145).
USB hosts	2	Used to connect USB peripherals such as a printer, a keyboard, a mouse or a storage device (see “USB Host” on page 145).
VGA/RS-232	1	Combination connector. Used to connect an external VGA video monitor. This feature is useful for presentations, training, and remote instrument monitoring (see “VGA Output” on page 141). Used to establish an RS-232 communication link (see “Serial Communication (RS-232)” on page 145).

The door of the computer connection compartment is kept closed by two thumb screws. You can also use a coin or a screwdriver to manipulate these thumb screws as needed.

CAUTION

Do not expose the instrument to harsh and wet environments while the computer connection compartment door is opened. To prevent connector corrosion and damage to the instrument, keep the computer connection compartment door closed and sealed when no cable is connected.

1.5 Various Hardware Features

The following sections describe various hardware features.

1.5.1 Removable Rubber Handle

The EPOCH 1000 Series features a removable rubber handle to ease transportation (see Figure 1-1 on page 20). This rubber handle is secured to each side of the instrument with four flat-head shoulder screws. This rubber handle can be removed using a screwdriver if necessary.

1.5.2 Instrument Stands

The EPOCH 1000 Series features two articulating stands for variable viewing angles (see Figure 1-13 on page 39). Each stand is attached to the instrument with two hard pivot blocks, and has been dipped into a high friction coating for resistance to sliding during use. Each stand is bent in the center to easily accommodate being placed on a curved surface.

One EPOCH 1000 Series pipe stand is located on the back of the instrument, attached to the battery compartment cover (see Figure 1-1 on page 20). This pipe stand allows for steep viewing angles. The second EPOCH 1000 Series stand is located underneath the front of the instrument. This is a smaller kick stand and allows for shallow viewing angles.

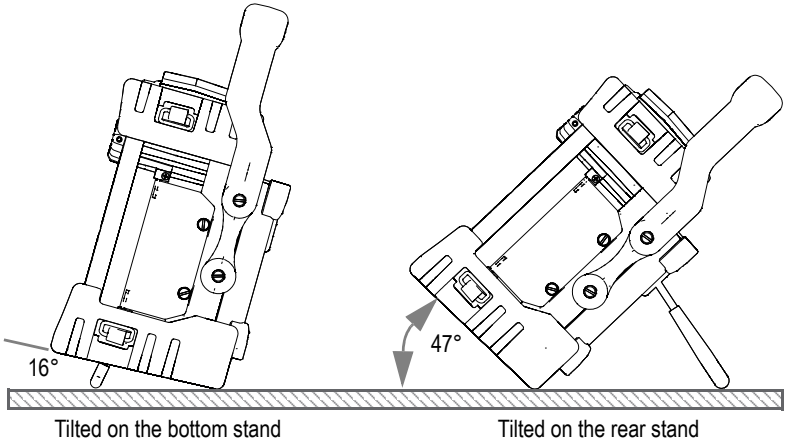


Figure 1-13 Tilting angles using the bottom and rear stands

1.5.3 O-Ring Gasket and Membrane Seals

The EPOCH 1000 Series contains seals that are used to protect the instrument's internal hardware from the environment. These include:

- Battery compartment cover seal
- Computer connection compartment door seal
- Membrane vent
- Phased array connection cover seal

These seals must be properly maintained to assure environmental durability. Instrument seals are evaluated and replaced as needed during the instrument's annual calibration. This should be performed at an authorized Olympus service center.

1.5.4 Display Protection

EPOCH 1000 Series instruments include a clear-plastic sheet protecting the instrument's display window. You are advised to leave this sheet in place. Replacements are available from Olympus in packages of 10 (PN: EP1000-DP).

CAUTION

The display window is permanently bonded to the instrument case to fully seal the instrument. If the display window becomes damaged, the front part of the case must be replaced, along with the instrument's direct-access keypad.

1.6 Environmental Ratings

The EPOCH 1000 Series are extremely rugged and durable instruments that can be used in harsh environments. To classify the instrument's durability in wet or damp environments, Olympus has adopted the IP (ingress protection) system to rate how well the instrument is sealed.

The EPOCH 1000 Series has been tested to the requirements of IP66. All instruments are designed and manufactured to meet this level of ingress protection when they leave the factory. To maintain this level of protection, you are responsible for the proper care of all routinely exposed membrane seals. Additionally, you are responsible for returning the instrument to an authorized Olympus service center each year to ensure that the instrument seals are properly maintained. Olympus cannot guarantee any level of ingress protection performance once the instrument seals have been manipulated. You must use sound judgment and take proper precautions before exposing the instrument to harsh environments.

The EPOCH 1000 adheres to the environmental standards listed in Table 29 on page 488.

2. Powering the EPOCH 1000 Series

This chapter describes how to operate the EPOCH 1000 Series instruments using different power supply options.

2.1 Starting the EPOCH 1000 Series

Press the **[ON/OFF]** power key to turn on EPOCH 1000 Series instruments (see Figure 2-1 on page 41). Pressing this key once causes an initial beep, followed by the instrument's startup screen. The instrument then goes through a series of self-tests for 45 to 60 seconds and then starts up.

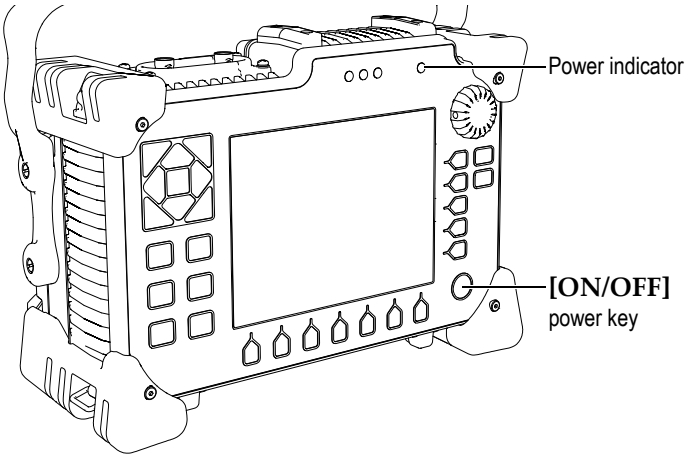


Figure 2-1 Location of the EPOCH 1000 power key and indicator

When the EPOCH 1000 is turned on for the first time, you will be prompted to choose the software language for the instrument. Once you have selected the desired language, press **[CHECK]** to continue to the main screen.

Figure 2-2 Initial language selection

When a phased array probe is connected to an EPOCH 1000 Series instrument (PA only), the instrument automatically detects it and completes the startup process by opening the **Beam** setup page, allowing you to validate probe parameters (see Figure 2-3 on page 43). See "Beam Setup Page" on page 304 for details on the **Beam** setup page. Press **[ESCAPE]** to save and close the **Beam** setup page.

Figure 2-3 The Beam setup page at startup when a PA probe is connected

2.2 Battery Operating Time

The lithium-ion (Li-ion) battery (P/N: EPXT-BAT-L [U8760021]) is the primary method for powering the EPOCH 1000 Series and comes installed in every instrument.

WARNING

Only use the Olympus rechargeable Li-ion battery pack (P/N: EPXT-BAT-L [U8760021]) with an EPOCH 1000 Series instrument. Using any other battery can cause death or serious personal injury as the result of the explosion while charging the battery.

Battery operating time depends on the age and manufacturer of the battery being used, the instrument mode (conventional or phased array), and on the instrument settings. To provide realistic battery operating times, the EPOCH 1000 Series instruments were tested with mid-level parameters in each mode.

The resulting battery operating times are:

- Conventional UT mode: 8 to 9 hours
- Phased array imaging mode: 7 to 8 hours

NOTE

The battery may need several complete charge/discharge cycles to reach full capacity. This conditioning process is normal for these types of rechargeable batteries.

2.3 Battery Usage and Reconditioning

By nature, unused batteries slowly discharge. A fully discharged battery will not recharge. Follow the guidelines below to maximize the battery performance:

- When the battery is used daily, connect it to the charger/adaptor when not in use.
- Whenever possible, the battery should remain connected to the EP-MCA charger/adaptor (overnight or over a weekend), so that it achieves 100 % full charge.
- The battery must reach full charge on a regular basis for proper capacity and cycle-life maintenance.
- Recharge discharged batteries as soon as possible after use.
- Store batteries in a cool, dry environment.
- Avoid long-term storage under sunlight or in other excessively hot places such as an automobile trunk.
- While in storage, fully recharge batteries at least once every two months.
- Never place partially discharged batteries in storage without a full recharge.

This battery is considered “smart battery” technology, which allows the EPOCH 1000 Series instruments to display the specific remaining battery percentage rather than just a generic bar indicator. The measurement of the current battery capacity accrues some error over the lifetime of the battery, resulting in some error in the battery measurement.

For example, a new battery could read a capacity of 95 % ±1 %, while the same battery after one year might read 95 % ±10 %. The margin of error associated with the battery measurement is called the “Max Error.” When the “Max Error” estimation reaches 10 % or higher, Olympus recommends that the user reconditions the battery. This is accomplished using the EPXT-EC external battery charger.

EPOCH 1000 Series instruments have the ability to read the “Max Error” value of the battery. If the “Max Error” is greater than 10 %, the instrument will change the color of the battery icon to yellow, indicating that the battery should be recalibrated (see “Power and Battery Indicators” on page 46 for more information on battery indicators). The “Max Error” is also displayed in the **Inst Setup > Status** submenu.

2.4 Charging the Battery

The EPOCH 1000 Series battery can be charged internally using the EP-MCA charger/adaptor included with the instrument, or externally using the optional standalone battery charger (P/N: EPXT-EC). Externally charging a battery is useful to charge one battery while using another in the instrument. For more information about this external charger, contact Olympus or your local sales representative.

WARNING

Only use the Olympus rechargeable Li-ion battery pack (PN: EPXT-BAT-L [U8760021]) with an EPOCH 1000 Series instrument. Using any other battery can cause death or serious personal injury as the result of the explosion while charging the battery.

WARNING

- Do not attempt to power or charge other electronic equipment with the EP-MCA charger/adaptor as this may cause death or serious personal injury as the result of the explosion while charging a battery.
- Do not attempt to charge other batteries with the EPXT-EC standalone battery charger as this may cause death or serious personal injury as the result of the explosion while charging a battery.

To charge the battery inside the instrument

1. Remove the AC adaptor seal plug on the back of the instrument, and then plug in the EP-MCA charger/adaptor.
2. Plug the power cord of the EP-MCA charger/adaptor to a power outlet.

   The battery will still charge whether the instrument is On or Off, but the rate of charge is slower when the instrument is On. (see “Power and Battery Indicators” on page 46 for more information on power indicators).

2.5 Power and Battery Indicators

The power and the battery indicators provide basic feedback regarding the operating/charging status of the instrument.

When an EPOCH 1000 Series instrument is connected to AC power and turned on, the battery indicator displays a lightning bolt symbol instead of the standard level indicator with percentage showing remaining battery life (see Table 5 on page 47).

A battery charge indicator is always present near the top right of the active instrument display (see Figure 2-4 on page 46). The battery charge indicator contains both a visual level representation of the remaining battery life, but also provides a numeric value of the remaining percentage of battery life on the unit. The battery charge indicator is accurate after 5 to 10 minutes of use.

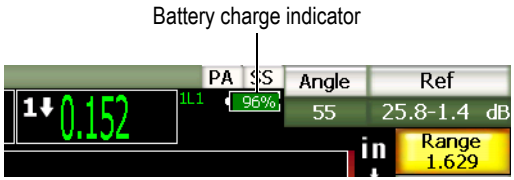


Figure 2-4 The battery charge indicator

Table 5 Power indicator status

Indicator state	AC line power	Indicator meaning	Battery indicator
Green	Yes	Internal battery fully charged	
Red	Yes	Internal battery is charging	
Off	No	AC line power not connected	85%

2.6 Installing or Replacing the Battery

The battery is located in a compartment that is accessible from the back of EPOCH 1000 Series instruments (see Figure 2-5 on page 47).

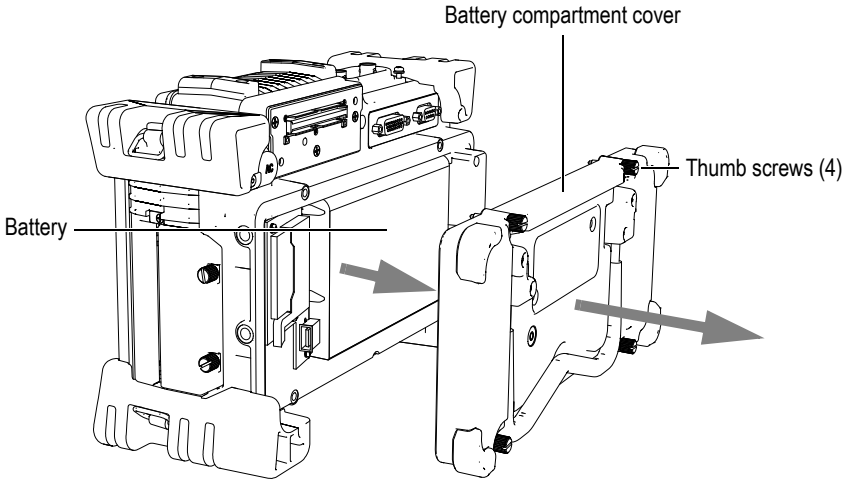


Figure 2-5 Opening the battery compartment

To replace the battery

1. Ensure that the instrument power is off.
2. Unscrew the four thumb screws of the battery compartment cover at the back of the instrument (see Figure 2-5 on page 47).
3. Remove the battery compartment cover.
4. Remove the battery (EPXT-BAT-L).

WARNING

Only use the Olympus rechargeable Li-ion battery pack (PN: EPXT-BAT-L) with an EPOCH 1000 Series instrument. Using any other battery may cause death or serious personal injury.

---

5. Push another battery (EPXT-BAT-L) into place in the battery compartment.
6. Ensure that the gasket of the battery compartment cover is clean and in good condition.
7. Install the battery compartment cover at the back of the instrument and then tighten the four thumb screws using your fingers.

3. EPOCH 1000 Series Software Features

This chapter describes the software components.

3.1 Software Main Display

The EPOCH 1000 Series software main display elements are exploded in Figure 3-1 on page 49. The following sections describe each of the main display elements.

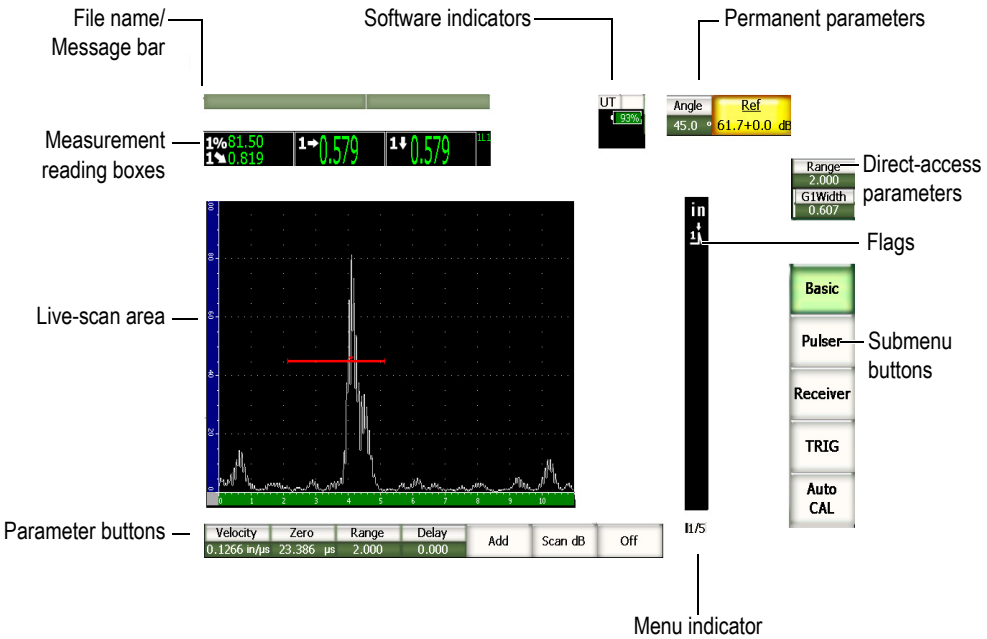


Figure 3-1 Exploded view of the software main display elements

3.1.1 About the Menu System

The intuitive menu system of the EPOCH 1000 Series consists of menus, submenu buttons and parameter buttons (see Figure 3-2 on page 50). The menu system includes five standard menus for both the UT and PA operation modes. Other menus appear when you purchase and activate particular software options.

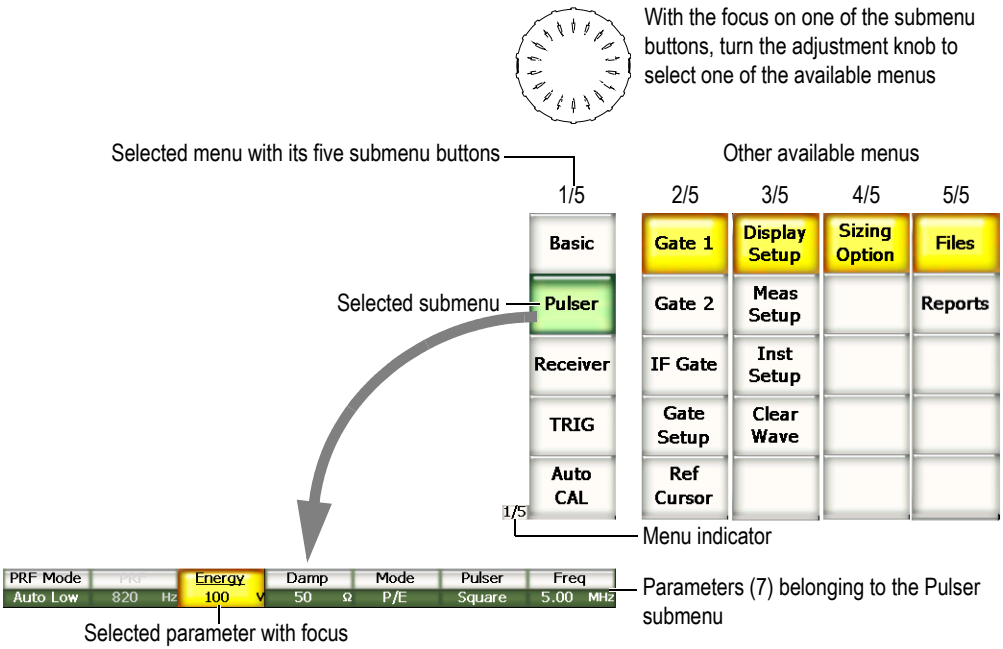


Figure 3-2 Overview of the menu system in UT operation mode

The menu indicator, located in the lower-right corner of the software main display, shows which menu is currently selected (see Figure 3-3 on page 51). For example, the menu indicator showing 1/5, means that there are five standard available menus and that the first one is currently selected.

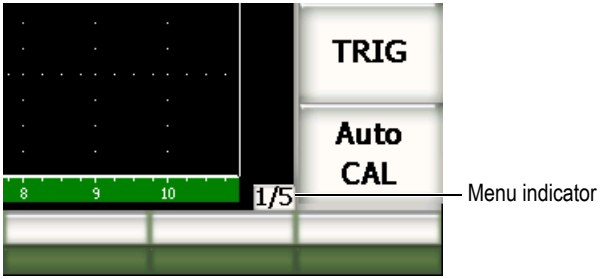


Figure 3-3 The menu indicator (1/5)

Each menu contains up to five submenu buttons appearing vertically on the right side of the software main display. The submenu buttons of only one menu appear at a given time on the software main display. Use the corresponding **[F<*n*>]** function key, the arrow keys, or the adjustment knob to select a submenu.

Seven parameter buttons, associated with the selected submenu button, appear horizontally at the bottom of the software main display. Press the corresponding **[P<*n*>]** parameter key or the arrow keys to select a parameter.

Section "Menu Contents" on page 69 provides a complete and quick reference to all menus, submenus and parameters available in both the UT and PA operation modes.

3.1.2 About the Convention to Identify Menu Elements

In this document, the following convention is used to concisely refer to an element in the menu structure:

Submenu > *Parameter* = *value*

where:

Submenu is replaced by the label of the submenu (ex.: **Meas Setup**);

Parameter is replaced by the label of the parameter (ex.: **Unit**); and,

Value is replaced by the desired editable or selectable value (ex.: **mm**).

For example, to instruct you to set the **Unit** parameter to **mm**, in the **Meas Setup** submenu of the third menu, the expression shown in Figure 3-4 on page 52 is used.

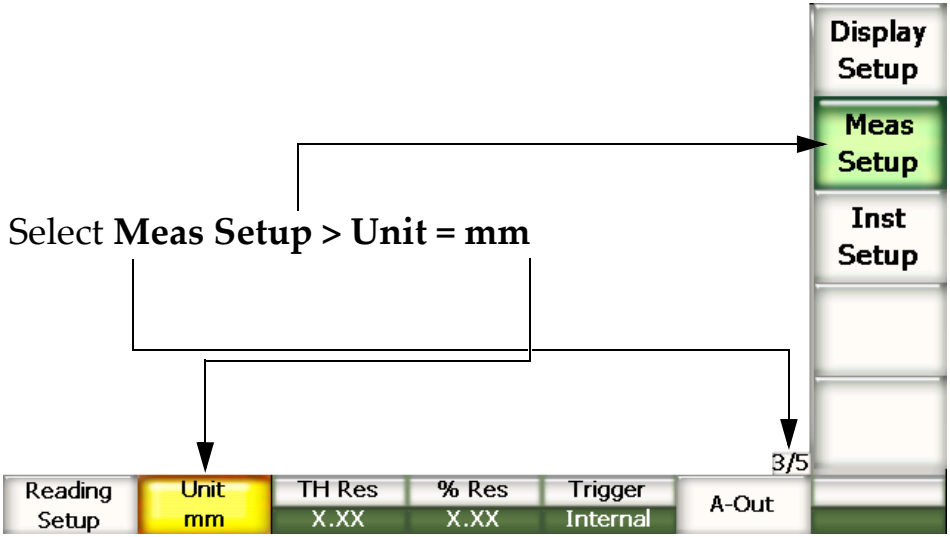


Figure 3-4 Concise convention to identify menu elements

Similarly, to instruct you to select the **Width** parameter of the **Gate 1** submenu in the second menu, the following expression is used:

Select **Gate 1** > **Width**.

3.1.3 About the Focus

The button that appears with a yellow background is the element that has the focus. There is always only one element that has the focus. When the focus is on a parameter button, the button background of the submenu to which it belongs, appears green (see the **Range** and the **Basic** buttons in Figure 3-5 on page 53).

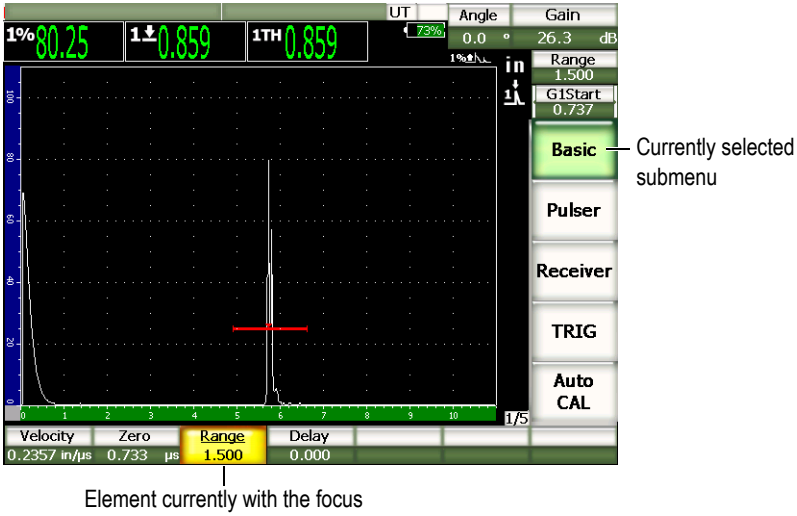


Figure 3-5 The focus is on the element appearing yellow

3.1.4 About Button Types

Table 6 on page 53 presents the various types of buttons found in the EPOCH 1000 Series interface.

Table 6 Button types

Type	Example	Description
Editable value	Range 2.272	Parameter with an editable value. Turn the adjustment knob or press the arrow keys to change the value.
Selectable value	Mode P/E	Parameter with a set of predetermined selectable values. Turn the adjustment knob or press the arrow keys to select the value.
Command	Zoom	Immediately executes a command when selected.

Table 6 Button types *(continued)*

Type	Example	Description
Function	General	Opens a dialog box or a screen with more parameters.

3.1.5 About the File Name/Message Bar

The file name/message bar appears at the top-left corner of the main display and shows the name of the currently open data file, together with its current identifier (ID) [see example in Figure 3-6 on page 54].

Figure 3-6 Message bar with a file name example

Text messages also appear in the bar as needed, following your actions (see example in Figure 3-7 on page 54).

Figure 3-7 Message bar with a message example

3.1.6 About Software Indicators

Software indicators appear in a area at the top of the main display screen (see Figure 3-8 on page 55). Table 7 on page 55 describes the various indicators that appear or may appear in the area.

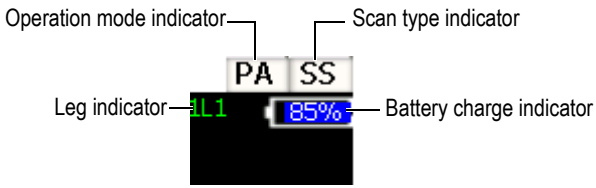


Figure 3-8 Example of software indicators

Table 7 Software indicators

Indicator	Icon	Description
Operation mode	UT	Instrument in conventional UT mode
	PA	Instrument in phased array mode
Scan type	SS	S-scan sector scan
	LS	Linear scan
	CS	C-scan from sector scan
	CL	C-scan from linear scan
Battery charge	95%	Indication (%) of the remaining battery charge
		Battery charging via AC power
Leg indicator	1L1	Indicates leg of gated signal for gates 1, 2, and/or IF gate in the format <gate>L<leg#>

Table 7 Software indicators *(continued)*

Indicator	Icon	Description
A-scan mode		Maximum amplitude A-scan mode in conventional UT
		Minimum thickness A-scan mode in conventional UT
		Composite A-scan mode in conventional UT

3.1.7 About Permanent Parameters

Two buttons for common and important parameters (**Angle** and **Gain**) always appear at the top-right corner of the software main display. This allows you to easily see their respective values.

Press the **[ANGLE]** or the **[GAIN]** direct-access key to respectively select the **Angle** or the **Gain** parameter. Once selected, the button appears yellow (see Figure 3-9 on page 56). Turn the adjustment knob or press the **[UP]** and **[DOWN]** arrow keys to edit the value.

Figure 3-9 Example of the Angle and Gain permanent parameters

3.1.8 About Direct-Access Parameters

Two buttons for direct-access parameters always appear at the top-right corner of the software main display, below the **Gain** button. By default, the **Range** and the **Delay** parameters appear for these two buttons. Pressing **[GATE]** makes the **G1Start** parameter appear over the **Delay** button. Pressing **[2ND F], [RANGE] (DELAY)** brings back the **Delay** parameter.

Press the desired direct-access key to select the **Range**, **Delay**, or **G1Start** parameter. Once selected, the button turns yellow (see Figure 3-10 on page 57). Turn the adjustment knob or press the **[UP]** and **[DOWN]** arrow keys to edit the value.

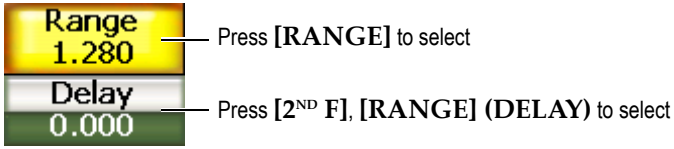


Figure 3-10 Example of the Range and Delay direct-access parameters

3.1.9 About Measurement Reading Boxes

The measurement reading boxes at the top-left corner of the software main display, below the message bar, present the icons and digital values for up to six selectable measurements (see Figure 3-11 on page 57). See “Reading Setup Page” on page 82 for details on how to select measurements and for a description of available measurements.

Figure 3-11 Example of measurement reading boxes with their icons

3.1.10 About the Live-Scan Area

The large fixed-size live-scan area displays the ultrasonic data graphically (see Figure 3-12 on page 58 and Figure 3-13 on page 59). In PA operation mode, different views are available (see “Display View Mode” on page 329 for details).

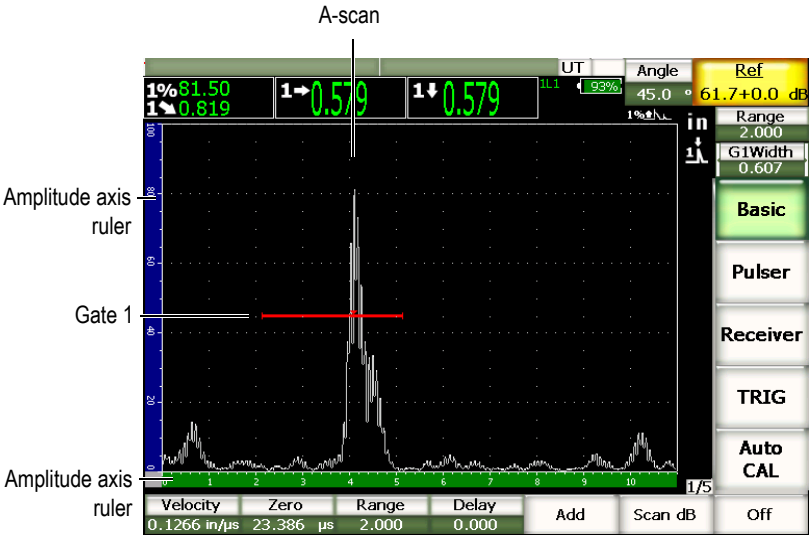


Figure 3-12 The live-scan area in UT mode

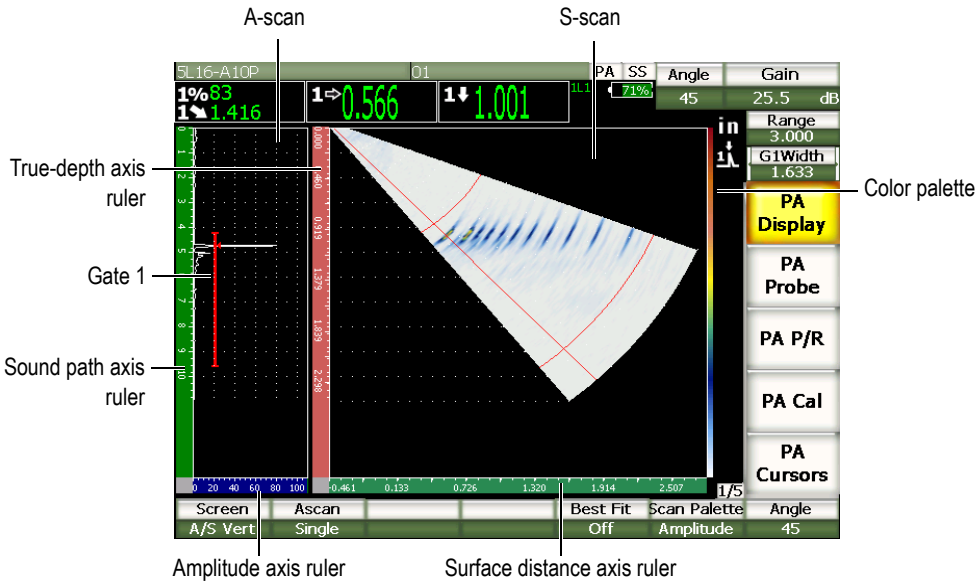


Figure 3-13 The live-scan area in PA mode (A/S Vert view)

3.1.11 About Flags

The EPOCH 1000 Series indicates when particular functions are active by displaying a set of flags, in a thin vertical area on the right of the live-scan area in both UT and PA modes (see Figure 3-14 on page 60). Table 8 on page 60 provides a description of the possible flags.

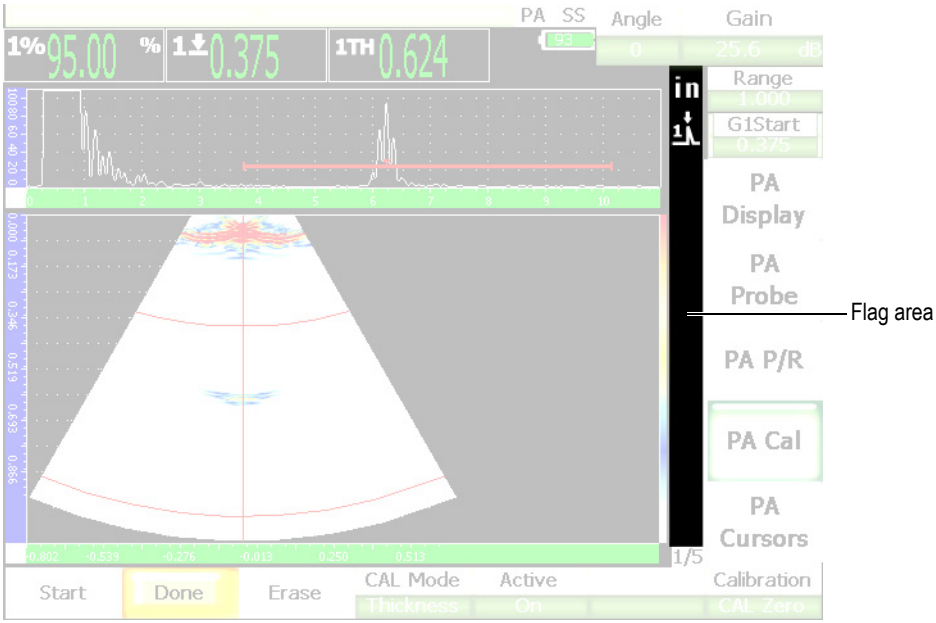


Figure 3-14 The area displaying flags

Table 8 Flag description

Flag	Description
in	Measurement units are inches.
mm	Measurement units are millimeters.

Table 8 Flag description *(continued)*

Flag	Description
µS	Measurement units are microseconds (time-of-flight mode).
⇧	Indicates that the **[2nd F]** key has been pressed.
1	Gate 1 is in peak measurement mode.
2	Gate 2 is in peak measurement mode.
IF	IF gate is in peak measurement mode.
1	Gate 1 is in edge (or flank) measurement mode.
2	Gate 2 is in edge (or flank) measurement mode.
IF	IF gate is in edge (or flank) measurement mode.
1	Gate 1 is in first-peak measurement mode.
2	Gate 2 is in first-peak measurement mode.
IF	IF gate is in first-peak measurement mode.
A A½ A¹ A₂	Indicates that an alarm for gate 1 and/or gate 2 has been triggered. Flashes on and off alternating with gate-measurement indicator.
API	API 5UE is active.

Table 8 Flag description *(continued)*

Flag	Description
AVG	AVG is active.
AWS	AWS D1.1/D1.5 is active.
ØCAL	Zero calibration in phased array mode is completed and active.
CAL	Calibration is in progress.
CAL	Access to Gain, Auto CAL, PA Cal, CAL Zero, Velocity, Angle, Pulser, Receiver, and PA P/R is locked (see “General Setup Page” on page 88).
CSC	Curved surface correction (CSC) is active.
DAC	DAC/TVG is active.
DGS	DGS is active.
E—E	Echo-to-echo measurement is active (see “Gate Tracking and Echo-to-Echo Measurements” on page 129).
F	Display **[FREEZE]** is active.
P	**[PEAK MEM]** is active.
PH	**[2ND F]**, **[PEAK MEM] (PK HOLD)** reference echo is active.
R	The recall freeze is active. Press **[ESCAPE]** to deactivate.
TVG	Gain (sensitivity) calibration in phased array mode is completed and active.

Table 8 Flag description *(continued)*

Flag	Description
Z	The zoom is active.
🔒	Access to all instrument function keys except **[ON/OFF]** is locked (see “General Setup Page” on page 88).

3.2 Basic Procedures

The procedures contained in the following sections provide step-by-step information to perform basic tasks that you can quickly learn. The detail contained in these basic procedures is not repeated in the more complex procedures available in this document.

3.2.1 Navigating in the Menu Structure

The following procedure provides generic instructions to navigate in the menu structure.

To choose a menu, a submenu, and a parameter value

1. Make sure that the focus is on one of the submenu buttons using one of the following methods (see “About the Focus” on page 52 for details on the focus concept):
   - Press one of the **[F<*n*>]** function key.
   - Press **[ESCAPE]** to return to the parent level in the menu hierarchy. Press the number of times needed to move the focus back to the submenu level.
   - With a USB mouse connected to the instrument, click a submenu button.
   - With a USB keyboard connected to the instrument, press the ESC key the number of times needed to move the focus back to the menu level.
2. Select the desired menu using one of the following methods:
   - Slowly turn the adjustment knob until the desired submenus appear on the right side of the software main display.
   - Press the **[RIGHT]** or the **[LEFT]** arrow keys until the desired submenus appear on the right side of the software main display.

- With a USB mouse connected to the instrument, rotate the wheel of the mouse until the desired submenus appear on the right side of the software main display.
- With a USB keyboard connected to the instrument, press the **[RIGHT]** or the **[LEFT]** arrow keys until the desired submenus appear on the right side of the software main display.
- The menu indicator identifies the selected menu (see "About the Menu System" on page 50 for details on the menu structure).

3. Select the desired submenu using one of the following methods:
   - Press the **[F**<*n*>**]** function key corresponding to the desired submenu button.
   - Press the **[UP]** or the **[DOWN]** arrow keys until the desired submenu has the focus.
   - With a USB mouse connected to the instrument, click the desired submenu.
   - With a USB keyboard connected to the instrument, press the **[UP]** or the **[DOWN]** arrow keys until the desired submenus appear on the right side of the software main display.
   - The parameters corresponding to the selected submenu appear at the bottom of the software main display.
4. Select the desired parameter using one of the following methods:
   - Press **[CHECK]** to move the focus to the parameter level, and then press the **[P**<*n*>**]** parameter key corresponding to the desired parameter button.
   - Press the **[RIGHT]** or the **[LEFT]** arrow keys until the desired parameter has the focus.
   - With a USB mouse connected to the instrument, click the desired parameter.
   - With a USB keyboard connected to the instrument, press ENTER to move the focus to the parameter level, and then press the **[RIGHT]** or the **[LEFT]** arrow keys until the desired parameter is selected.

3.2.2 Navigating in a Setup Page

Setup pages are accessible from parameter buttons. A setup page contains related parameters.

To navigate in a setup page

1. Access the desired setup page using the appropriate parameter (ex.: choose **PA Probe > Beam**).

2. Select the desired parameter using one of the following methods:
   - Press the **[UP]** or the **[DOWN]** arrow key until the desired parameter has the focus.
   - With a USB mouse connected to the instrument, click the desired parameter.
   - With a USB keyboard connected to the instrument, press the **[UP]** or the **[DOWN]** arrow keys until the desired parameter is selected.
3. Change the value using one of the following methods:
   - Turn the adjustment knob.
   - Press the **[RIGHT]** or the **[LEFT]** arrow key.
   - If values appear in the buttons at the bottom of the screen, select the button containing the desired value by pressing the corresponding **[P**<*n*>**]** parameter key.
   - With a USB mouse connected to the instrument, rotate the wheel of the mouse.
   - With a USB keyboard connected to the instrument, press the **[RIGHT]** or the **[LEFT]** arrow key.
4. Leave the setup page using one of the following methods:
   - Press **[ESCAPE]**.
   - With a USB keyboard connected to the instrument, press the ESCAPE key.
   - The edited values are effective immediately. It is not possible to cancel the changes.

3.2.3 Changing a Parameter Value

The following procedure describes how to change the value associated with a parameter button. The parameter value may be editable or selectable.

To change the value of a parameter with a selectable value

1. Select the parameter with a selectable value for which you want to change the value (see “Navigating in the Menu Structure” on page 63 for details).

   The button background of the selected parameter turns to yellow, showing that it now has the focus (see “About the Focus” on page 52 for details on the focus concept).

2. Use one of the following methods to change the parameter value:
   - Turn the adjustment knob until the desired value appears in the button below the label.
   - Press the **[UP]** or the **[DOWN]** arrow key until the desired value appears in the button below the label.
   - With a USB mouse connected to the instrument, rotate the wheel of the mouse until the desired value appears in the button below the label.
   - With a USB keyboard connected to the instrument, press the **[UP]** or the **[DOWN]** arrow key until the desired value appears in the button below the label.

   The edited value is immediately effective.

To change the value of a parameter with an editable value

1. Select the parameter with an editable value for which you want to change the value (see "Navigating in the Menu Structure" on page 63 for details).

   The button background of the selected parameter turns to yellow, showing that it now has the focus (see "About the Focus" on page 52 for details on the focus concept).
2. If needed, toggle the increase/decrease value mode from coarse to fine using one of the following methods:
   - Press **[CHECK]**.
   - With a USB keyboard connected to the instrument, press ENTER.

   The increase/decrease value mode is coarse when the button label is underlined and fine when not underlined. When changing parameter values using coarse adjustment, all digits after the digit being adjusted are set to zero for the parameters below. Fine adjustment allows you to modify the remaining digits.
   - **Range**
   - **Delay**
   - **Zero** (UT mode only)

   Adjusting the parameters below using coarse adjustment toggles through the preset values from the **Editable Parameters** screen (see "Editable Parameters" on page 93 for additional information on **Editable Parameters**). Fine adjustment scrolls through all non-preset values.
   - **Velocity**
   - **Frequency**
   - **Angle** (UT mode only)

- **Thick**
- **X-Value** (UT mode only)

3. Use one of the following methods to change the parameter value:
   - Turn the adjustment knob until the desired value appears in the button below the label.
   - Press **[UP]** or the **[DOWN]** arrow key until the desired value appears in the button below the label.
   - With a USB mouse connected to the instrument, rotate the wheel of the mouse until the desired value appears in the button below the label.
   - With a USB keyboard connected to the instrument, press the **[UP]** or the **[DOWN]** arrow key until the desired value appears in the button below the label.

   The edited value is immediately effective.

3.2.4 Entering an Alphanumeric Value Using the Virtual Keyboard

A setup page containing one or more parameters with alphanumeric values also contains a virtual keyboard. The virtual keyboard allows you to easily enter alphanumeric characters without having to use a USB keyboard.

To enter an alphanumeric value using the virtual keyboard

1. Access a setup page that contains parameters with alphanumeric values.

   For example, select **Inst Setup > Owner Info** to access the **Owner Info** setup page shown in Figure 3-15 on page 68.

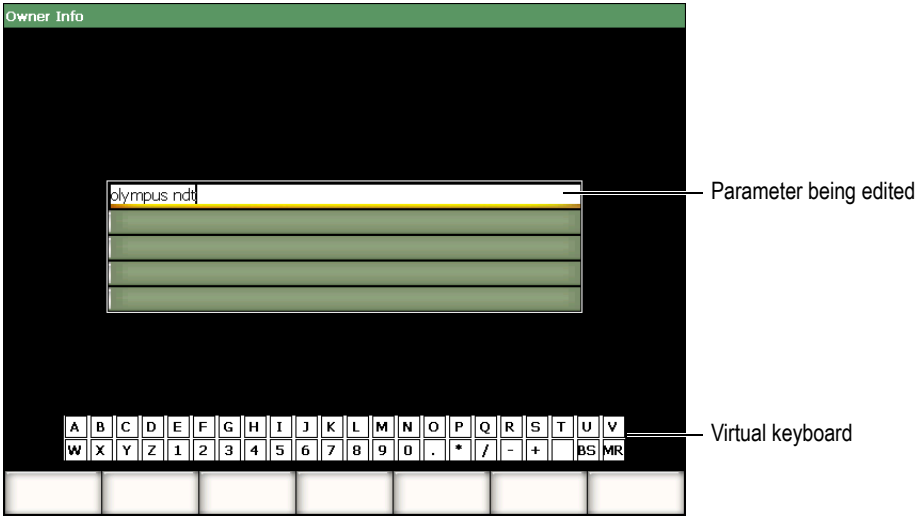


Figure 3-15 The Owner Info setup page with its virtual keyboard

2. Select the parameter that you want to edit.
3. To enter a character from the virtual keyboard:
   - Turn the adjustment knob until the desired character is selected, and then press **[F1]** to add the character to the parameter. Use the vertical arrow key (↑) to switch between uppercase and lowercase letters.

     OR

     With a USB mouse connected to the instrument, click the desired character. Press and hold **[2nd F]** while clicking a character to enter an uppercase letter.
4. Repeat step 3 to enter other characters.
5. To delete an already entered character:
   a) Move the cursor to the right of the character to delete by pressing the **[LEFT]** or the **[RIGHT]** arrow key.
   b) Turn the adjustment knob to select **BS** on the virtual keyboard, and then press **[CHECK]**.
6. To insert a character:
   a) Move the cursor to the insert point by pressing the **[LEFT]** or the **[RIGHT]** arrow key.
   b) Repeat step 3 to insert a character.

7. To save the entered data and exit the setup page, press **[ESCAPE]**.

3.2.5 Interacting with a Dialog Box

The EPOCH 1000 Series software presents dialog boxes to allow you to edit the value of a parameter (during calibration, for example). The following procedure describes how to interact with a dialog box.

To interact with a dialog box

1. Considering the dialog box example shown in Figure 3-16 on page 69, press **[LEFT]** or **[RIGHT]** to position the cursor over the digit that you need to modify in the parameter value.

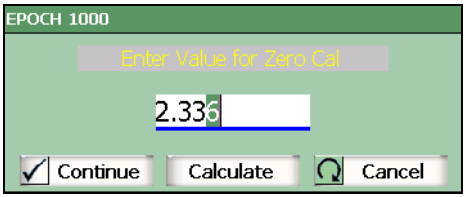


Figure 3-16 Dialog box example

2. Press **[UP]** or **[DOWN]** or turn the adjustment knob to modify the digit to the appropriate value.
3. If needed, repeat steps 1 and 2 to modify other digits.
4. When the value is adjusted, press **[LEFT]** or **[RIGHT]** to move the focus to the desired dialog box button.
5. Press **[CHECK]** to activate the selected button.

3.3 Menu Contents

EPOCH 1000 Series instruments use menus to categorize similar functions in both conventional ultrasound and phased array modes.

3.3.1 Conventional UT Mode Menus

The EPOCH 1000 Series conventional UT mode includes the five standard menus shown in Table 9 on page 70.

Table 9 Standard menus in UT mode

Menu	1/5	2/5	3/5	4/5	5/5
Submenu buttons	Basic	Gate 1	Display Setup	Sizing Option	Files
	Pulser	Gate 2	Meas Setup	B Scan	Reports
	Receiver	IF Gate	Inst Setup	BEA	
	TRIG	Gate Setup	Clear Wave		
	Auto CAL	Ref Cursor			

Table 10 on page 70 to Table 14 on page 72 provide a quick reference of available submenu and parameter buttons for each conventional UT mode menu.

Table 10 Content of the 1/5 standard menu in UT mode

Submenu	Parameters						
Basic	Velocity	Zero	Range	Delay			
Pulser	PRF Mode	PRF	Energy	Damp	Mode	Pulser	Freq
Receiver	Filter Group	Filter	Rect				Reject
TRIG	Angle	Thick	X Value	CSC	Diameter		
Auto Cal	CAL Mode	CAL Velocity	CAL Zero	Velocity	Zero		

Table 11 Content of the 2/5 standard menu in UT mode

Submenu	Parameters						
Gate 1	Zoom	Start	Width	Level	Alarm	Min Depth	Status
Gate 2	Zoom	Start	Width	Level	Alarm	Min Depth	Status
IF Gate	Zoom	Start	Width	Level	Alarm	Alarm	Status
Gate Setup	Setup	G1 Tracks	G2 Tracks	IF Run			
Ref Cursor	Cursor A	Cursor A	Cursor B	Cursor B			

Table 12 Content of the 3/5 standard menu in UT mode

Submenu	Parameters						
Display Setup	Color Setup	A-Scan Setup	VGA				
Meas Setup	Reading Setup	Unit	TH Res	% Res	Trigger	A-Out	
Inst Setup	General	Owner Info	Status	Auto Cal	Comm. Setup	Editable Parameters	
Clear Wave	Ascan Mode	Baseline	Average	Sure View	Persistence	Contrast	Waveforms

Table 13 Content of the 4/5 standard menu in UT mode

Submenu	Parameters						
Sizing Option	DAC/TVG	DGS	AWS D1.1				
B Scan	Screen	Mode	Source	Correlated	Source	BScan	Setup
BEA	Back wall Gain						BEA

Table 14 Content of the 5/5 standard menu in UT mode

Submenu	Parameters						
Files	Open	Create	Reset & Manage	Export/ Import	Memo	Last ID	Id:
Reports	Report	Image	HTML	Report Setup	Page Setup	Media	

3.3.2 Phased Array Mode Menus

The EPOCH 1000 Series phased array mode includes five standard menus shown in Table 15 on page 72. Many of these menus are identical to their corresponding conventional UT mode menus.

Table 15 Phased array standard menus

Menu	1/5	2/5	3/5	4/5	5/5
Submenu buttons	PA Display	Gate 1	Display Setup	Sizing Option	Files
	PA Probe	Gate 2	Meas Setup	C Scan	Reports
	PA P/R	Gate Setup	Inst Setup	Encoder	
	PA Cal	Ref Cursor			
	PA Cursors				

Table 16 on page 73 to Table 20 on page 74 provide a quick reference of available submenu and parameter buttons for each PA mode menu.

Table 16 Content of the 1/5 standard menu in PA mode

Submenu	Parameters						
PA Display	Screen	Ascan			Best Fit	Scan Palette	Angle
PA Probe	Beam	Edit	Advanced				Elem. Chk
PA P/R	PRF	Freq	Energy	Rect	Video Filter	Filter	Reject
PA Cal	Depth 1	Depth 2	Cal Mode	Velocity			Calibration
PA Cursors	Cursors	Cursor X1	Cursor X2	Cursor Y1	Cursor Y2		

Table 17 Content of the 2/5 standard menu in PA mode

Submenu	Parameters						
Gate 1	Zoom	Start	Width	Level	Alarm	Min Depth	Status
Gate 2	Zoom	Start	Width	Level	Alarm	Min Depth	Status
Gate Setup	Setup	G1 Tracks	G2 Tracks				
Ref Cursor	Cursor A	Cursor A	Cursor B	Cursor B			

Table 18 Content of the 3/5 standard menu in PA mode

Submenu	Parameters						
Display Setup	Color Setup	A-Scan Setup	VGA	Image Overlay	Contrast		
Meas Setup	Reading Setup	Unit	TH Res	% Res	A-Out		
Inst Setup	General	Owner Info	Status	Auto Cal	Comm. Setup	Editable Parameters	

Table 19 Content of the 4/5 standard menu in PA mode

Submenu	Parameters						
Sizing Option	DAC/TVG	DGS	AWS D1.1				
C Scan	Screen	Mode	Source	Best Fit	Source	C Scan	Setup
Encoder	Calibration						

Table 20 Content of the 5/5 standard menu in PA mode

Submenu	Parameters						
Files	Open	Create	Reset	Page Setup	First ID	Last ID	Id:
Reports	Report	Image	HTML	Report Setup	Page	Setup	Media

3.4 About Setup Pages

The EPOCH 1000 Series software features a number of setup pages allowing you to adjust instrument features and functions to your preferences. The setup pages are accessible by selecting the corresponding parameter. For example, in UT operation mode, select **Gate Setup > Setup** to access the **Gates** setup page shown in Figure 3-17 on page 75.

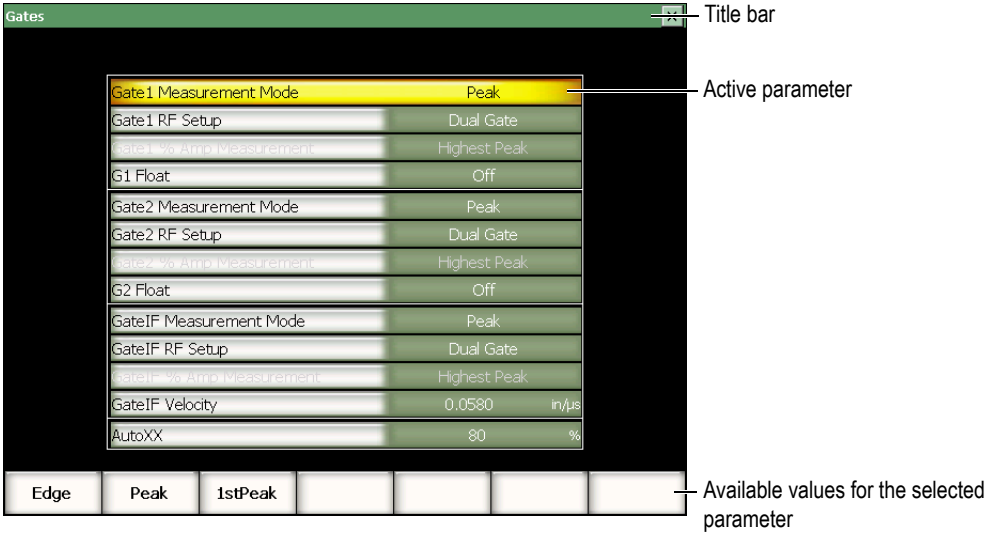


Figure 3-17 The Gates setup page and its elements

A title bar identifies the setup page. Parameters appear in a table form with the parameter label in the column on the left and its current value and units (if applicable) in the column on the right. A series of seven buttons appears at the bottom of setup pages and contain available values corresponding to the currently selected parameter.

Press **[ESCAPE]** to leave a setup page. When a USB keyboard is connected to the EPOCH 1000 Series instrument, pressing the ESCAPE key also allows you to leave a setup page.

The following sections describe the available setup pages.

3.4.1 Color Setup Page

The **Color** setup page, shown in Figure 3-18 on page 76 and Figure 3-19 on page 77, is accessible by choosing **Display Setup > Color Setup**.

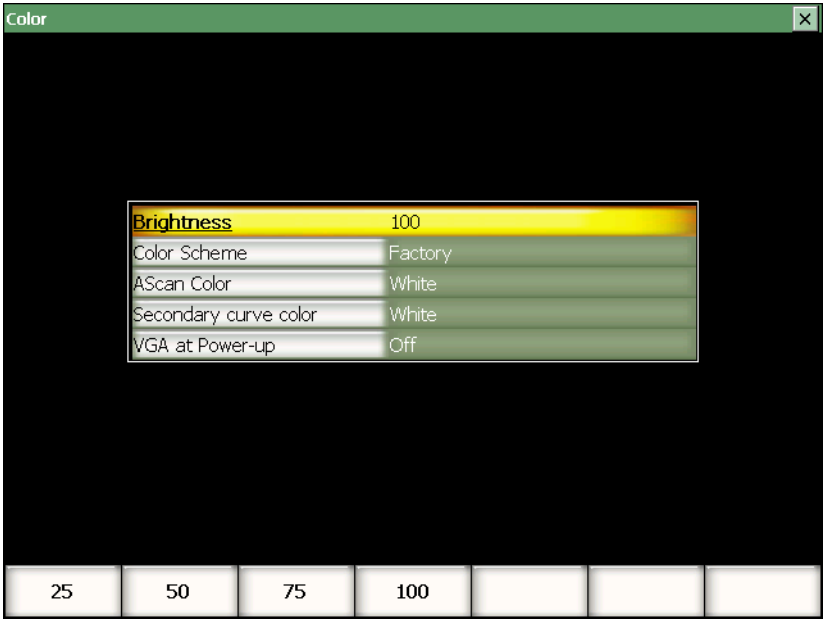


Figure 3-18 The Color setup page in conventional UT mode

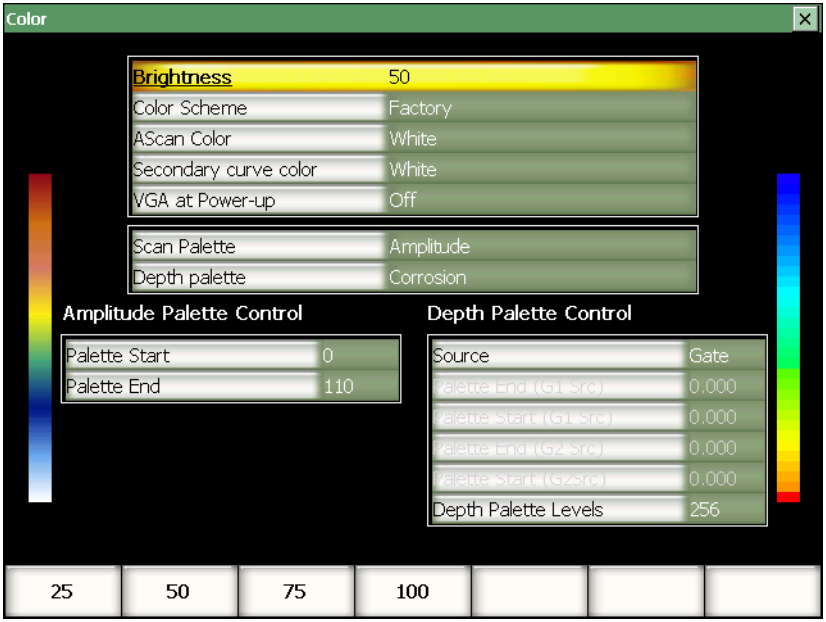


Figure 3-19 The Color setup page in PA mode

The available parameters are:

Brightness

Used to adjust the screen brightness in 5 % increments or by choosing one of the preset values (**0%**, **25%**, **50%**, **75%**, or **100%**).

Color Scheme

Used to set the overall instrument color scheme:

Factory: default multicolor display

Outdoor: white background, black text

AScan Color

Used to select the color of the live A-scan (white, black, green, yellow, red, blue).

Secondary Curve Color

Used to select the color of secondary A-scan curves such as the DAC/TVG and DGS/AVG warning curves (white, black, green, yellow, red, blue, magenta).

VGA at Power-Up

Used to automatically turn on the VGA output at start up.

Scan Palette (Phased array mode only)

Used to set the color palette for phased array amplitude image scans (see "Manual Receiver Adjustments" on page 325 for additional information).

Depth Palette (Phased array mode only)

Used to set the color palette for phased array depth image scans (see "Manual Receiver Adjustments" on page 325 for additional information).

3.4.2 A-Scan Setup Page

The **A-Scan** setup page, shown in Figure 3-20 on page 78 and Figure 3-21 on page 79, is accessible by selecting **Display Setup > A-Scan Setup**.

Figure 3-20 A-Scan setup page in conventional UT mode

Figure 3-21 A-Scan setup page in PA mode

The available parameters are:

Live A-Scan Display

Used to set the live A-scan drawing mode:

- **Outline**
- **Filled**

Envelope Display

Used to set the peak memory and peak hold A-scan envelope drawing mode:

- **Outline**
- **Filled**

X-Axis Grid Mode

Used to set the horizontal X-Axis grid display mode:

Off: no grid.

Standard: 10 divisions spaced evenly and labeled 1 to 10.

Soundpath: five divisions spaced evenly and labeled with corresponding sound path values.

Leg: up to four divisions representing half-skip distances in angle beam inspection mode, based on test piece thickness value, and labeled L1 to L4.

Y-Axis Grid

Used to set the vertical Y-axis grid display mode to either 100 % or 110 % full-screen height.

Baseline Break

Used to turn this feature on or off (see chapter "ClearWave Visualization Package" on page 117).

Ascan (PA mode only)

Used to select the A-scan mode (**Single** or **Multi-Angle**). When **Multi-Angle** is selected, angles for three A-scans can be selected.

Angle AScan 1, **2**, or **3 (PA mode only)**

Used to set the angle for three A-scans in **Multi-Angle** mode.

3.4.3 Image Overlay Page (Phased Array Mode Only)

The Display setup page, shown in Figure 3-22 on page 81, is accessible by selecting **Display Setup > Image Overlay**. The page allows you to activate overlays for use on phased array image scans.

Figure 3-22 The Image Overlay setup page

The available parameters are:

Leg Indicator

Used to display a visual marker in the S-scan image representing skip distance. This parameter is active when the part thickness is defined in the **PA Probe > Beam** setup page.

Sector Grid

Used to display the X-axis grid in the S-scan.

Ascan Grid

Used to display the X-axis grid in the A-scan.

Probe Front Cursor

Used to display a visual marker in the S-scan to represent the front of the phased array probe. This feature is used for surface distance measurements, much like X-value correction, because the beam index point (BIP) in phased array mode varies depending on the selected focal law.

Weld Overlay

Used to display a weld overlay on the live sector or linear scan image. Weld overlay is a visualization tool that provides weld geometry for ease of indication placement. When the Weld Overlay is enabled, you can then choose an **Overlay Name**, **Weld Rotation**, and **Weld Color**.

Center Line Cursor

Used to display the centerline cursor for a weld. This parameter is automatically turned on when the **Weld Overlay** is active.

3.4.4 Reading Setup Page

The Reading setup page, shown in Figure 3-23 on page 82, is accessible by selecting **Meas Setup > Reading Setup**. This page allows you to choose which measurement appears in the measurement reading boxes at the top of the software main display (see "About Measurement Reading Boxes" on page 57).

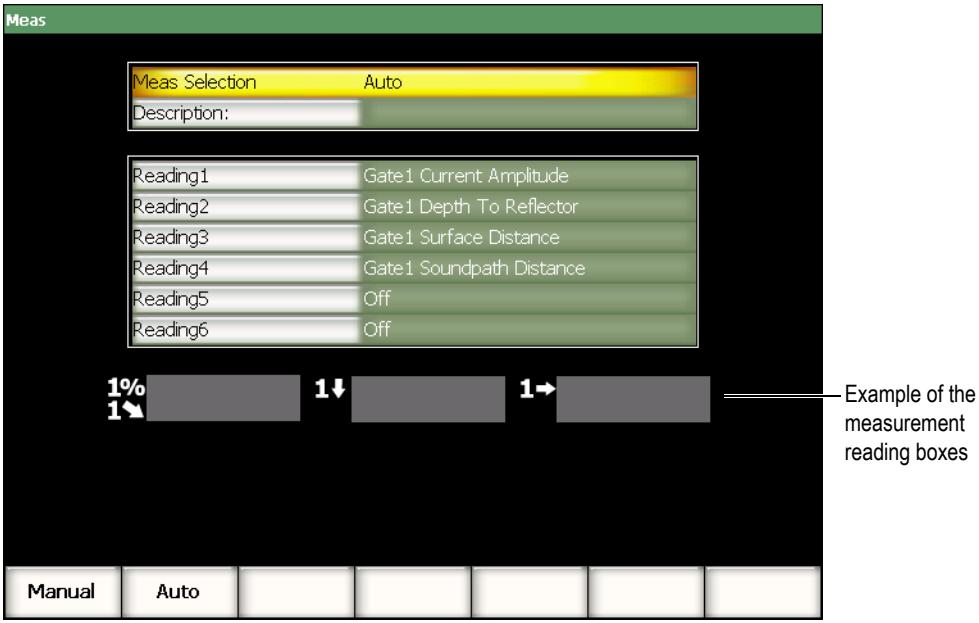


Figure 3-23 The Reading setup page

The available parameters are:

Meas Selection

Used to set the measurement reading box definition mode to be automatically selected based on instrument function (**Auto**), or to be manually defined (**Manual**).

Description

Used to choose custom measurement schemes loaded using the GageView Pro interface program.

Reading 1 to **6**

Each measurement reading box is defined independently when in manual mode. Below the reading selection parameters, an example of the measurement reading boxes is displayed to illustrate the position of the measurement being adjusted (see Figure 3-23 on page 82). Table 21 on page 83 presents the available measurement readings.

Figure 3-24 Example of measurement reading boxes with icons

Table 21 Available measurement readings

Icon	Measurement readings	Description
1TH	**Gate 1 Thickness**	Thickness in gate 1. Not used with **Angle**.
2TH	**Gate 2 Thickness**	Thickness in gate 2. Not used with **Angle**.
IF TH	**IF Gate Thickness**	Thickness in IF gate. Not used with **Angle**.
1	**Gate 1 Sound Path Distance**	Sound path (Angular) distance in gate 1.
2	**Gate 2 Sound Path Distance**	Sound path (Angular) distance in gate 2.
1	**Gate 1 Depth to Reflector**	Depth to reflector in gate 1. Used with **Angle**.

Table 21 Available measurement readings *(continued)*

Icon	Measurement readings	Description
2↕	**Gate 2 Depth to Reflector**	Depth to reflector in gate 2. Used with **Angle**.
1→	**Gate 1 Surface Distance**	Horizontal distance to reflector in gate 1. Used with **Angle**.
2→	**Gate 2 Surface Distance**	Horizontal distance to reflector in gate 2. Used with **Angle**.
1⇨	**Gate 1 Surface Distance — X Value**	Horizontal distance minus X-Value (distance from beam index point to front of wedge) in gate 1. Used with **Angle**.
2⇨	**Gate 2 Surface Distance — X Value**	Horizontal distance minus X-value (distance from beam index point to front of wedge) in gate 2. Used with **Angle**.
1↓	**Gate 1 Minimum Depth**	Minimum depth in gate 1. Resets on gate adjustment and on most pulser/receiver adjustments.
2↓	**Gate 2 Minimum Depth**	Minimum depth in gate 2. Resets on gate adjustment and on most pulser/receiver adjustments.
1↑	**Gate 1 Maximum Depth**	Maximum depth in gate 1. Resets on gate adjustment and on most pulser/receiver adjustments.
2↑	**Gate 2 Maximum Depth**	Maximum depth in gate 2. Resets on gate adjustment and on most pulser/receiver adjustments.
1%	**Gate 1 Current Amplitude**	Amplitude measurement in gate 1. Displays as % of full-screen height (FSH).
2%	**Gate 2 Current Amplitude**	Amplitude measurement in gate 2. Displays as % of full-screen height (FSH).
1%↑	**Gate 1 Max. Amplitude**	Maximum amplitude in gate 1. Resets on gate adjustment and on most pulser/receiver adjustments.

Table 21 Available measurement readings *(continued)*

Icon	Measurement readings	Description
2%↑	**Gate 2 Max. Amplitude**	Maximum amplitude in gate 2. Resets on gate adjustment and on most pulser/receiver adjustments.
1%↓	**Gate 1 Min. Amplitude**	Minimum amplitude in gate 1. Resets on gate adjustment and on most pulser/receiver adjustments.
2%↓	**Gate 2 Min. Amplitude**	Minimum amplitude in gate 2. Resets on gate adjustment and on most pulser/receiver adjustments.
1%C	**Gate 1 Amplitude to Curve**	Amplitude measurement in gate 1. Displays echo height as a percentage of DAC/TVG curve height.
2%C	**Gate 2 Amplitude to Curve**	Amplitude measurement in gate 2. Displays echo height as a percentage of DAC/TVG curve height.
1dBC	**Gate 1 dB to Curve**	Amplitude measurement in gate 1. Displays echo dB value compared to curve height where the curve equals 0 dB.
2dBC	**Gate 2 dB to Curve**	Amplitude measurement in gate 2. Displays echo dB value compared to curve height where the curve equals 0 dB.
G2-1	**Echo-to-Echo (Gate 2 — Gate 1)**	Gate 2 thickness minus gate 1 thickness (echo-to-echo measurement).
G1-IF	**Gate 1 — IF Gate**	Gate 1 thickness minus IF gate thickness.
G2-IF	**Gate 2 — IF Gate**	Gate 2 thickness minus IF gate thickness.
D=	**AWS D1.1/D1.5 Weld Rating (D)**	D rating calculated for the gated echo.
ERS	**Equivalent reflector size**	Equivalent flat-bottom hole (FBH) size for DGS/AVG evaluation.

Table 21 Available measurement readings *(continued)*

Icon	Measurement readings	Description
OS	**Overshoot (OS)**	Overshoot value in dB comparing echo height to DGS/AVG curve.
DT	**Distance Travelled**	Distance traveled by encoder during encoded scans.
SR	**Scan Rate**	Encoded scan rate (readings per second).
Rej%	**Reject**	Percentage of reject applied to the current live display.
A-G1	**Cursor A — Gate 1**	Difference between the position of cursor A and the position of the indication in gate 1.
B-G1	**Cursor B — Gate 1**	Difference between the position of cursor B and the position of the indication in gate 1.
B-A	**Cursor B — Cursor A**	Difference between the position of cursor B and the position of cursor A.
A-G2	**Cursor A — Gate 2**	Difference between the position of cursor A and the position of the indication in gate 2.
B-G2	**Cursor B — Gate 2**	Difference between the position of cursor B and the position of the indication in gate 2.
A-IF	**Cursor A — IF Gate**	Difference between the position of cursor A and the position of the indication in IF gate.
B-IF	**Cursor B — IF Gate**	Difference between the position of cursor B and the position of the indication in IF gate.
X_2-X_1	**Cursor X2 — Cursor X1**	Difference between the position of cursor X2 and the position of cursor X1 in frozen sector scan sizing mode.

Table 21 Available measurement readings *(continued)*

Icon	Measurement readings	Description
Y_2-Y_1	**Cursor Y2 — Cursor Y1**	Difference between the position of cursor Y2 and the position of cursor Y1 in frozen S-scan sizing mode.
X_1Y_1	**Cursor X1, Cursor Y1 Intersect Depth**	Value of the thickness/depth measurement at the intersection of cursor X1 and cursor Y1 in frozen S-scan sizing mode.
A=	**AWS D1.1/D1.5 Weld Rating (A)**	A rating calculated for the gated echo.
B=	**AWS D1.1/D1.5 Weld Rating (B)**	B rating calculated for the gated echo.
C=	**AWS D1.1/D1.5 Weld Rating (C)**	C rating calculated for the gated echo.
dB^{1-2}	**Gate 1 Echo Height — Gate 2 Echo Height**	Amplitude height difference between gate 1 and gate 2 measured in dB.
dB^{2-1}	**Gate 2 Echo Height — Gate 1 Echo Height**	Amplitude height difference between gate 2 and gate 1 measured in dB.

3.4.5 General Setup Page

The **General** setup page, shown in Figure 3-25 on page 88, is accessible by selecting **Inst Setup > General**. This page allows you to configure general parameters such as the user interface language and the instrument date and time.

Figure 3-25 The General setup page

The available parameters are:

Language

Used to select the user interface language (English, Japanese, German, French, Spanish, Russian, or Chinese).

Key Beep

Used to activate an audible tone after every key press.

Alarm Beep

Used to activate an audible tone when a **Gate Alarm** is triggered.

All Lock

Used to lock access to all instrument function keys except **[ON/OFF]**. A padlock symbol appears in the flag area of the live display when active. Turn the instrument off and on to unlock the keys.

Cal Lock

Used to lock access to the following functions: **Gain**, **Auto CAL**, **PA Cal**, **CAL Zero**, **Velocity**, **Angle**, **Pulser**, **Receiver**, and **PA P/R**. A half padlock symbol appears in the flag area of the live display when active.

Temp Cal

Used to select automatic or manual temperature calibration of the instrument.

Temperature calibration is used to normalize the response of internal components of the instrument as the internal temperature of the instrument changes. This calibration ensures proper vertical alignment and response of the A-scan.

Temperature calibration suspends all data acquisition for 1 or 2 seconds. For manual scanning applications, automatic temperature calibration is recommended. For automated scanning applications, manual temperature calibration is recommended to avoid loss of data.

Locale

Used to select the format used by the instrument to display numeric values (radix) and the date.

Power Key Function

Used to control standby mode. Standby mode uses half as much battery life in a given time period as leaving the unit on. When the unit is put into standby mode, the current on-screen parameters are saved and displayed again at start-up or in case power is accidentally lost while in standby mode.

Standby

Used to put the unit into standby mode the Power key is pressed.

On/Off

Used to turn the unit off when the Power key is pressed.

Max. Standby Time

Used to set the amount of time the unit will remain in standby mode before shutting down.

Recall Function

Used to choose whether the data logger Recall function simply recalls the selected file or whether the file is both recalled and opened.

Automatic Probe Recognition

Used to turn on or off the automatic phased array probe recognition function in PA mode only.

Month

Used to set the month for the instrument internal clock.

Date

Used to set the day of the month for the instrument internal clock.

Year

Used to set the year for the instrument internal clock.

Hour

Used to set the hour for the instrument internal clock.

Minute

Used to set the minutes for the instrument internal clock.

Mode

Used to set the hour display mode (**AM**, **PM**, or **24H**) for the instrument internal clock.

3.4.6 Owner Info

The **Owner Info** setup page, shown in Figure 3-26 on page 91, is accessible by selecting **Inst Setup > Owner Info**. This page allows you to input up to five lines of text displayed during the instrument start-up at the end of the start-up screens. This text is typically used to show owner or company information, such as an address and a phone number.

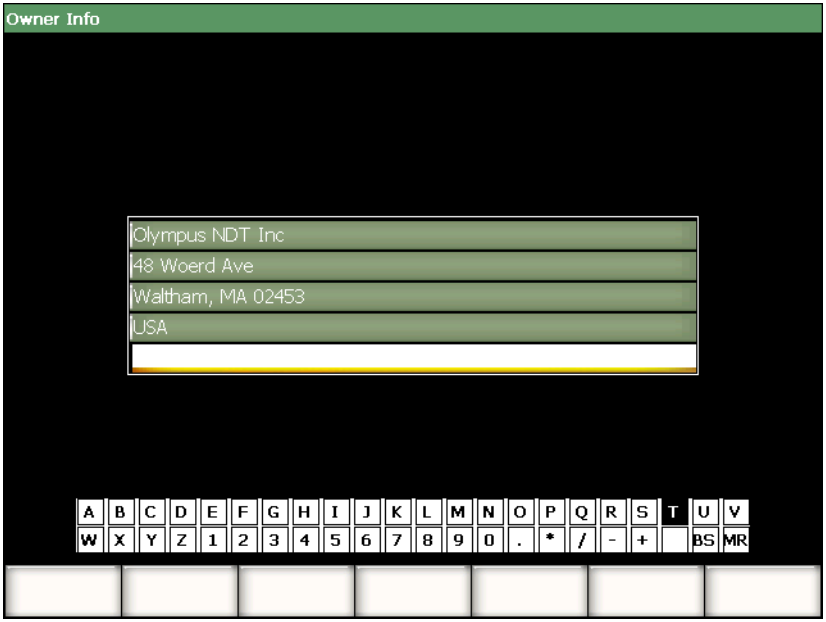


Figure 3-26 The Owner Info setup page

3.4.7 Status Setup Page

The **Status** setup page, shown in Figure 3-27 on page 92, is accessible by selecting **Inst Setup > Status**. This page provides information about the current status of the instrument, such as the internal temperature, battery status, and instrument hardware/software identification data.

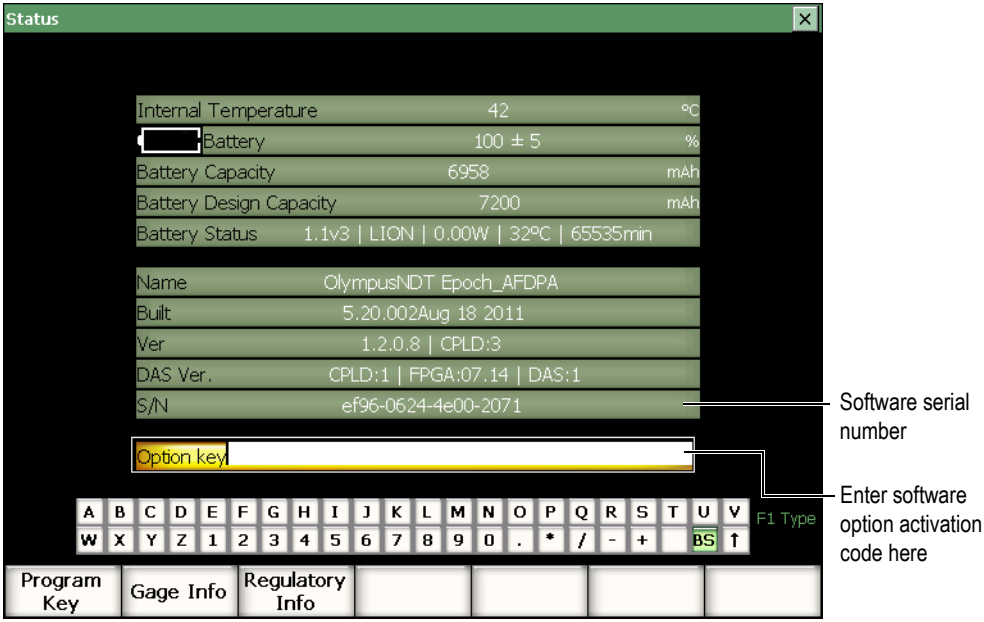


Figure 3-27 The Status setup page

On the **Status** page, there is a box where you can enter an activation code that will enable you to access a software option not included with the standard package of instrument features. This code is provided by an Olympus representative after the purchase of a particular software option. Refer to the “Defining Licensed and Unlicensed Software Features” on page 235 for details on software option activation.

The **Gage Info** menu is not yet operational.

The **Regulatory Info** page, shown in Figure 3-28 on page 93, is accessible by selecting **Regulatory Info**. The page provides regulatory compliance information for the instrument.

Figure 3-28 The Regulatory Information screen

3.4.8 Editable Parameters

The **Editable Parameters** function is now a standard software feature on EPOCH 1000 Series instruments. This feature allows you to customize the preset values that are displayed during coarse adjustment for these specific parameters.

If desired, you can export the editable parameters setup in XML format to a USB memory stick and then import it to another EPOCH 1000 Series instrument.

To access the **Editable Parameters** menu, select **Inst Setup > Editable Parameters**.

Each instrument mode (UT and PA) has its own **Editable Parameters** menu with separate sets of parameters.

UT Mode Parameters (see Figure 3-29 on page 94):

- **Velocity**
- **Gain Step**
- **Freq**

- **Angle**
- **Thick**
- **X Value**
- **Auto XX**

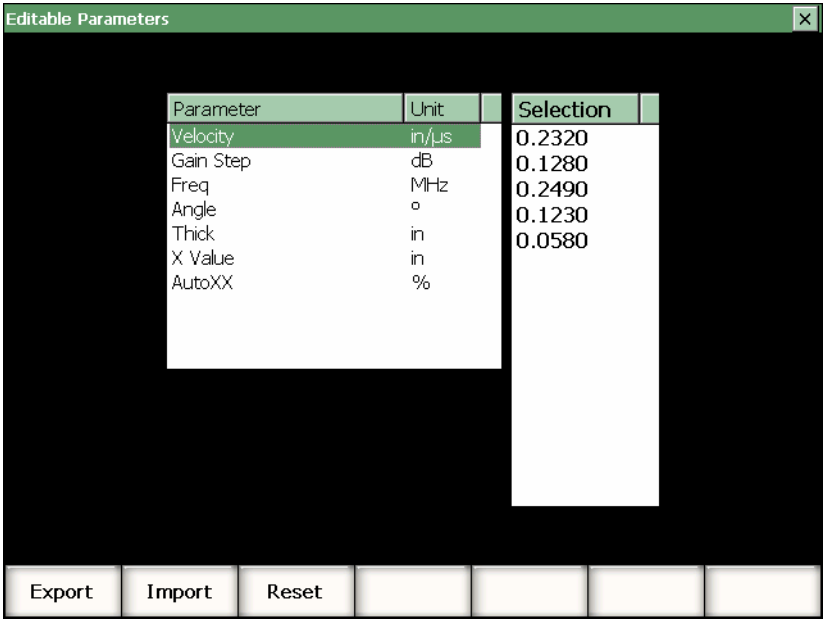


Figure 3-29 Editable parameters in UT mode

PA Mode Parameters (see Figure 3-30 on page 95):

- **Velocity**
- **Gain Step**
- **Freq**
- **Thick**
- **Auto XX**

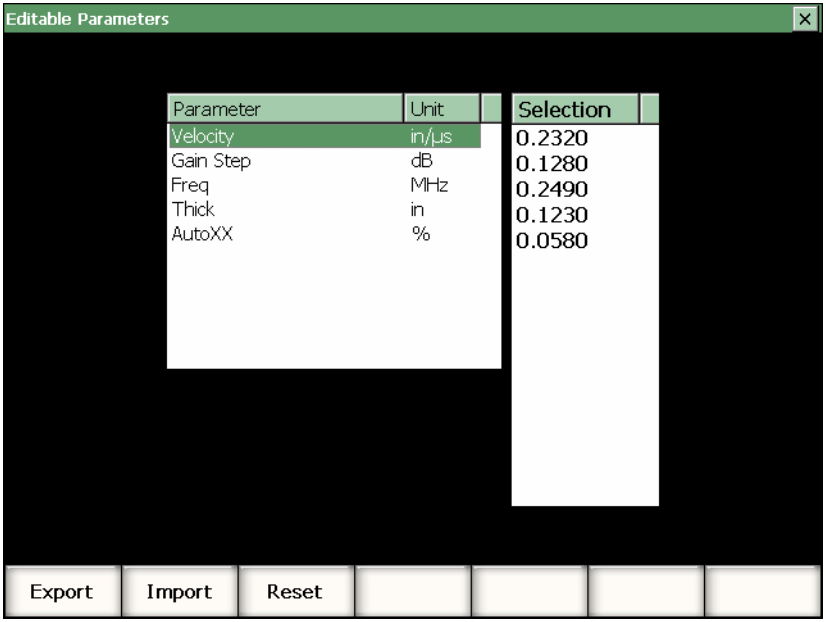


Figure 3-30 Editable parameters in PA mode

The instrument comes with certain preset values for each of the parameters, but you can change any of these values as necessary to meet your needs.

To change a preset value

1. Choose the **Parameter** you want to edit, and then press the **[RIGHT]** arrow key to view the **Selection** measurements.
2. Choose the value you want to change, and then press **[CHECK]**.
3. Adjust to the desired value, and then press **[CHECK]** to confirm (see Figure 3-31 on page 96).

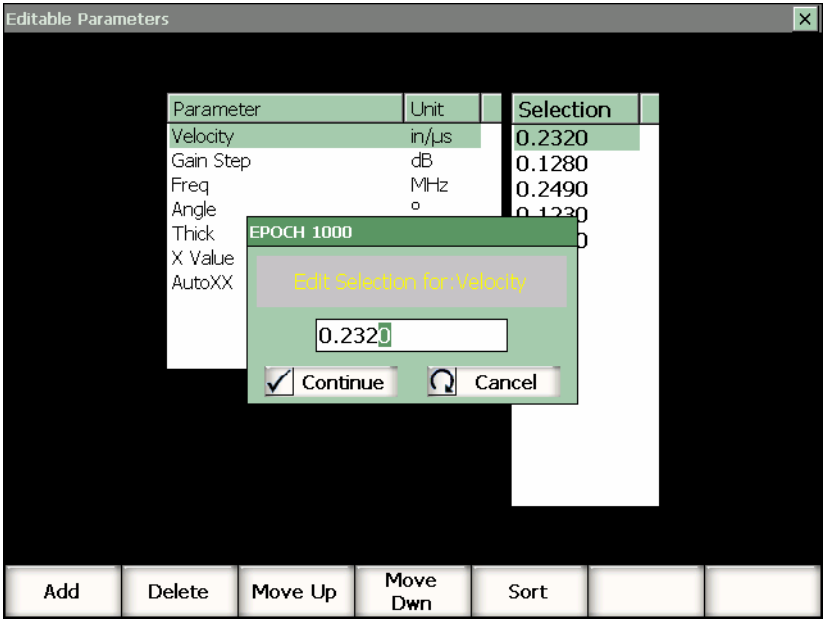


Figure 3-31 Changing a preset value

To add a preset value

1. Choose the **Parameter** you want to edit, and then press the **[RIGHT]** arrow key to view the **Selection** measurements.
2. Press **[P1]** to add a preset value.
3. Adjust to the desired value, and then press **[CHECK]** to confirm.

   The new value will be added to the bottom of the list.
4. To rearrange the order of the preset values, use the **Move Up [P3]**, **Move Dwn [P4]**, or **Sort [P5]** functions (see Figure 3-32 on page 97).
5. To delete a preset value, choose the desired value, and then press **[P2]**.

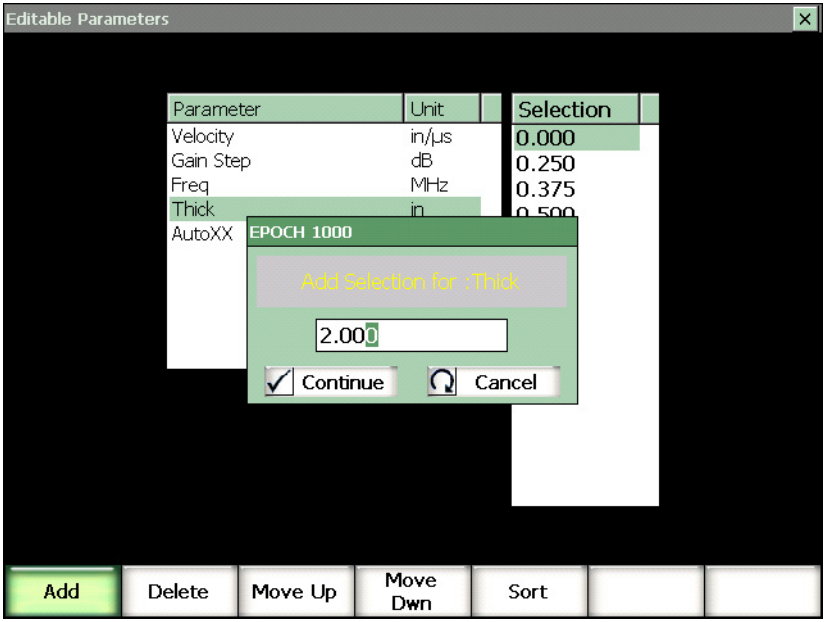


Figure 3-32 Adding a preset value

NOTE

The EPOCH 1000 can only accommodate certain pulse frequency values. If a non valid frequency value is entered, the instrument will display an error and automatically rounds down to the closest valid frequency.

In the **Beam** setup menu in PA mode (**PA Probe > Beam**), the preset values for **Thick** and **Velocity** will also be displayed above the parameter keys.

If desired, you can export the editable parameters setup in XML format to a USB memory stick and import it to another EPOCH 1000 Series instrument using the **Export [P1]** and **Import [P2]** functions in the **Editable Parameters** menu. To reset the **Editable Parameters** back to the system default values, press **[P3]**.

NOTE

For parameters that have different values in metric and Imperial units (e.g. **Velocity**), you can store different values in each measurement system. Only the values for the current unit's setting will be displayed in the **Editable Parameters** menu.

3.5 Managing Data with GageView Pro Interface Program

The EPOCH 1000 Series is fully compatible with Olympus' standard portable instrument computer interface program, GageView Pro. Through the GageView Pro interface program, you can download inspection data, review measurements on a computer, export measurements and calibration data to common spreadsheet programs, back up calibration and inspection data from the instrument, and perform basic operations such as instrument firmware upgrades and screen captures. To purchase GageView Pro, please contact your local Olympus sales representative.

4. Adjusting the Pulser/Receiver (Conventional UT Mode)

This chapter describes how to adjust the pulser/receiver of EPOCH 1000 Series instruments while in conventional ultrasound mode.

4.1 Adjusting the System Sensitivity (Gain)

To adjust the system sensitivity

1. Press **[GAIN].**
2. Use the **[CHECK]** key to select either coarse or fine adjustments.
3. Adjust the gain setting.

NOTE

The total system sensitivity is 110 dB.

4.2 Setting Reference Gain and Scanning Gain

Establishing the current system gain as the reference (base) level is useful for inspections that require the establishment of a reference gain level, and then the addition or subtraction of scanning gain.

To add scanning gain

1. Press **[2nd F]**, **[GAIN] (REF dB)**.

   The gain display reads: **REF XX.X + 0.0 dB**. Scanning gain can now be added or subtracted.
2. Press **[CHECK]** to choose either the coarse or fine adjustment mode.

NOTE

Coarse adjustment varies the gain value by ±6 dB. Fine adjustment varies the gain value by ±0.1 dB. These values can be adjusted in the **Editable Parameters** menu (see "Editable Parameters" on page 93).

---

3. Adjust the scanning gain.

While using the reference gain and scanning gain, the following parameters appear in the **Basic** submenu.

Add

Used to add the scanning gain to the reference gain and deactivate the reference gain feature.

Scan dB

Used to toggle the scanning gain from the active level to 0.0 dB (reference level), allowing a direct amplitude comparison to the reference indication.

Off

Used to exit the reference gain function without adding the scanning gain to the base instrument gain.

4.3 Using the AUTO-XX% Feature

The **AUTO-XX%** feature is used to quickly adjust the instrument's gain (dB) setting to bring the gated peak echo to XX% FSH. **AUTO-XX%** is especially useful for bringing the echo from a reference indication to XX% FSH to establish the instrument's reference gain level (see "Setting Reference Gain and Scanning Gain" on page 99 for further information).

In the EPOCH 4 Series, the **AUTO-XX%** feature was called AUTO-80 %. The default setting for **AUTO-XX%** in the EPOCH 1000 Series is 80 % of full-screen height (FSH). You can adjust the FSH target value (XX) to meet the demands of the application.

You can use the **AUTO-XX%** feature to bring an echo to XX% FSH in any gate.

To use AUTO-XX% feature

1. Press **[GATE]** to select the gate that measures the echo to be adjusted.
2. Press **[2nd F]**, **[GATE] (AUTO XX%)** to activate **AUTO XX%** feature.

NOTE

AUTO-XX% can be activated at any time during operation. If you do not actively select a gate, **AUTO-XX%** is applied to the most recently adjusted gate.

NOTE

AUTO-XX% can be used when an echo exceeds the desired amplitude. The echo can be either above or below XX% FSH. If a signal is very high in amplitude (above 500 % FSH), it might be necessary to activate the **AUTO-XX%** function more than once.

4.4 Pulser Functions

The pulser settings in the EPOCH 1000 Series conventional ultrasound mode are available from the **Pulser** submenu. The pulser setup parameters are:

- Pulse Repetition Frequency (PRF)
- Pulse Energy (Voltage)
- Damping
- Test Mode
- Pulser Waveform
- Pulser Frequency Selection (Pulse Width)

4.4.1 Pulse Repetition Frequency (PRF)

Pulse repetition frequency (PRF) is a measure of how often the transducer is being pulsed by the electronic circuitry in the EPOCH 1000 Series instrument.

PRF is typically adjusted based on the test method or test piece geometry. For parts with long sound paths, it is necessary to lower the PRF to avoid wrap-around interference that results in spurious signals on the display. For applications with rapid scanning, it is often necessary to use a high PRF rate to assure that small defects are detected as the probe moves past the part.

The EPOCH 1000 Series allows you to manually adjust the PRF from 5 Hz to 6000 Hz in 50 Hz (coarse) or 5 Hz (fine) increments. The instrument also has two **Auto-PRF** settings to automatically adjust the PRF based on screen range.

To select a PRF adjustment method

◆ Select **Pulser > PRF Mode**, and then vary the setting. The available choices are:

Auto Low

Used to adjust the PRF to the lowest standard value based on screen range and test mode (default setting).

Auto High

Used to adjust the PRF to the highest possible value based on screen range and test mode.

Manual

Used to manually set the PRF value.

To adjust the PRF value in Manual PRF Mode

1. Select **Pulser > PRF Mode = Manual**.
2. Select **Pulser > PRF**, and then vary the setting.

NOTE

The EPOCH 1000 Series are *single-shot* instruments. This means that they acquire, measure, and draw the complete A-scan with each pulse rather than using multiple acquisitions to construct a full waveform. The measurement rate in the EPOCH 1000 Series conventional ultrasound mode is always equal to the PRF rate unless you are using a multiplexer.

4.4.2 Pulse Energy (Voltage)

The EPOCH 1000 Series conventional ultrasound mode can adjust the pulse energy from 50 V to 475 V in increments of 25 V. With this flexibility, you can set the pulse energy to a minimum when you want to extend the battery life, or provide a very high power pulser for the most difficult materials.

To adjust the pulser energy

- Select **Pulser > Energy**, and then vary the value. In the **Energy** adjustment, coarse and fine steps are equal (25 V).

NOTE

To maximize instrument battery life and transducer life, it is recommended that you use lower energy settings when the application permits it. For most applications, the energy setting does not need to exceed 200 V.

4.4.3 Damping

The damping control allows you to optimize the waveform shape for high resolution measurements using an internal resistive circuit. There are four damping settings on the EPOCH 1000 Series conventional ultrasound mode: **50 Ω**, **100 Ω**, **200 Ω**, or **400 Ω**.

To adjust the damping

- Select **Pulser > Damp**, and then vary the setting.

TIP

Generally, the lowest resistance (Ω) setting increases the system damping and improves near-surface resolution, while the highest resistance setting decreases system damping and improves the instrument penetration power.

Selecting the correct damping setting fine-tunes the EPOCH 1000 Series instrument so that it can operate with a particular transducer selection. Depending on the transducer being used, the various damping settings either improve near-surface resolution or improve the instrument's penetration power.

4.4.4 Test Mode

The EPOCH 1000 Series conventional ultrasound mode can operate in three test modes that you can select using the **Pulser > Mode** parameter:

P/E

Used to select the pulse-echo mode where a single element transducer sends and receives the signal. Use either transducer connector.

Thru

Used to select the through transmission mode where two separate transducers are typically located on opposite sides of the test specimen. One transducer transmits, the other receives. Use the T/R labeled transducer connection as the transmit connector.

Dual

Used to select the pitch-and-catch mode where dual-element transducers, with one element transmits and the other receives. Use the T/R labeled transducer connection as the transmit connector.

NOTE

To compensate for the one-way sound path in through transmission (**Thru**) mode, the EPOCH 1000 Series does not divide transit time by two when calculating thickness measurements.

To adjust the test mode

- Select **Pulser > Mode**, and then vary the setting.

4.4.5 Pulser Waveform

The EPOCH 1000 Series conventional ultrasound mode operates in two pulser waveform modes that you can select using the **Pulser > Pulser** parameter:

Spike

Used to mimic a traditional high frequency spike pulse by using a narrow-width pulse to excite the transducer.

Square

Used to tune the width of the pulse to optimize the response of the transducer.

NOTE

EPOCH 1000 Series instruments use PerfectSquare technology to achieve an optimal response from the tunable square wave pulser. This PerfectSquare technology maximizes the energy used to drive the connected transducer while providing excellent near-surface resolution.

To adjust the pulser waveform

- Select **Pulser > Pulser**, and then vary the setting.

4.4.6 Pulser Frequency Selection (Pulse Width)

The pulser frequency selection sets the pulse width when **Pulser > Pulser = Square**. This frequency selection allows you to tune the shape and duration of each pulse to obtain the best performance from the transducer being used. In general, the best performance is achieved by tuning the pulser frequency as close as possible to the center frequency of the transducer being used.

To adjust the pulser frequency

- Select **Pulser > Frequency**, and then vary the setting.

NOTE

Actual results could vary due to the test material and/or variation in the transducer center frequency. Try various settings with a transducer and test piece to maximize ultrasonic performance.

4.5 Receiver Functions

The receiver settings in the EPOCH 1000 Series conventional ultrasound mode are accessed from the **Receiver** submenu. The receiver parameters are:

- Filter Group
- Digital Receiver Filters
- Waveform Rectification

4.5.1 Filter Group

The EPOCH 1000 Series conventional ultrasound mode has three standard digital filter groups:

Standard

Seven digital filter sets with a total bandwidth of 0.2 MHz to 26.5 MHz. Each filter is EN12668-1 compliant (see “Standard Filter Set” on page 107).

Advanced

Thirty (30) digital filter sets. Total bandwidth allows all frequencies to be received. Filters not tested to EN12668-1 (see “Advanced Filter Set” on page 107).

AxleInspFR

Three digital filter sets. Special filters for unique axle inspection application.

To adjust the filter group

◆ Select **Receiver > Filter Group**, and then vary the setting.

4.5.2 Digital Receiver Filters

EPOCH 1000 Series instruments have a total bandwidth of 26.5 MHz at −3 dB. The instruments offer several broadband and narrow-band digital filters. These filters are designed to improve the signal-to-noise ratio by filtering out unwanted high and/or low frequency noise outside of the test frequency spectrum. The **Standard** filter set also provides the dynamic range (dB) required by EN12668-1.

In most cases, you should select either a broadband filter or a narrow-band filter that covers the frequency of the transducer being used. Because of the shifting of frequency spectrum in most materials, it may be necessary to adjust the filter settings to maximize instrument performance. Every material is different, and you must optimize the receiver settings based on the application.

Digital filter settings vary based on **Filter Group** (see “Filter Group” on page 106).

To adjust the Filter

◆ Select **Receiver > Filter**, and then vary the filter setting.

4.5.2.1 Standard Filter Set

The EPOCH 1000 Series **Standard Filter Set** contains the following seven filters, compliant with EN12668-1:

- 2.0 MHz to 21.5 MHz (broadband 1)
- 0.2 MHz to 10.0 MHz (broadband 2)
- 0.2 MHz to 1.2 MHz
- 0.5 MHz to 4.0 MHz
- 1.5 MHz to 8.5 MHz
- 5.0 MHz to 15.0 MHz
- 8.0 MHz to 26.5 MHz (high-pass)

4.5.2.2 Advanced Filter Set

The EPOCH 1000 Series **Advanced** filter set takes advantage of the instruments’ unique digital receiver design and allows unprecedented filtering flexibility. There are

several distinct performance advantages that result from this filter set. Specific performance improvements include:

- Performance improvement with low frequency probes that are commonly used for inspection of composites and plastics. Greater sensitivity and reduced distortion are easily observed.
- Improved initial pulse (main bang) recovery with new DC coupled setups compared to the standard lower frequency band-pass filter settings (0.2 MHz to 10 MHz, 1.5 MHz to 8.5 MHz, etc.).
- Optimized broadband response from medium-to-high frequency transducers.
- Use of very low frequency transducers (50 kHz to 100 kHz range) for specialized applications.

The **Advanced** filter set contains the following 30 filters. These filters are not tested to the EN12668-1 code requirements.

- A DC — 1.2 MHz
- A DC — 4.0 MHz
- A DC — 8.5 MHz
- A DC — 10.0 MHz
- A DC — 15.0 MHz
- A DC — 26.5 MHz
- A BYPASS — This setting turns off all digital filtering.
- A BYP_EXT — Same as above. Used at extended ranges.
- A 0.2 — 4.0 MHz
- A 0.2 — 8.5 MHz
- A 0.2 — 15.0 MHz
- A 0.2 — 26.5 MHz
- A 0.2 MHz — BYP
- A 0.5 — 8.5 MHz
- A 0.5 — 10.0 MHz
- A 0.5 — 15.0 MHz
- A 0.5 — 26.5 MHz
- A 0.5 MHz — BYP
- A 1.0 — 3.5 MHz
- A 1.5 — 10.0 MHz
- A 1.5 — 15.0 MHz

- A 1.5 — 26.5 MHz
- A 1.5 MHz — BYP
- A 2.5 — 7.0 MHz
- A 5.0 — 10.0 MHz
- A 5.0 — 26.5 MHz
- A 5.0 MHz — BYP
- A 6.0 — 12.0 MHz
- A 8.0 — 15.0 MHz
- A 8.0 MHz —BYP

NOTE

Because the advanced filters are not tested to be compliant with EN12668-1, the letter *A* appears before each filter in this set. This allows you to easily identify if the filter being used complies or not with EN12668-1.

4.5.3 Waveform Rectification

EPOCH 1000 Series instruments can operate in one of four different rectification modes, which you can select using the **Receiver > Rect** parameter: **Full-wave**, **Half-wave Positive**, **Half-wave Negative**, or **RF** (unrectified).

NOTE

The **RF** mode is not active while operating in special software feature modes, such as **DAC** mode or **Peak Memory**.

To adjust the rectification

◆ Select **Receiver > Rect**, and then vary the rectification setting.

4.6 Custom Filter Sets

EPOCH 1000 Series instruments are capable of storing custom filter sets that are developed by Olympus at the request of a customer. The **AxleInspFR** filter selection is an example of a custom filter designed to meet the demands of a particular application. For more information, contact Olympus.

5. Managing Special Waveform Functions (Conventional UT Mode)

This chapter describes how to manage special waveform functions.

5.1 Reject

The **Receiver > Reject** parameter enable you to eliminate unwanted low-level signals from the display. The reject function is linear and adjustable from 0 % to 80 % FSH. Increasing the reject level does not affect the amplitude of the signals above the reject level.

NOTE

The reject function can also be used in the unrectified **Receiver > Rect = RF** mode.

The reject level is displayed as an horizontal line on the instrument display (see Figure 5-1 on page 112) or two lines in the case of the **Receiver > Rect = RF** mode.

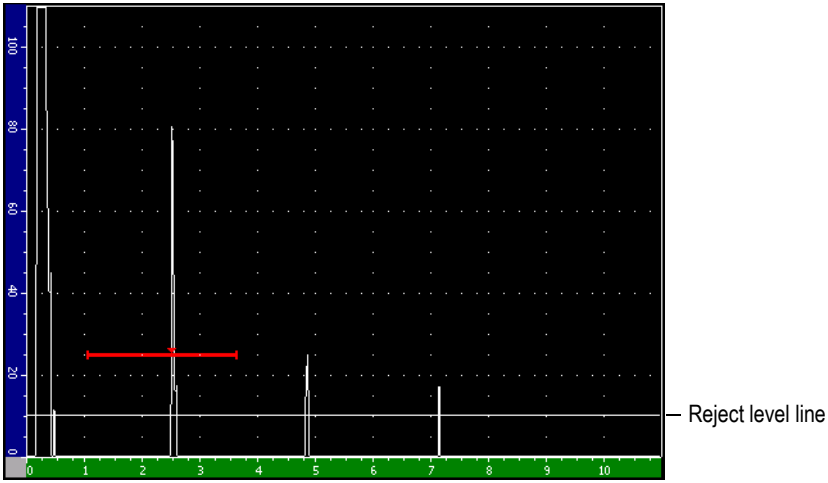


Figure 5-1 Horizontal line indicating the reject level

5.2 Peak Memory

The peak memory function enables the display to capture and store on the screen the amplitude of each A-scan acquisition. The display updates each pixel if a signal of greater amplitude is acquired. When you scan the transducer over a reflector, the signal envelope (echo dynamic as a function of transducer position) is held on the screen as a green line (see Figure 5-2 on page 113). In addition, the current live waveform is displayed at the appropriate place within the signal envelope.

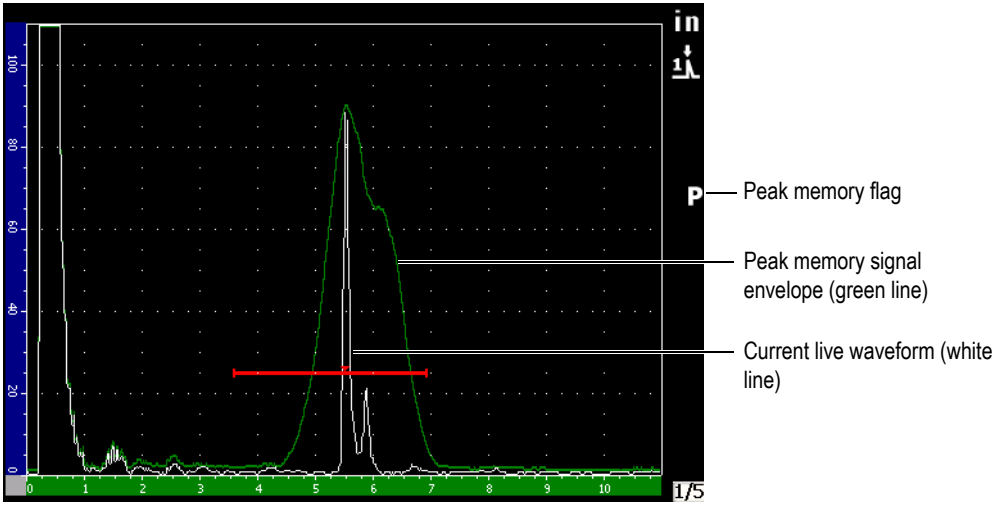


Figure 5-2 Peak memory signal envelope example

This function is useful when it is necessary to find the peak from an indication during an angle beam inspection.

NOTE

The peak memory function cannot be activated in the unrectified **Receiver > Rect = RF** mode.

To activate peak memory function

1. Press **[PEAK MEM]**.

   The **P** symbol appears in the flag area to indicate that the function is active.
2. Scan over a reflector to acquire the echo envelope.
3. Press **[PEAK MEM]** again to turn off the peak memory function.

5.3 Peak Hold

The peak hold function is similar to peak memory as it captures the current screen when the function is accessed. The difference is that with peak hold, the captured waveform is frozen on the screen and does not update even if the live waveform exceeds the frozen waveform's amplitude.

Peak hold is useful when you want to obtain a waveform from a known sample and compare it to a waveform from an unknown test piece. Similarities and/or differences in the waveforms can be noted to help determine the acceptance criteria for the unknown material.

To activate peak hold

1. Obtain an echo on the screen.
2. Press **[2ND F]**, **[PEAK MEM] (PK HOLD)**.

   This captures the screen and still allows viewing of the live waveform. The P symbol appears on the right side of the A-scan display, indicating that the function is active.
3. Press **[2ND F]**, **[PEAK MEM] (PK HOLD)** again to shut off the peak hold function.

5.4 Freeze

The freeze function holds, or freezes, the information on the screen at the moment you press **[FREEZE]**. Once the freeze function is activated, the pulser/receiver of the EPOCH 1000 Series instrument becomes inactive and does not acquire any further data. A F symbol appears on the right side of the screen indicating that the function is active. Press **[FREEZE]** again to restore the normal live display.

The freeze function is useful when storing waveforms, as it holds the current A-scan, allowing the transducer to be removed from the test piece. Once the display is frozen, you can use a variety of instrument functions. These include:

- Gate movement: to position the gate(s) over area(s) of interest to obtain measurement data.
- Gain: to amplify signals of interest or to reduce the amplitude of signals when high-scanning gain values are being used.
- Range and delay: manipulating the time base to focus on area of interest. The total instrument range can not be increased.

- Data logger
- Printing

When freeze function is active, the following parameters cannot be changed/accessed:

- Zero offset
- Range (cannot be increased)
- Pulser/Receiver settings other than gain

5.5 Grid Modes

EPOCH 1000 Series instruments provide multiple grid modes for easy A-scan interpretation, depending on the application.

To adjust the grid modes

1. Select **Display Setup > A-Scan Setup** to open the **A-Scan** setup page.
2. Move the focus to the **X-Axis Grid Mode** parameter (see Figure 5-3 on page 115).

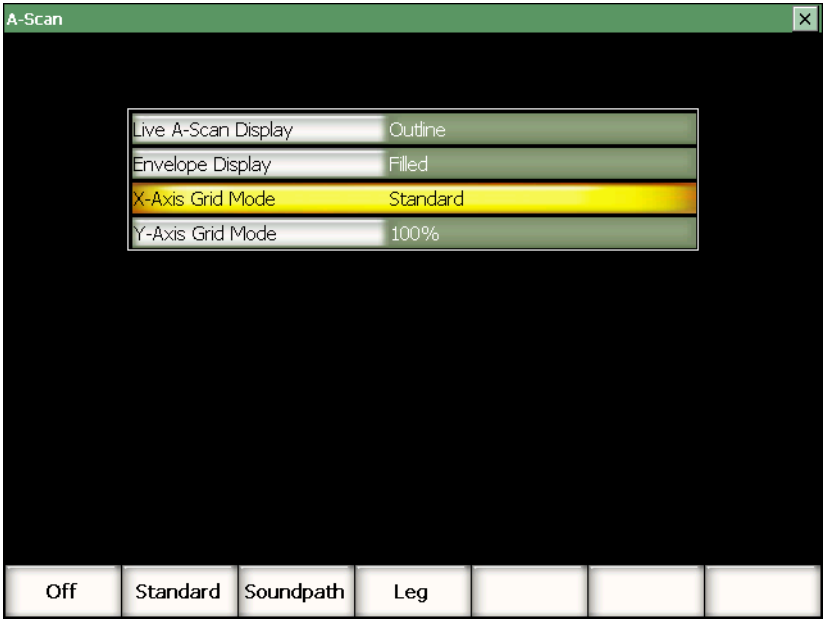
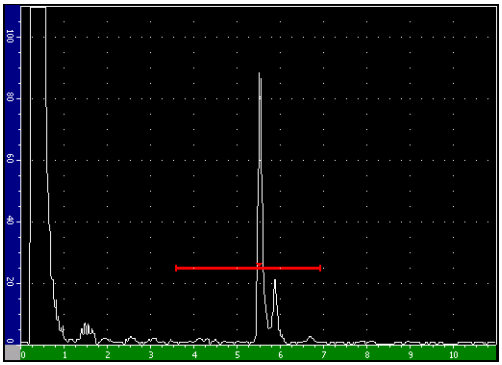
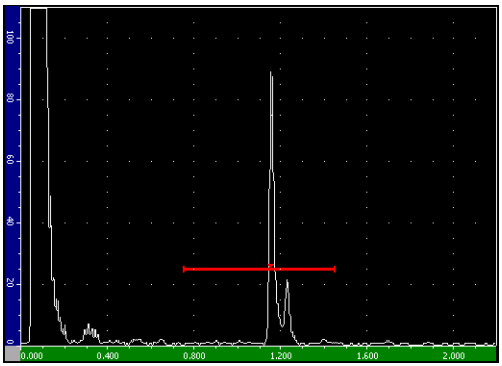


Figure 5-3 Selecting the X-Axis Grid Mode

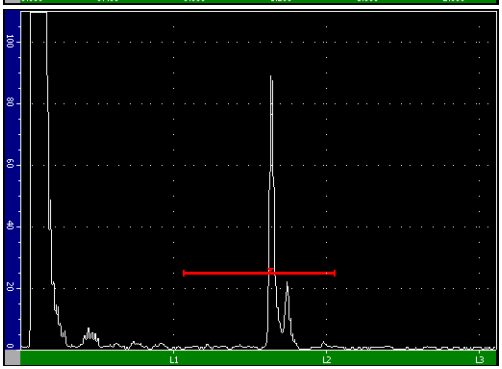
3. Choose the desired **X-Axis Grid Mode** (see Figure 5-4 on page 116).



Standard grid: traditional flaw detector view with 10 divisions equally spaced across the screen range, and the numbers 1 - 10 appearing below each division.



Sound Path grid: displaying actual sound path measurements at equally spaced increments along the horizontal axis. This mode displays 5 divisions, each labeled with its corresponding sound path value (depending on the **Basic > Range**, **Basic > Delay**, and **Meas Setup > Units** settings).

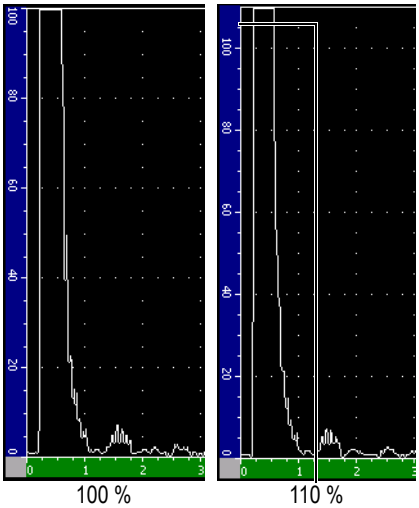


Leg grid: displaying vertical lines representing angle beam inspection legs. This mode displays up to four (4) divisions, labeled **L1** to **L4**, which represent each half-skip distance of a test piece during an angle beam inspection. The spacing and number of divisions displayed depends on the **Basic > Range**, **Basic > Delay**, and **TRIG > Thick** (material thickness) parameters.

Figure 5-4 The X-Axis Grid Modes

4. Move the focus to the **Y-Axis grid Mode** parameter.

5. Choose the desired y-axis grid mode (see Figure 5-5 on page 117).



100% or **110%** grid: maximum amplitude height displayed on the vertical Y-Axis.

Figure 5-5 The y-axis grid modes

5.6 ClearWave Visualization Package

EPOCH 1000 Series instruments provide multiple methods of displaying acquired A-scans to ensure that information displayed always represents the most important and relevant data for the inspection. The ClearWave Visualization Package is a group of functions that allow adjustment between these display methods in the conventional UT mode.

The methods included in the ClearWave Visualization package are:

- Composite A-Scan
- Max Amplitude
- Min Thickness
- Averaged A-Scan
- SureView Visualization Mode
- Persistence Mode
- Baseline Break

5.6.1 Composite A-Scan

Composite A-scan mode is the equivalent of the standard display mode of previous EPOCH flaw detectors. This feature displays all A-scans acquired in between screen update rates (multiple A-scans when PRF > 60 Hz) and overlays them together on the screen. Even at high PRF rates, you will not miss a single indication. This mode can create an enveloping effect with fast scanning.

To select the Composite A-scan mode

- Select **ClearWave > Ascan Mode =** Σ.

5.6.2 Max Amplitude

Max Amplitude mode analyzes all acquired A-scans between display updates and displays only the A-scan with the highest gated amplitude reading. It will not display all acquired A-scans. This function helps reduce signal noise in applications where highest amplitude readings are the key factor for inspection.

To select the Max Amplitude A-scan mode

- Select **ClearWave > Ascan Mode =** 1%↑.

5.6.3 Min Thickness

Min Thickness mode analyzes all acquired A-scans between display updates and displays only the A-scan with the minimum gated thickness reading. It will not display all acquired A-scans. This function helps reduce signal-to-noise ratio for applications where minimum thickness is the key factor for inspection.

To select the Min Thickness A-scan mode

- Select **ClearWave > Ascan Mode =** 1↓.

5.6.4 Averaged A-Scan

Averaged A-scan mode provides you with an average of acquired A-scans. You can select the precision of the averaging by choosing between 2×, 4×, 8×, 16×, 32×, or 64× averaging. This mode helps to remove spurious noise signals from the A-scan while maintaining relevant signals. At higher averaging rates, the screen update rate may be less than 60 Hz, depending on the PRF value.

To set the A-scan averaging rate

◆ Select **ClearWave > Average**, and then adjust the averaging rate.

5.6.5 SureView Visualization Mode

SureView emulates the response of an analog CRT display by enhancing the peaks of every indication within the instrument screen range by adding a point of light along the A-scan trace where the peak occurs. This has been an advantage of analog versus digital flaw detectors for years, and is a helpful visualization effect for fine crack detection. SureView allows you to visualize peak indications from reflectors even when the instrument range compresses these indication peaks beyond visual perception.

To turn on SureView

1. Select **ClearWave > SureView = On** (see Figure 5-6 on page 120).
2. Select **ClearWave > Contrast** to adjust the contrast of the light peaks.

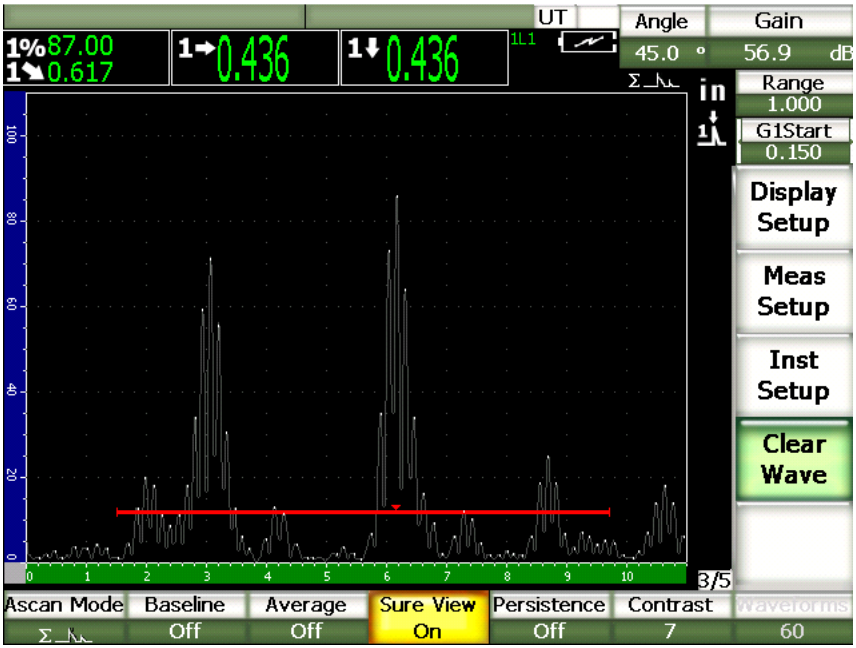


Figure 5-6 The SureView screen

5.6.6 Persistence Mode

Persistence mode holds A-scans on the screen while new A-scans are drawn for a user-selectable time interval to allow small windows of comparison to previous data. This is accomplished by allowing a certain number of waveforms to remain on the screen at any given time.

For example, if you select **Waveforms = 60**, the instrument will draw 60 unique waveforms on the screen before anything is erased. When 61 waveforms have been drawn, the first waveform displayed will be erased and only the live A-scan and the previous 60 waveforms will be displayed.

To activate the Persistence mode

1. Select **ClearWave > Persistence = On** (see Figure 5-7 on page 121).
2. Select **ClearWave > Contrast** to adjust the contrast between the live A-scan and persist A-scan.

3. Select **ClearWave > Waveforms** to adjust the number of waveforms to persist on screen.

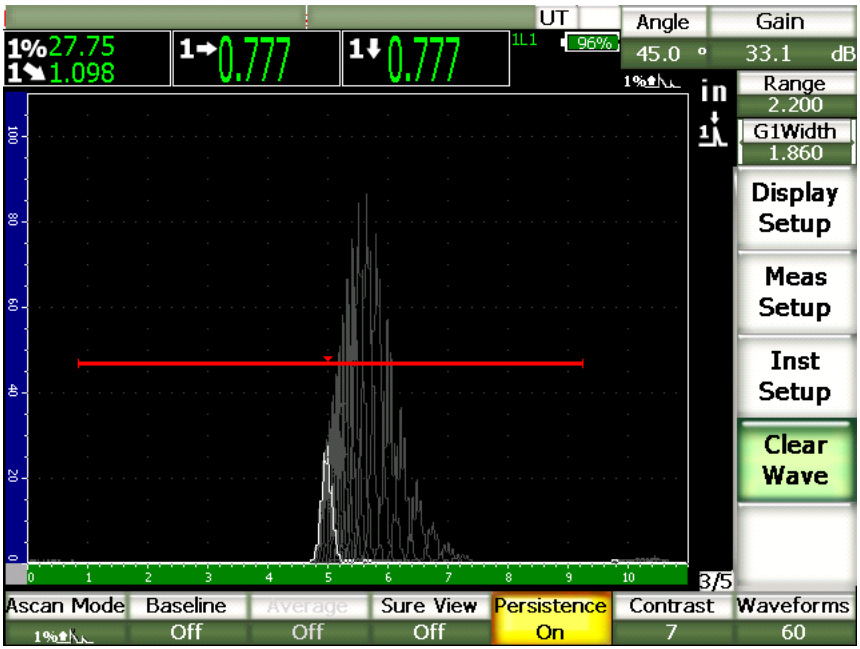


Figure 5-7 The Persistence screen

5.6.7 Baseline Break

This feature modifies the appearance of the A-scan in full-wave rectified mode. When Baseline Break is active, the instrument identifies all “zero-cross” points of each waveform using RF data and displays these “zero-cross” points as lines connecting individual A-scan lobes to the baseline on the display. This feature can help to visually separate far surface defect echoes from the back surface echo.

To turn on the Baseline Break

◆ Select **ClearWave > Baseline = On**.

6. Gates (Conventional UT Mode)

This chapter describes how to use the gates in the conventional ultrasound mode of EPOCH 1000 Series instruments.

6.1 Measurement Gates 1 and 2

EPOCH 1000 Series instruments have two independent flaw gates. In the A-scan, a gate is represented by an horizontal line. The length and horizontal position of the line identifies the sound path range, while the vertical position of the gate line represents a threshold amplitude level for echoes of interest. On the EPOCH 1000 Series display, gate 1 appears as a red line while gate 2 appears as a blue line.

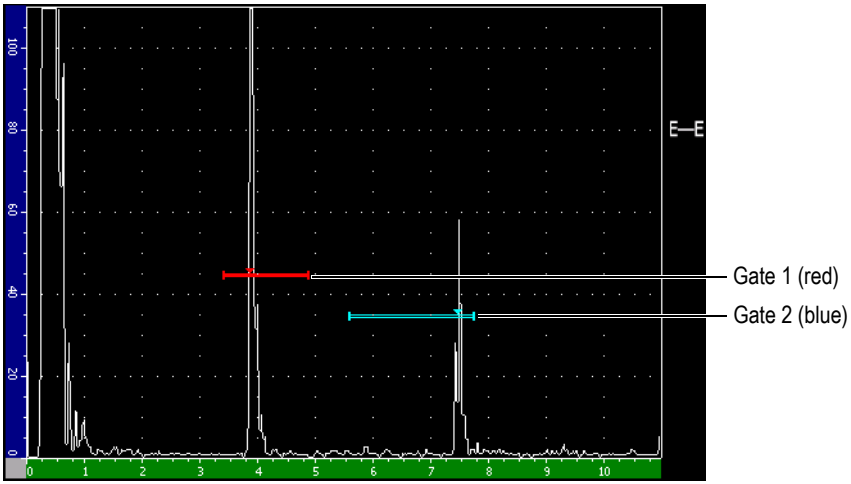


Figure 6-1 Gate 1 and gate 2

Both gates can be used to take thickness measurements with straight-beam transducers or sound path measurements with angle beam transducers, to measure signal amplitude or time-of-flight (in microseconds), or to trigger threshold and minimum-depth alarms. The gates can also be used together to take echo-to-echo thickness measurements (see “Gate Tracking and Echo-to-Echo Measurements” on page 129).

You can control the gates using the parameters in the **Gate 1** and **Gate 2** submenus (see Figure 6-2 on page 124).

Figure 6-2 The Gate 1 submenu

The available gate parameters are:

Zoom

Used to zoom the display on the width of the gate (see “Using the Zoom” on page 132 for details).

Start

Used to adjust the gate start position.

Width

Used to adjust the gate width.

Level

Used to adjust the vertical position of the gate.

Alarm

Used to select a gate alarm condition (see “Gate Alarms” on page 133 for details).

Min Depth

Used to adjust the minimum depth value that triggers a minimum depth alarm.

Status

Used to toggle the state (**On** and **Off**) of the gate.

6.2 Quickly Adjusting Basic Gate Parameters

You can perform basic gate adjustments using the **[GATE]** direct-access key.

To quickly adjust the position of a gate

1. Press the **[GATE]** direct-access key.

   The focus moves to the direct-access gate button on the right side of the main display. The gate button shows the first available gate parameter (see Figure 6-3 on page 125).

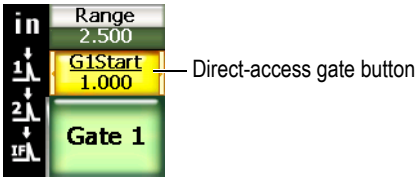


Figure 6-3 The direct-access gate button

2. Edit the value.
3. To select the same parameter for another active gate, press **[GATE]** until the desired gate is selected.

   The gate button successively presents the **G1Start**, **GIFStart**, and **G2Start** parameters.

NOTE

The **[GATE]** key only allows access to gates that are currently active. To activate a gate, select **Gate<*n*> > Status = On**.

4. Use the **[RIGHT]** or **[LEFT]** arrow keys to scroll between the gate start, width, and level of the selected gate.
5. Edit the value of the selected gate parameter.

NOTE

When adjusting a gate using the direct-access **[GATE]** key, the previous selected submenu does not change. This allows you to make fast adjustments to the gate position and immediately return to the parameter of the previous operation.

6.3 Interface Gate (Optional)

EPOCH 1000 Series instruments feature an optional interface gate, providing a third measurement gate. The interface gate positioning is controlled using the same two methods as described in “Measurement Gates 1 and 2” on page 123 and “Quickly Adjusting Basic Gate Parameters” on page 125 for measurement gates 1 and 2.

For further information about special interface gate functions, see “Interface Gate” on page 273.

6.4 Gate Measurement Modes

EPOCH 1000 Series instruments’ gate 1 and gate 2 provide measurements of a gated indication based on one of three possible measurements modes. You can define the measurement mode of each gate in the **Gates** setup page (shown in Figure 6-4 on page 127), which is accessed by selecting **Gate Setup > Setup**.

Figure 6-4 The Gates setup page

The available parameters are:

Gate *n* Measurement Mode

Each gate can make measurements using the following modes:

Edge

Acquires measurement readings based on the position of the first crossing point of a gated signal. The indication must break the threshold of the gate for a measurement to be acquired. Also known as the *flank* mode.

Peak

Acquires measurement readings based on the position of the highest peak within the gated screen range. The indication does not have to break the gate threshold for a measurement to be acquired.

1stPeak

Acquires measurement readings based on the position of the first peak to break the threshold of the gate within the gated region.

When a measurement is being made using one of the measurement gates, a small triangle appears on the gate to indicate from which echo/point the measurement is being acquired (Figure 6-5 on page 128).

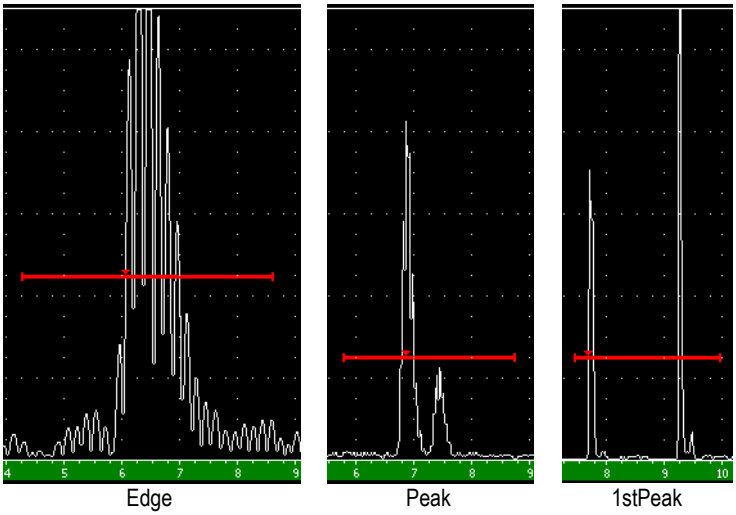


Figure 6-5 Arrow indicating measurement trigger in Edge, Peak, and 1stPeak modes

Gate RF Setup

In unrectified (RF) mode, this selection is used to choose the polarity of the gate. Options include:

Dual Gate

The gate appears in the positive and negative side of the x-axis. Position and width are identical, and the gate level mirrors across the x-axis (example: 25 % and −25 %).

Positive

The gate appears only on the positive side of the x-axis.

Negative

The gate appears only on the negative side of the x-axis.

Gate % Amp Measurement

In **Edge** mode only, this selection allows you to define the method for measuring amplitude of the gated indication. Options include:

Highest Peak

Acquires the amplitude measurement of the indication from the highest peak within the gate.

1stPeak

Acquires the amplitude measurement of the indication from the first peak within the gate. The peak must break the threshold of the gate to be measured.

NOTE

EPOCH 1000 Series instruments do not acquire measurement readings unless the indication of interest is within a gated region of the screen. You should be careful to adjust the **Start**, **Width**, and **Level** of a measurement gate so that only the indication of interest falls within the gated region, per the measurement mode definitions above.

6.5 Viewing Measurement Readings

EPOCH 1000 Series instruments provide six customizable measurement reading boxes to display acquired measurements. These measurement readings must be properly defined to view the desired information from a given indication.

For more information on defining measurement reading boxes and for a full list of possible measurement readings, see “Reading Setup Page” on page 82.

6.6 Gate Tracking and Echo-to-Echo Measurements

The gate tracking feature of EPOCH 1000 Series instruments allows you to make echo-to-echo measurements whenever this feature is required by an application. Echo-to-echo measurements can be made between: Gate 2 — Gate 1, Gate 2 — IF Gate, and Gate 1 — IF Gate.

Gate tracking maintains a constant separation between the position of the indication in the first gate and the start position of the second gate. With this dynamic mobility, the tracking gate is always positioned where you want to measure other indications. When gate tracking is active, the start position value of the tracking gate (the second gate involved in the measurement) defines the separation between the gates, not a fixed start position.

To make echo-to-echo measurements with gate 1 and gate 2

1. Activate both gates by selecting **Gate 1 > Status = On** and **Gate 2 > Status = On**.
2. As shown in the example of Figure 6-6 on page 130, position gate 1 over the first echo to detect, and then position gate 2 over the second echo to detect.

   The **Gate 2 > Start** position defines the separation between the position of the indication in gate 1 and the start of gate 2.

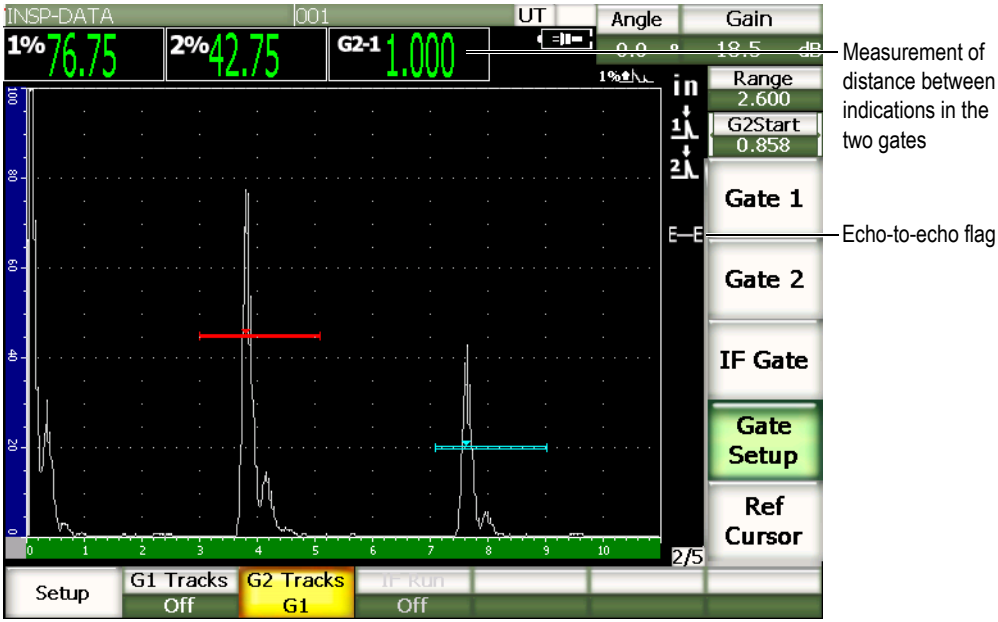


Figure 6-6 Echo-to-echo measurement example

3. Set gate 2 as the tracking gate by selecting **Gate Setup > G2 Tracks = G1**.

The echo-to-echo mode flag appears on the right side of the display, indicating that the instrument is measuring the distance between positions of the indications in gate 1 and gate 2.

4. To see the measurement value, configure one of the measurement reading boxes to display the **G2-1** parameter (see "Reading Setup Page" on page 82 for details).

6.7 Operating in Time-of-Flight Mode

EPOCH 1000 Series instruments are capable of displaying time-of-flight (TOF) sound path data for a gated indication. Time-of-flight is the location of the reflector in terms of microseconds (µs).

The time-of-flight mode does not divide the measurement reading value by two. The entire time-of-flight through the test piece in both directions is displayed.

Remember, when taking thickness measurements, your EPOCH 1000 Series instrument must divide the product of material velocity and time-of-flight by two in order to calculate the thickness of the part. If this were not done, the instrument would display twice the actual thickness because the sound energy passes through the part twice.

NOTE

When the instrument is set up to display distances in time-of-flight mode, the **Basic > Velocity** parameter becomes inactive. This is because the time-of-flight mode does not use the material velocity to calculate sound path measurements.

To operate in time-of-flight mode

◆ Select **Meas Setup > Unit = µs**.

In time-of-flight mode, all distance measurements are displayed in microsecond values instead of inches or millimeters.

6.8 Using the Zoom

EPOCH 1000 Series instruments allow you to quickly zoom the screen range to provide fine resolution of a particular inspection zone. When you activate the zoom, the instrument automatically uses screen delay to bring the point that corresponds to the gate start to the left side of the screen and adjusts the displayed range to match the gate width. The new range equals the unzoomed gate width. The lowest achievable value of the expanded range is equivalent to the minimum range of the instrument at the current material-velocity setting. When the zoom is active, the Z flag appears on the right side of the display.

6.8.1 Activating the Zoom

To activate the zoom for gate 1

1. Select **Gate 1 > Status = On** to activate gate 1.
2. Position gate 1 to the desired position.
3. Select **Gate 1 > Zoom**.

6.8.2 Zoom Applications

Zooming is especially useful for certain flaw detection applications. For example, when detecting branches of cracking such as intergranular stress-corrosion cracking (IGSCC), the inspection can be complicated by the geometry of the test specimen and also by the specific characteristics of the defect itself. In instances where the pipe counter bore is close to the weld root, it is possible to have three signals that all appear quite close to each other (the weld root, the counter bore, and the crack itself). In this situation, you can use the zoom to improve the visual resolution of the instrument's display so that each individual signal can be more easily identified.

When evaluating a crack signal, attention is usually focused on the leading edge of an indication. By observing the number and location of small peaks along the leading edge of the signal, it is possible to make some assumptions regarding the presence and location of different branches of cracking. However, you can use the zoom to get a much more detailed view of an indication and to make better judgments regarding flaw location and depth.

Zooming is useful when inspecting particularly large or thick components and detail is lost due to using long-screen ranges. You can use the zoom to look at small sections of the test piece without disturbing the instrument's original calibration.

6.9 Gate Alarms

EPOCH 1000 Series instruments feature a variety of alarm configurations for each measurement gate. In unrectified (RF) mode, these alarms can be used in positive, negative, or dual gate modes.

By default, when an alarm condition is triggered, EPOCH 1000 Series instruments emit an audible beep. The red indicator (above the display window) that corresponds to the gate with which the alarm has been triggered also illuminates. To toggle the audible alarm on and off, see "General Setup Page" on page 88.

The three primary types of gate alarms are positive threshold, negative threshold, and minimum depth.

6.9.1 Threshold Alarms

Threshold alarms can be set on gate 1, gate 2, and/or on the interface gate.

A positive logic alarm is triggered when a signal breaks the gate threshold. A negative logic alarm is triggered when a signal drops out of the gate threshold.

When you set a threshold alarm, the appearance of the tick marks at the end of the gate changes. For positive logic alarms, the tick marks point upward and for negative logic alarms they point downward (see Figure 6-7 on page 134).

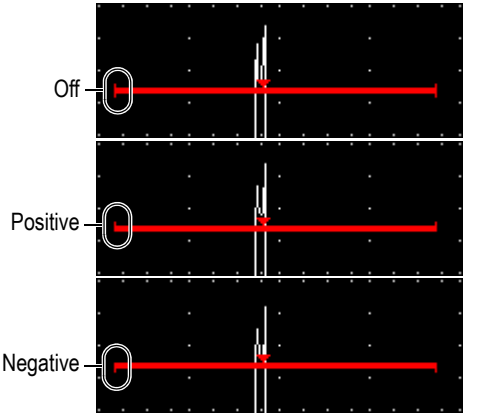


Figure 6-7 Gate tick marks indicating the alarm threshold type

To set a threshold alarm

1. Activate the gate by selecting **Gate<*n*> > Status = On**.
2. Position the gate to cover the desired area.
3. Select **Gate<*n*> > Alarm**, and then choose either the **Positive** or **Negative** threshold alarm condition.

6.9.2 Minimum Depth Alarm

EPOCH 1000 Series instruments are equipped with a minimum depth alarm that is triggered whenever the current thickness measurement reading falls below an user-defined level. The minimum depth alarm can be used either with a single gate or in echo-to-echo measurement mode.

6.9.3 Minimum Depth Alarm with a Single Gate

When the minimum depth alarm is activated, a marker appears on the gate to visually indicate the current setting. Any indication that exceeds the gate threshold to the left of the marker triggers the alarm.

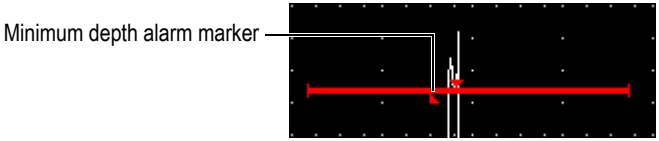


Figure 6-8 The minimum depth alarm marker

To set a minimum depth alarm

1. Activate the gate by selecting **Gate<*n*> > Status = On**.
2. Position the gate to cover the desired area.
3. Select **Gate<*n*> > Alarm = MinDep**.
4. Select **Gate<*n*> > Min Depth**, and then adjust the desired minimum value. The minimum depth alarm value must be greater than the gate start value and less than the gate width value.

6.9.4 Minimum Depth Alarm with Gate Tracking

EPOCH 1000 Series instruments can use the minimum-depth alarm when making echo-to-echo thickness measurements with gate tracking. When gate tracking is active, the tracking gate moves side-to-side, tracking the position of the echo in the non tracking (first) gate. With gate tracking active, the **Min Depth** alarm threshold is relative to the position of the echo in the non tracking gate (first gate).

To set up a minimum depth alarm with gate tracking, follow the steps described in “Minimum Depth Alarm with a Single Gate” on page 134.

7. Reference Cursors

This chapter describes how to use the A-scan reference cursors on EPOCH 1000 Series instruments.

7.1 Cursors A and B

EPOCH 1000 Series instruments provide two visual and measurement reference cursors that can be displayed on the A-scan view. These cursors are controlled with parameters from the **Ref Cursor** submenu.

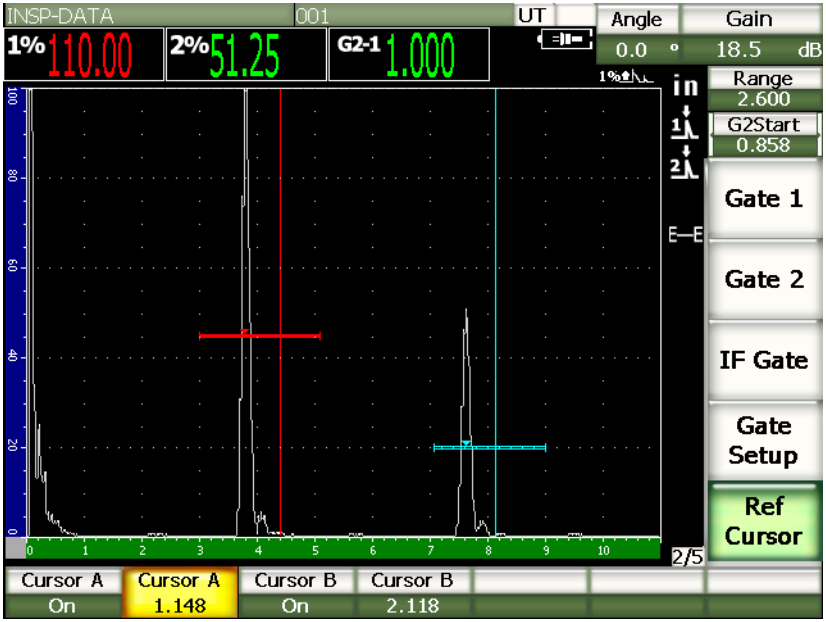


Figure 7-1 A-scan with active reference cursors

Reference cursors allow you to position one or two vertical lines on the A-scan display as a visual marker. These cursors represent a particular point in the screen range of the current inspection and can represent a variety of meaningful benchmarks within the displayed range. Examples include: weld crown position, weld root position, bond line/interface of two components or materials, known geometric or other inclusion(s) that may produce a reflection, etc.

7.2 Activating and Positioning Cursors

The reference cursors cannot be positioned beyond the visible screen range. Also, Cursor B can only be positioned over, or on, the right of Cursor A.

To activate both cursors

1. Select **Ref Cursor > Cursor A = On**.
   Cursor A (red line) appears on the screen.

2. To move cursor A along the screen range, select **Ref Cursor > Cursor A**, and then adjust the position.
3. Select **Ref Cursor > Cursor B = On**.

   Cursor B (blue line) appears on top or on the right of cursor A on the screen.
4. To move cursor B along the screen range, select **Ref Cursor > Cursor B**, and then adjust the position.

7.3 Cursor Measurements

The EPOCH 1000 Series reference cursors can also be used to display reference measurement readings. These measurements are comparative and can be made between cursors A and B, or between one cursor and a gate. Gate tracking is not available with cursors.

You can select the measuring reading to appear at the top of the main display screen using the **Meas** setup page accessible by selecting **Meas Setup > Reading Setup** (see "Reading Setup Page" on page 82 for details). You can select the following cursor measurements (refer to Table 21 on page 83 for details):

- **Cursor A - Gate 1**
- **Cursor B - Gate 1**
- **Cursor B - Cursor A**
- **Cursor A - Gate 2**
- **Cursor B - Gate 2**
- **Cursor A - IF Gate**
- **Cursor B - IF Gate**
- **CursorX2 - CursorX1**
- **CursorY2 - CursorY1**
- **CursorX1, CursorY1 Intersect Depth**

NOTE

If the gated indication used in a cursor-to-gate comparative measurement precedes the position of the cursor, the EPOCH 1000 Series instrument displays a negative value.

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8. Input and Output Features

This chapter describes the input and output features of the EPOCH 1000 Series.

8.1 VGA Output

EPOCH 1000 Series instruments come standard with VGA output capability. This function uses pins on the output port located in the computer connection compartment on the right side of the instrument. This port is a combination VGA/RS-232 port. Using the VGA output, you are able to display the full contents of the EPOCH 1000 Series instrument's screen on any device that accepts VGA input.

To use the VGA output

1. Turn off the EPOCH 1000 Series instrument and the VGA device.
2. Connect the EPXT-C-VGA-6 cable (U8779019) [optional item] to the VGA/RS-232 output connector of the EPOCH 1000 Series instrument (see Figure 8-1 on page 142), and then connect the cable to the VGA device.

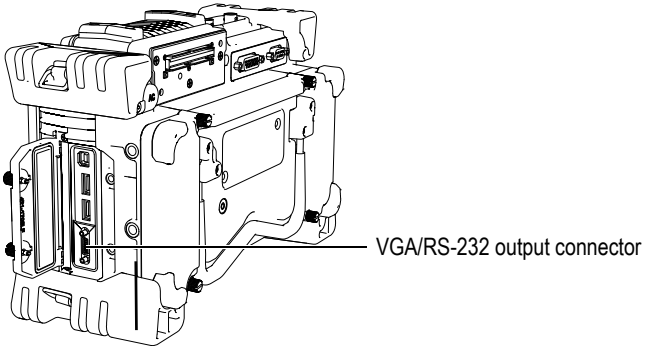


Figure 8-1 The VGA/RS-232 output connector

3. Turn on the EPOCH 1000 Series instrument and the VGA device.
4. Activate the VGA output of the EPOCH 1000 Series instrument by selecting **Display Setup > VGA = On**.

   The content of the instrument screen appears on the display of the VGA device.
5. By default, the VGA output is deactivated when the EPOCH 1000 Series instrument first starts up. To set the VGA output to automatically activate whenever the instrument first starts up:
   a) Select **Display Setup > Color Setup** to open the **Color** setup page.
   b) Move the focus to **VGA at Power-up**, and then set the value to **On**.
   c) Press **[ESCAPE]** to exit the **Color** setup page.

8.2 Analog Outputs

EPOCH 1000 Series instruments feature four programmable analog outputs. These analog outputs allow the EPOCH 1000 Series instruments to continuously output thickness or amplitude information to an external device, such as a strip chart recorder or a computer outfitted with an analog/digital converter card.

The information is output as a scaled voltage, on either a 0–1 V or 0–10 V scale. These voltage signals are output via the 9-pin ANALOG OUT D-sub connector, located on the back of the instrument (see “Input/Output Connectors” on page 34). Refer to Table 38 on page 493 for the ANALOG OUT connector pinout. Each scaled voltage is output at full PRF rate (up to 6 kHz).

The analog output setup parameters are located in the **A-Out** setup page accessible by selecting **Meas Setup > A-Out** (see Figure 8-2 on page 143).

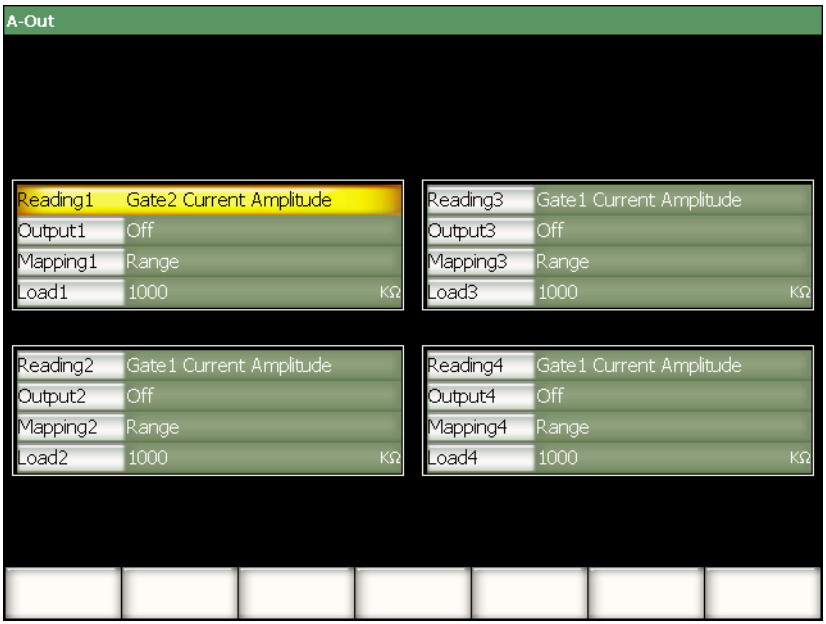


Figure 8-2 The A-Out setup page

There are four main parameters that control each analog output signal:

Reading<*n*>

Used to select the measurement (thickness or amplitude) to output to the ANALOG OUT connector.

Output<*n*>

Used to select the range of voltage output from the instrument (**0-1 V** or **0-10 V**).

Mapping<*n*>

Used to select the scale of the output voltage based either on the full-screen range (**Range**) or on the gate width (**GateWidth)**.

Load<*n*>

Used to select the value for the impedance of the peripheral device measuring the analog output of the EPOCH 1000 Series instrument.

Matching the impedance of the output from the EPOCH 1000 Series instrument with the impedance of the input to the peripheral device, allows the EPOCH 1000 Series instrument to properly offset the analog output to produce predictable output voltages based on screen measurements. For example, a measurement on the instrument of 10 mm on a 100 mm screen range, with an analog output range of 0–10 V, should produce an analog output of 1 V. Without impedance matching, the value can be skewed above or below the expected 1 V output value (0.95 V or 1.02 V, etc).

8.3 Trigger Input and Output

EPOCH 1000 Series instruments feature trigger syncing capabilities that allow the instrument to be used in conjunction with other devices/instruments in a system. This triggering capability governs the timing of each instrument pulse based on the chosen method and, where applicable, external input. The EPOCH 1000 Series trigger input and output signals are accessed via the 26-pin ALARMS D-sub connector on the back of the instrument (see "Input/Output Connectors" on page 34). Refer to Table 37 on page 492 for the ALARMS connector pinout.

The trigger input and output mode is set using the **Meas Setup > Trigger** parameter, which offers three options:

Internal

Standard operational mode internally controlling the pulse timing and frequency. With this selection, the EPOCH 1000 Series instrument is not affected by the external trigger input, but outputs a synchronization pulse that triggers other devices at the same rate and timing as it is sending a pulse to the connected transducer(s).

External

This selection allows an external device to control the pulse timing and frequency of the EPOCH 1000 Series instrument via the EXT TRIG IN pin on the 26-pin ALARMS D-sub connector. When no external input pulse is provided, the instrument does not send any pulse to the connected transducer(s) and appears frozen.

Single

This selection allows the instrument pulse timing and frequency to be manually controlled by you or via computer commands. When in **Single** mode, the instrument does not send a pulse to the connected transducer(s) until **[CHECK]** is pressed (directly or via RS-232 or USB). If **[CHECK]** is not pressed, the instrument appears frozen.

8.4 Serial Communication (RS-232)

EPOCH 1000 Series instruments come standard with a serial communications (RS-232) port. Serial communication uses pins on the combined VGA/RS-232 output connector located in the computer connection compartment on the right side of the instrument. Through serial communication, you are able to connect the EPOCH 1000 Series instrument to a computer for communication with the EPOCH 1000 Series computer interface program, GageView Pro.

Serial communication also allows remote command of EPOCH 1000 Series instruments. Please note that a null modem is required for serial communication via RS-232. For more information, please see “Serial/USB Command Protocol” on page 146.

8.5 USB Communication

EPOCH 1000 Series instruments come standard with four USB ports:

- One USB Client port, located in the computer connection compartment.
- Two USB Host ports, located in the computer connection compartment.
- One USB Host port, located inside the battery compartment.

8.5.1 USB Client

The USB Client port is used for computer communication. USB Client allows a peripheral device to pass commands to the EPOCH 1000 Series instrument, but does not allow the EPOCH 1000 Series instrument to command a peripheral device. The USB Client port is the standard port for communication with the EPOCH 1000 Series computer interface program, GageView Pro.

8.5.2 USB Host

The USB Host ports allow the EPOCH 1000 Series instrument to pass commands to peripheral USB devices. EPOCH 1000 Series instruments have the ability to interact with the following devices using the USB Host ports:

- USB printers using the PCL5 printer control language.
- USB mouse

- USB keyboard
- USB storage device

For more information regarding report printing see “Reports Submenu” on page 223.

8.6 Serial/USB Command Protocol

EPOCH 1000 Series instruments can be remotely controlled via either the serial (RS-232) communications port or the USB Client port. A comprehensive series of remote commands is available to allow you access to all functions of your instrument. Contact Olympus for further information.

9. Calibrating the EPOCH 1000 Series (Conventional UT Mode)

This chapter describes how to calibrate EPOCH 1000 Series instruments while in conventional ultrasound mode. Calibration is the process of adjusting the instrument so that it measures accurately on a particular material, using a particular transducer at a particular temperature.

You must adjust the zero offset and velocity parameters of the EPOCH 1000 Series instrument during calibration. Zero offset (sometimes referred to as probe delay) compensates for the dead time between the firing of the main bang and the entry of the sound into the test piece. The instrument must be programmed with the correct velocity setting so that it matches the material velocity of the test piece.

The EPOCH 1000 Series features an advanced auto-calibration (parameters in the **Auto CAL** submenu), which provides for a fast and easy calibration process. The following section details the procedure to calibrate the EPOCH 1000 Series instruments when using the four basic transducer configurations: straight beam, delay line, dual element, and angle beam.

NOTE

Do not use the auto-calibration when the EPOCH 1000 Series instrument is in the following modes: Microsecond (time-of-flight), DAC, or TVG.

9.1 Getting Started

Until you are completely comfortable operating your EPOCH 1000 Series instrument, we recommend that a basic review and setup procedure be used prior to starting the actual calibration.

To setup the EPOCH 1000 Series conventional UT mode before calibrating

1. Press **[GAIN]** to select an initial gain value that is appropriate for the calibration.

   If the appropriate gain level is unknown, set the initial gain at 20 dB, and adjust it as necessary during calibration.
2. Select **Basic** > **Velocity**, and then enter an approximate velocity for the test material. Refer to Appendix "Sound Velocities" on page 497 for a table with sound velocities for various materials.

NOTE

The **Velocity** parameter is disabled when the instrument is in time-of-flight mode. Select **Meas Setup > Unit = mm** or **in** (inches) to enable the **Velocity** parameter.

---

3. Select **Basic** > **Zero**, and then adjust the zero offset of the instrument to 0.000 µs.
4. Select **Basic** > **Range**, and then set the range based on the sound path range within the selected calibration block.

TIP

Use a wider range than necessary to ensure that all calibration echoes appear on the screen.

---

5. Select **Basic > Delay**, and then set the screen delay to 0.000 in. (0.00 mm).
6. Select **TRIG > Angle**, and then enter the correct refracted angle for the probe (0 for a straight beam or 90° probe, 45 for a 45° probe, etc.).
7. Select **TRIG > Thick**, and then set the material thickness to 0.00 in. (0.00 mm).
8. Select **Receiver > Reject**, and then set the reject level to 0 %.
9. Select **Gate 1 > Status = On** to activate gate 1.
10. Couple the transducer to the block, and then adjust the pulser and filter settings to create a clean A-scan.

For more information on pulser and receiver adjustments, see “Pulser Functions” on page 101 and “Receiver Functions” on page 106.

TIP

Use the auto measurement reading selection feature so that the EPOCH 1000 Series instrument automatically displays relevant thickness/sound path measurements during calibration based on the instrument settings. For more information, see “Reading Setup Page” on page 82.

9.2 Calibration Modes

EPOCH 1000 Series instruments feature multiple calibration modes to accurately meet the requirements of the selected transducer, calibration test block, and application. These calibration modes can be adjusted in the **Auto CAL** submenu. There are two modes for straight beam transducers and two modes for angle beam transducers.

9.2.1 Straight Beam Modes

Straight beam calibrations can be performed by two methods. For the purposes of this calibration discussion, *straight beam* refers to all zero-degree probes, including contact, dual, delay line, immersion, etc. The two methods of straight beam calibration are:

Thickness

This standard straight beam calibration mode requires you to provide two different, known material thicknesses to properly calibrate the instrument. The thin material thickness allows for zero offset calibration, and the thick material thickness allows for velocity calibration.

Echo-to-echo

This calibration mode allows you to use any echo-to-echo measurement to calibrate for material velocity only. In echo-to-echo calibration, the effects that cause zero offset are eliminated by gating a particular indication that represents the start point of the measurement. A second gate is set to track that gated indication to acquire a measurement. The method allows accurate echo-to-echo measurements using only a calibrate material velocity. You can perform echo-to-

echo measurements using the following pairs of gates: **G2 - G1**, **G2 - IF**, or **G1 - IF** (see "Gate Tracking and Echo-to-Echo Measurements" on page 129).

9.2.2 Angle Beam Modes

Angle beam calibrations can be performed by two methods:

Sound path

This standard angle beam calibration mode uses the sound path measurement of two different, known material thicknesses to properly calibrate the instrument. Typically, these sound path measurements are made from the radius of a calibration test block. The thin material thickness allows for zero offset calibration, and the thick material thickness allows for velocity calibration.

Depth

This angle beam calibration mode uses the known depth of two different reflectors to properly calibrate the instrument. Typically, these depth measurements are made from side-drilled holes of equal size. For accurate measurements, you must first verify the refracted angle of the transducer, as the EPOCH 1000 Series instrument calculates depth values based on sound path and known refracted angle. The shallow reflector depth allows for zero offset calibration, and the deep reflector depth allows for velocity calibration.

9.3 Calibrating with a Straight Beam Transducer

The sample straight beam calibration described below is performed using an Olympus transducer, part number, A109S-RM, with a frequency of 5.0 MHz and an element diameter of 0.50 in. (12.7 mm).

The calibration requires a test block with two known thicknesses that is made from the material to be measured. Ideally, the two thicknesses should represent thicknesses that are both below and above the expected thickness of the material being inspected.

For this example, Olympus standard 5-step steel test block (part number, 2214E) is used. The steps measure 0.100 in. (02.60 mm), 0.200 in. (5.08 mm), 0.300 in. (7.62 mm), 0.400 in. (101.6 mm), and 0.500 in. (12.70 mm).

NOTE

If the EPOCH 1000 Series instrument is set to work in metric units, the calibration process is exactly the same, except that the entries are in millimeters rather than inches.

To calibrate using a straight-beam transducer

1. Follow the initial setup procedure outlined in section “Getting Started” on page 148.
2. Using an appropriate cable, connect the transducer to either of the conventional transducer connectors at the top of the instrument.
3. Select **Auto CAL > CAL Mode = Thickness**.
4. Couple the transducer to the thin calibration block step. For this example, the transducer is coupled to the 0.200 in. (5.080 mm) step.

NOTE

Depending on the frequency of the contact transducer being used, it may be impossible to obtain a proper reading on very thin material.

5. Use the **[GATE]** key to position gate 1 so that it surrounds the first back wall echo from the known thickness step.
6. Press **[GAIN]**, and then adjust the gain value so that the echo amplitude is at approximately 80 %.

   A thickness measurement reading appears in large text above the A-scan (see Figure 9-1 on page 152).

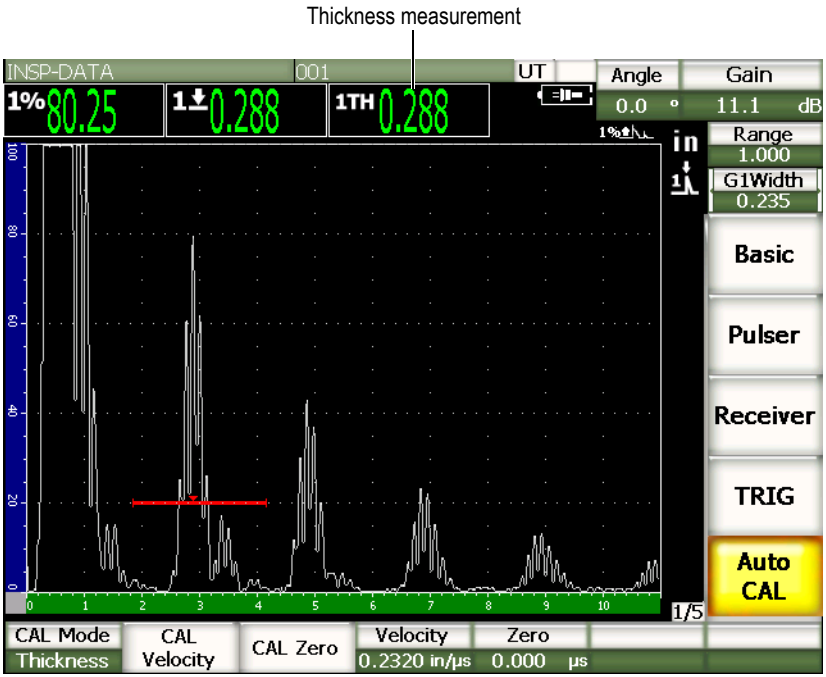


Figure 9-1 Example of a gated calibration signal

7. When a steady reading has been achieved, select **Auto CAL > CAL Zero**.

   The screen freezes and the **Enter Value for Zero Cal** dialog box appears (see Figure 9-2 on page 152).

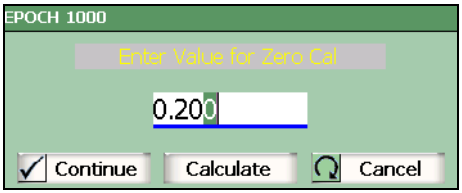


Figure 9-2 The Enter Value for Zero Cal dialog box

8. Adjust the value to match the known thickness of the gated indication (for this example, 0.200 in. [5.080 mm]), and then press **[CHECK]** to continue to the second calibration step (see Figure 9-3 on page 153).

NOTE

If for any reason, you need to exit without acquiring calibration data, press **[ESCAPE]** to exit calibration mode.

Figure 9-3 The second gated calibration signal

9. Couple the transducer to the thick calibration block step.

   In this example, the transducer is coupled to the 0.500 in. (12.700 mm) step.
10. Use the **[GATE]** key to position gate 1 so that it surrounds the first back wall echo from the known thickness step.
11. Press **[GAIN]** to adjust the gain setting so that the echo amplitude is at approximately 80 %.

A thickness measurement reading appears in large text above the A-scan.

12. Once a steady reading is achieved, select **Auto CAL > CAL Velocity**.

    The screen freezes and the **Enter Value for Velocity Cal** dialog box appears.

13. Adjust the value to match the known thickness of the gated indication (for this example, 0.500 in. [12.700 mm]), and then press **[CHECK]** to calculate and complete the calibration process.

TIP

It is possible to use the auto-calibration on a test block with only one known thickness. In this scenario, leave the transducer coupled on the unique thickness, move the gate over to one of the multiple back wall echoes, and then enter the correct sound path thickness (the appropriate multiple of the first back wall echo) during the velocity portion of the calibration.

9.4 Calibrating with a Delay Line Transducer

The sample delay line calibration described below is performed using an Olympus transducer, part number, V202-RM, with a frequency of 10.0 MHz and an element diameter of 0.25 in. (6 mm).

The calibration requires a test block with two known thicknesses that is made from the material to be measured. Ideally, the two thickness measurements are both below and above the expected thickness of the material to be inspected. For this example, we are using Olympus standard 5-step steel-test block, part number, 2214E. The steps measure 0.100 in. (02.60 mm), 0.200 in. (5.08 mm), 0.300 in. (7.62 mm), 0.400 in. (101.6 mm), and 0.500 in. (12.70 mm).

NOTE

If the EPOCH 1000 Series instrument is set to work in metric units, the calibration process is exactly the same, except that the entries are in millimeters rather than inches.

To calibrate using a delay line transducer

1. Follow the initial setup procedure outlined in section “Getting Started” on page 148.
2. Using an appropriate cable, connect the transducer to either of the conventional transducer connectors at the top of the instrument.

   With a zero offset of 0.000 µs, the excitation pulse (or main bang) should appear on the left side of the screen.
3. Select **Basic > Zero**, and then increase the value until the excitation pulse moves off the left side of the screen and the interface echo from the end of the delay line tip appears on the screen.
4. Verify that the echo represents the end of the delay by tapping your finger on the end of the couplant-coated delay line. This dampens the signal and the echo should jump up and down on the screen.
5. Select **Basic > Zero**, and then increase the value to move this echo to the left side of the screen so that it is barely visible.
6. Select **Auto CAL > CAL Mode = Thickness**.
7. Couple the transducer to the thin calibration block step. For this example, the transducer is coupled to the 0.100 in. (2.600 mm) step.
8. Use the **[GATE]** key to position gate 1 so that the first back wall echo from the known thickness step exceeds the gate threshold.

9. Press **[GAIN]**, and then adjust the gain value so that the echo amplitude is at approximately 80 %.

   A thickness measurement reading appears in large text above the A-scan (see Figure 9-4 on page 156).

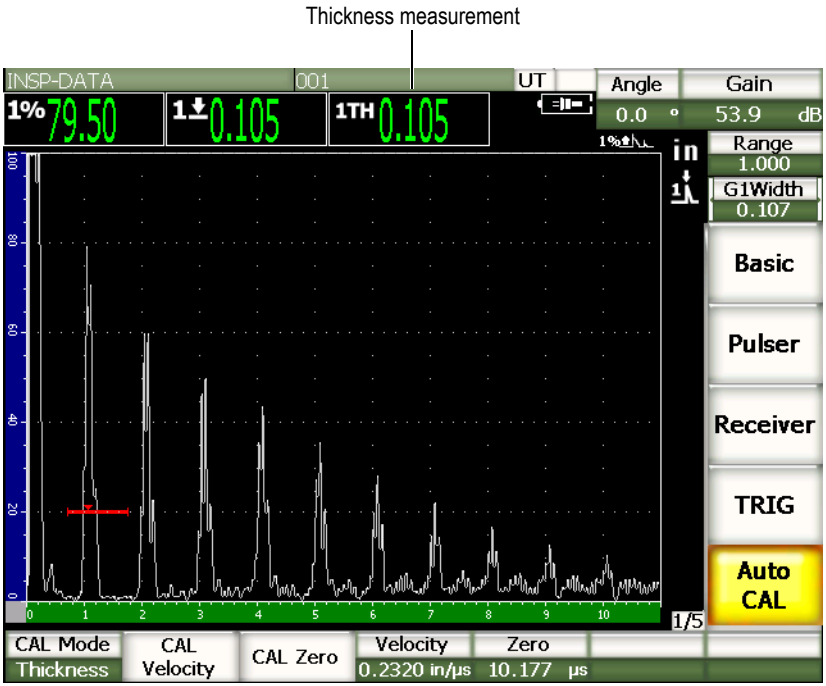


Figure 9-4 Example of a gated calibration signal

NOTE

Ensure that it is the first back wall echo being gated, not a multiple echo from the end of the delay line tip.

10. When a steady reading has been achieved, select **Auto CAL > CAL Zero**.

    The screen freezes and the **Enter Value for Zero Cal** dialog box appears (see Figure 9-2 on page 152).

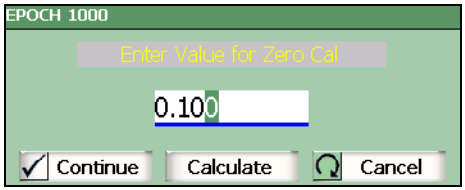


Figure 9-5 The Enter Value for Zero Cal dialog box

11. Adjust the value to match the known thickness of the gated indication (for this example, 0.100 in. [2.600 mm]), and then press **[CHECK]** to continue to the second calibration step (see Figure 9-6 on page 158).

NOTE

If for any reason, you need to exit without acquiring calibration data, press **[ESCAPE]** to exit calibration mode.

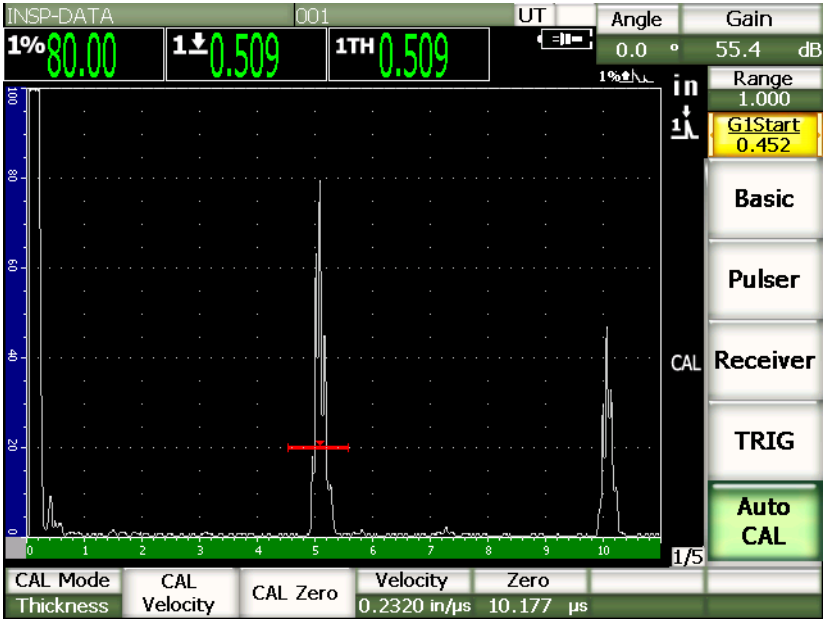


Figure 9-6 The second gated calibration signal

12. Couple the transducer to the thick calibration block step.

    In this example, the transducer is coupled to the 0.500 in. (12.700 mm) step.
13. Use the **[GATE]** key to position gate 1 so that it surrounds the first back wall echo from the known thickness step.
14. Press **[GAIN]**, and then adjust the gain value so that the echo amplitude is at approximately 80 %.

    A thickness measurement reading appears in large text above the A-scan.
15. When a steady reading has been achieved, select **Auto Cal > CAL Velocity**.

    The screen freezes and the **Enter Value for Velocity Cal** dialog box appears.
16. In the dialog box, adjust the value to match the known thickness of the gated indication (for this example, 0.500 in. (12.700 mm)), and then press **[CHECK]** to calculate and complete the calibration process.

NOTE

It is possible to use the auto-calibration on a single test block of known thickness. You can use multiple back wall echoes instead of coupling on both a thin step and a thick step. In this scenario, leave the transducer coupled on the thin step, move the gate over to one of the multiple back wall echoes, and then enter the correct sound path thickness (2, 3, 4, etc., multiples of the first back wall echo) during the velocity portion of the calibration.

9.5 Calibrating with a Dual Element Transducer

The sample dual element calibration described below is performed using an Olympus transducer, part number, DHC711-RM, with a frequency of 5.0 MHz and an element diameter of 0.25 in. (6 mm).

The calibration requires a test block with two known thicknesses that is made from the material to be measured. Ideally, the two thicknesses should represent thicknesses that are both below and above the expected thickness of the material to be inspected. For this example, Olympus standard 5-step steel test block (part number 2214E) is used. It has steps measuring 0.100 in. (02.60 mm), 0.200 in. (5.08 mm), 0.300 in. (7.62 mm), 0.400 in. (101.6 mm), and 0.500 in. (12.70 mm).

NOTE

If the EPOCH 1000 Series instrument is set to work in metric units, the calibration process is exactly the same, except that the entries are in millimeters rather than inches.

NOTE

Because of the acoustic characteristics of dual transducers, nonlinearity in the distance calibration occurs as the thickness of the material decreases. The point of maximum sensitivity is determined by the roof angle of the particular dual transducer. It is recommended that the distance calibration is carried out using a step block that covers the range of interest. Be careful when interpreting thickness measurement

readings made outside the calibrated range. The EPOCH 1000 Series does not have v-path correction; therefore, there might be some nonlinearity within the calibrated range depending on the minimum thickness used in the calibration process.

The zero offset value of dual element transducers can vary significantly at extreme temperatures. If the temperature changes more than a few degrees from the temperature at which the zero offset value was established, recheck its value. If thickness measurements are to be made over a wide temperature range, it is strongly recommended to use Olympus dual transducers that are designed for high-temperature applications and that have built-in delay lines with a stable sound velocity that does not change significantly with temperature. Specific recommendations are Olympus D790-SM and D791 dual element transducers.

To calibrate using a dual element transducer

1. Follow the initial setup procedure outlined in section “Getting Started” on page 148.
2. Using an appropriate cable, connect the transducer to the conventional transducer connectors at the top of the instrument.
3. Select **Pulser > Mode = Dual**.
4. Press **[GAIN]**, and then adjust the value very high so that the leading edges of the back wall echoes appear as nearly vertical lines on the screen.
5. To use the leading edge when making thickness measurements, set the measurement gate(s) to the edge detection mode:
   a) Select **Gate Setup > Setup** to open the **Gates** setup page.
   b) In the **Gates** setup page, highlight **Gate<*n*> Measurement Mode,** and set its value to **Edge**.
   c) Press **[ESCAPE]** to exit the setup page.
6. Select **Auto CAL > CAL Mode = Thickness**.
7. Couple the transducer to the thin calibration block step.

   For this example, the transducer is coupled to the 0.100 in. (2.600 mm) step. As noted above, a higher gain setting is required to produce a clean leading edge of the signal. Do not be concerned with the jagged peaks of the echo. Concentrate on the leading edge only.
8. Use the **[GATE]** key to position gate 1 so that it surrounds the first back wall echo from the known thickness step.

9. Press **[GAIN]** to adjust the gain setting so that the echo amplitude is at approximately 80 %.

   A thickness measurement reading appears in large text above the A-scan.

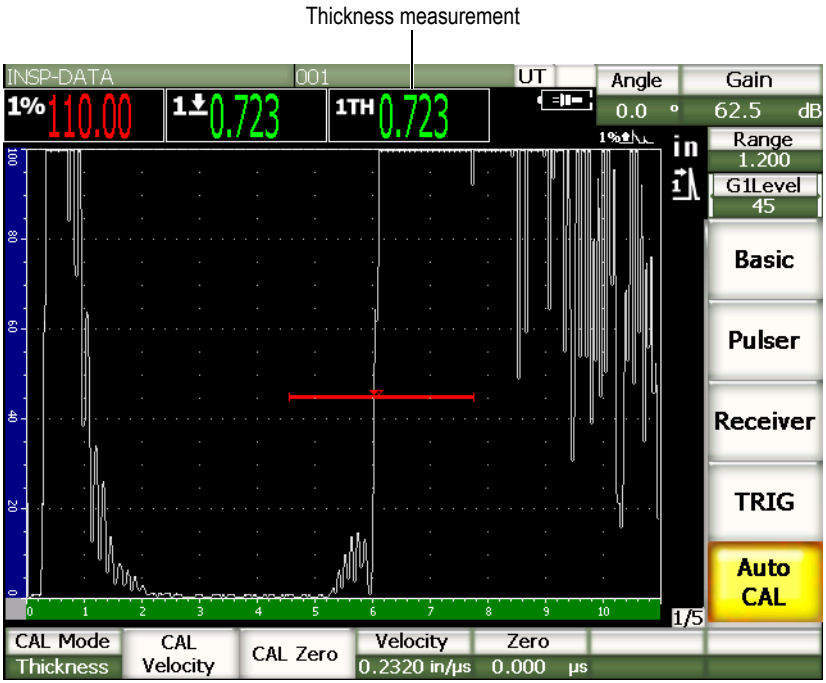


Figure 9-7 Example of a gated calibration signal

10. When a steady reading has been achieved, select **Auto CAL > CAL Zero**.

    The screen freezes and the **Enter Value for Zero Cal** dialog box appears.

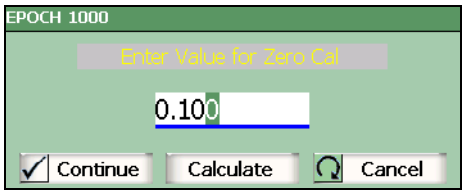


Figure 9-8 The Enter Value for Zero Cal dialog box

11. Adjust the value to match the known thickness of the gated indication (for this example, 0.100 in. [2.600 mm]), and then press **[CHECK]** to continue to the second calibration step.

NOTE

If for any reason, you need to exit without acquiring calibration data, press **[ESCAPE]** to exit calibration mode.

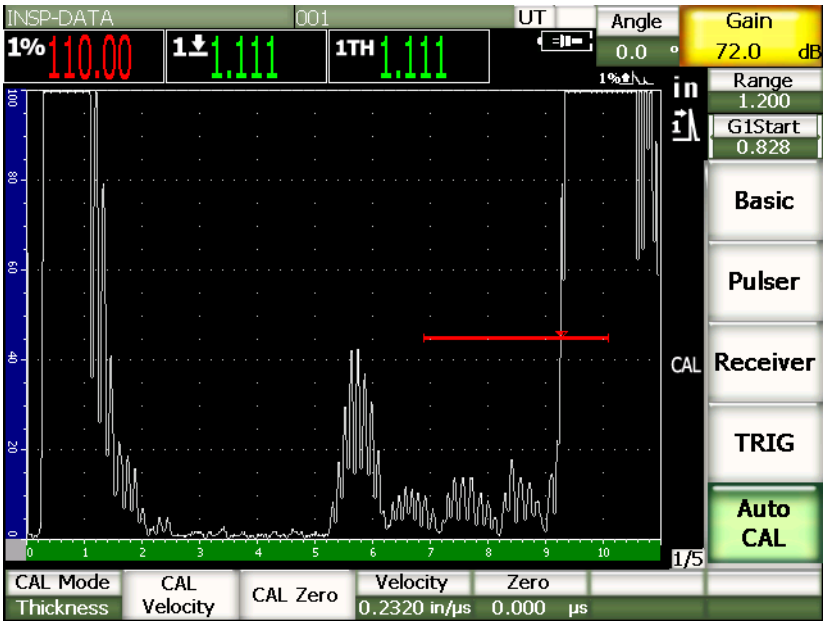


Figure 9-9 The second gated calibration signal

12. Couple the transducer to the thick calibration block step.

    In this example, the transducer is coupled to the 0.500 in. (12.700 mm) step.

13. Use the **[GATE]** key to position gate 1 so that the first back wall echo from the known thickness step exceeds the gate threshold. Adjust the gain so that the echo amplitude is at approximately 80 %.

14. When a steady reading has been achieved, select **Auto CAL > CAL Velocity**.

    The screen freezes and the **Enter Value for Velocity Cal** dialog box appears.
15. Adjust the value to match the known thickness of the gated indication (for this example, 0.500 in. [12.700 mm]), and then press **[CHECK]** to calculate and complete the calibration process.

9.6 Calibrating in Echo-to-Echo Mode

The sample echo-to-echo calibration described below is performed using an Olympus delay line transducer, part number, V202-RM, with a frequency of 10.0 MHz and an element diameter of 0.25 in. (6 mm).

In echo-to-echo mode, the calibration requires a test block with only one known thickness that is made from the material to be measured. Ideally, the thickness measurement is very close to the expected thickness of the material to be inspected. Echo-to-echo mode measures the distance between two actual indications, one representing the measurement start point and one representing the measurement end point. This eliminates the need for zero offset calibration, because the effects that cause a zero offset are accounted for by gating the start-point indication. Therefore, in an echo-to-echo mode calibration, the instrument must only calibrate for material velocity to provide accurate readings.

For this example, we are using Olympus standard 5-step steel-test block, part number 2214E. The steps measure 0.100 in. (02.60 mm), 0.200 in. (5.08 mm), 0.300 in. (7.62 mm), 0.400 in. (101.6 mm), and 0.500 in. (12.70 mm).

NOTE

If the EPOCH 1000 Series instrument is set to work in metric units, the calibration process is exactly the same, except that the entries are in millimeters rather than inches.

To calibrate in echo-to-echo mode using a delay line transducer

1. Follow the initial setup procedure outlined in section “Getting Started” on page 148.
2. Using an appropriate cable, connect the transducer to either of the conventional transducer connectors at the top of the instrument.

With a zero offset of 0.000 µs, the excitation pulse (or main bang) should appear on the left side of the screen.

3. Select **Basic > Zero**, and then increase the value until the excitation pulse moves off the left side of the screen and the interface echo from the end of the delay line tip appears on the screen.
4. Verify that the echo represents the end of the delay by tapping your finger on the end of the couplant-coated delay line.

   This dampens the signal and the echo should jump up and down on the screen.
5. Select **Basic > Zero**, and then increase the value to move this echo to the left side of the screen so that it is barely visible.

   At least two gates must be active to acquire an echo-to-echo measurement. Gate tracking must also be active.
6. Activate gate 1 and gate 2, by selecting **Gate 1 > Status = On** and **Gate 2 > Status = On** to use them as measurement gates.
7. Select **Gate Setup > G2 Tracks = G1** so that gate 2 tracks gate 1.

   For more information on gate tracking activation, see section “Gate Tracking and Echo-to-Echo Measurements” on page 129.
8. Select **Auto CAL > CAL Mode = G2 - G1**.
9. Couple the transducer to the calibration block.

   For this example, the transducer is coupled to the 0.300 in. (7.620 mm) step.
10. Use the **[GATE]** key to position gate 1 so that the first back wall echo from the known thickness step exceeds the gate threshold.
11. Use the **[GATE]** key to position the separation of gate 1 and gate 2 so that the second back wall echo from the known thickness step exceeds the gate 2 threshold.
12. Adjust the gain so that neither signal is saturated and the echo amplitude in gate 2 is above 50 %.

    A thickness measurement reading appears in large text above the A-scan, labeled **G2-G1**.

TIP

In attenuating materials, it may be impossible to bring the second indication above 50 % while avoiding saturation of the first signal. If this is the case, try using the edge detection mode instead of the peak detection to ensure accurate measurements (see “Gate Measurement Modes” on page 126 for details).

NOTE

Ensure that gate 1 and gate 2 are capturing successive back wall echoes, not multiple echoes from the end of the delay line tip.

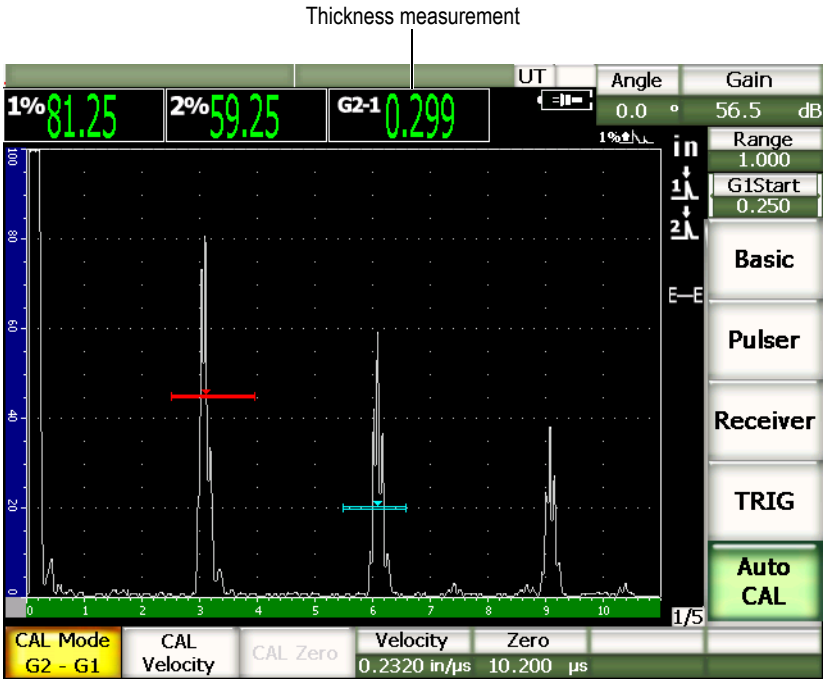


Figure 9-10 Example of a gated calibration signal

13. When a steady reading has been achieved, select **Auto CAL > CAL Velocity**. The screen freezes and the **Enter Value for Velocity Cal** dialog box appears.

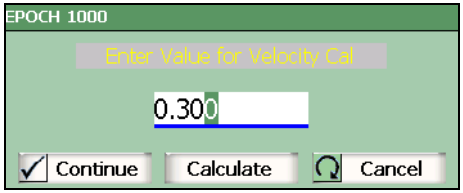


Figure 9-11 The Enter Value for Velocity Cal dialog box

14. Adjust the value to match the known thickness of the gated indication (for this example,0.300 in. [7.620 mm]), and then press **[CHECK]** to calculate and complete the calibration process.

NOTE

If for any reason you need to exit without acquiring calibration data, press **[ESCAPE]** to exit calibration mode.

9.7 Calibrating to Known Sound Path Values with an Angle Beam Transducer

The following sample angle beam calibration procedure is performed using an Olympus transducer, part number, A430S-SB, with a frequency of 2.25 MHz and an element size of 0.625 in. (15.88 mm) × 0.625 in. (15.88 mm). The transducer is mounted on a 45° wedge, part number ABWS-6-45. An Olympus IIW Type I carbon-steel calibration block, part number TB7541-1, is used.

To calibrate using an angle beam transducer

1. Follow the initial setup procedure outlined in section “Getting Started” on page 148.
2. Using an appropriate cable, connect the transducer to either of the conventional transducer connectors at the top of the instrument.
3. Select **TRIG > Angle**, and then enter the correct refracted angle for the transducer/wedge combination (45° for this example).

4. Select **Basic > Velocity**, and then enter the approximate shear-wave velocity of the material being inspected (for this example, 0.1280 in./µs [3251 m/s], if working in metric units, using carbon steel).
5. Select **Basic > Range**, and then enter an appropriate range for the test block being used (for this example, 12.000 in. [304.80 mm], if working in metric units).

9.7.1 Locating the Beam Index Point

The beam index point (BIP) is the point at which the sound leaves the wedge and enters the material with maximum energy. The following procedure provides a method to identify the BIP for your transducer/wedge.

To locate the BIP

1. Couple the probe to the test block at the 0 mark.

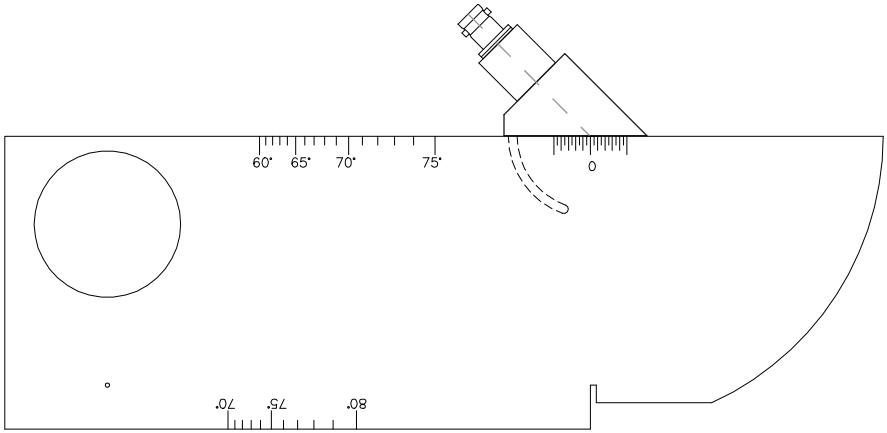


Figure 9-12 IIW block with probe at 0 mark

2. Manipulate the probe until a high-amplitude signal appears on the screen after the excitation pulse.

   This is the reflection from the large arc of the block that is located on the Type I block at 4.00 in. (101.6 mm).
3. Move the probe forward and backward to bring the echo to its maximum amplitude (peak).
4. Ensure the echoes do not exceed 100 %. If necessary, reduce the gain.

TIP

The peak memory is an excellent tool for finding the BIP. Press **[PEAK MEM]** to turn peak memory on. This feature draws and collects the echo envelope of the signal while also drawing the live waveform (see Figure 9-13 on page 168). Match the live waveform with the maximum point corresponding to the previously accumulated echo dynamic curve. Press **[PEAK MEM]** again to turn peak memory off.

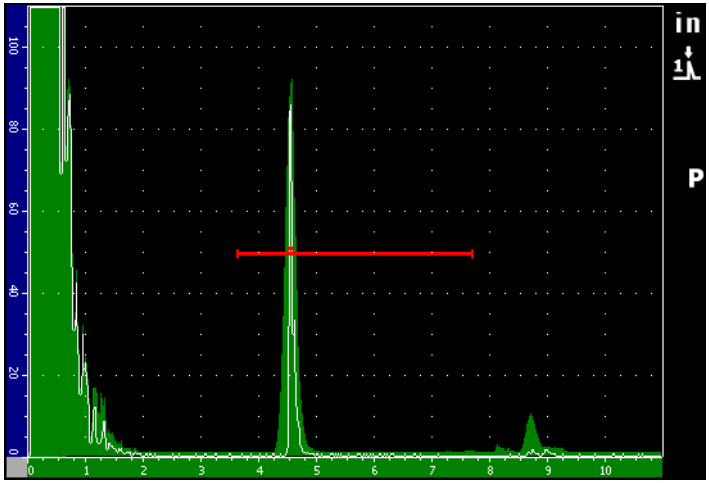


Figure 9-13 Using the peak memory to find the BIP

5. Hold the transducer stationary once the signal is peaked up and mark the side of the wedge directly over the 0 mark on the block.

   This is the BIP, the point at which the sound leaves the wedge and enters the material with maximum energy.

9.7.2 Verifying the Refracted Angle

The expected refracted angle of the probe should already have been entered in the EPOCH 1000 Series instrument in the initial steps of the calibration procedure. Although the wedge may be marked 45° for example, the actual refracted angle could be slightly different due to the properties of the test material or the amount of wear on the wedge. It is necessary to verify the actual angle. This ensures that the EPOCH 1000 Series instrument's sound path calculations are accurate.

To verify the refracted angle

1. Position the probe over the appropriate angle mark on the block (for this example, 45°).

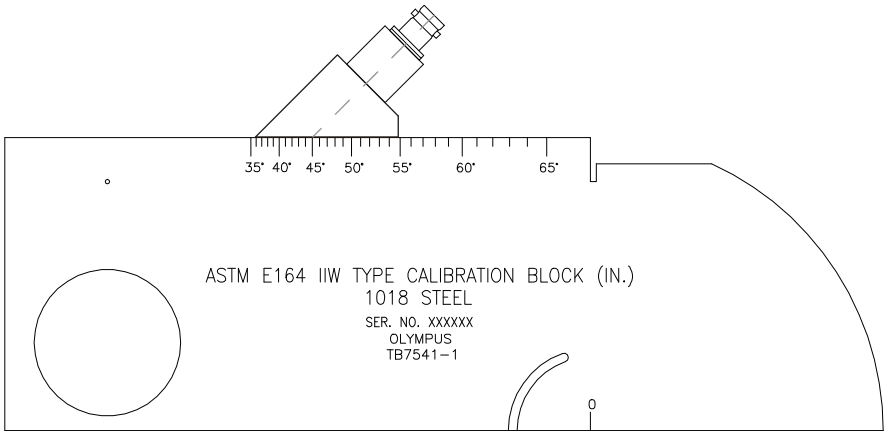


Figure 9-14 The IIW block with probe at the 45° mark

2. Move the probe backward and forward to maximize the amplitude of the echo coming from the large circular hole in the side of the block. The circular hole may be filled with Plexiglas, but the procedure is the same.

TIP

Press **[PEAK MEM]** to help find the peak of the signal.

---

3. Hold the probe stationary when the signal reaches its maximum amplitude, and then note the degree mark on the block that is aligned with the BIP, which was marked on the side of the wedge in the procedure of section "Locating the Beam Index Point" on page 167.

   This is the actual refracted angle (Beta) for this particular transducer and wedge in steel.
4. If this refracted angle value (Beta) differs from the value entered previously, press **[ANGLE]**, and then enter the corrected angle.

9.7.3 Calibrating for Distance

The ASTM E-164 IIW Type I block, which has a crescent cut in the side, produces echoes at 4 in. (101.6 mm) and 9 in. (228 mm) on the screen. These measurements are used for sound path distance calibration. The following procedure uses the Olympus IIW Type I carbon steel calibration block, part number TB7541-1. For information on distance calibration with other standard calibration blocks, see “Common Angle Beam Calibration Block Diagrams” on page 181.

NOTE

If the EPOCH 1000 Series instrument is set to work in metric units, the calibration process is exactly the same, except that the entries are in millimeters rather than inches.

To calibrate for sound path distance

1. Select **Basic > Range**, and then set the value to 12.00 in. (304.8 mm).

   This should ensure that the echoes from the block are visible on screen.
2. Select **Auto CAL > CAL Mode = Soundpath**.
3. Couple the transducer to the calibration block so that the BIP is directly over the 0 mark on the ASTM test block. Do not move the transducer from this point during the distance calibration step.
4. Use the **[GATE]** key to position gate 1 so that it surrounds the first reflection from the arc of the block.

   This reflection should be close to 4 in. (101.6 mm).
5. Press **[GAIN]**, and then adjust the gain setting so that the echo amplitude is at approximately 80 %.

   A soundpath measurement reading is displayed above the A-scan.

Figure 9-15 Example of a gated calibration signal

6. When a steady reading has been achieved, select **Auto CAL > CAL Zero**. The screen freezes and the **Enter Value for Zero Cal** dialog box appears.

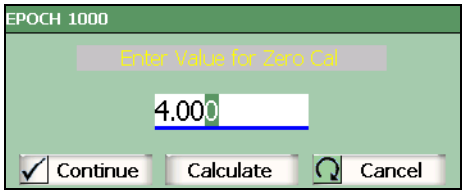


Figure 9-16 The Enter Value for Zero Cal dialog box

7. Adjust the value to match the known thickness of the gated indication (for this example, 4.000 in. [101.6 mm]), and then press **[CHECK]** to continue to the second calibration step.

NOTE

If for any reason you need to exit without acquiring calibration data, press **[ESCAPE]** to exit calibration mode.

8. Use the **[GATE]** key to position gate 1 so that the second echo reflection from the arc of the block is within the gated region. This reflection should be close to 9 in. (225 mm).

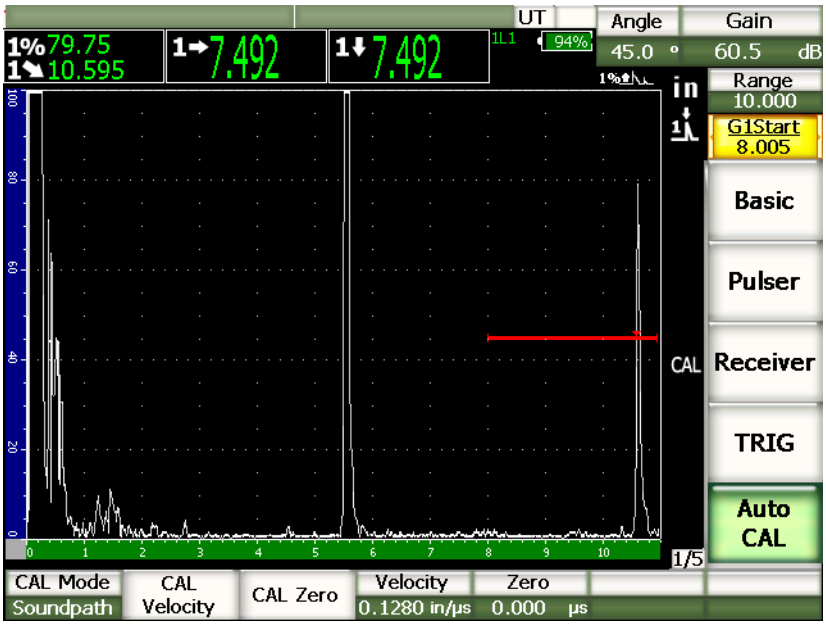


Figure 9-17 The second gated calibration signal

NOTE

Another echo might be present on the screen at approximately the 8 in. (203.2 mm) point. Disregard this echo as it is usually the result of beam spreading and sound bouncing off the side of the block. Ensure that gate 1 is not over this echo.

9. Press **[GAIN]**, and then adjust the gain so that the echo amplitude is at approximately 80 %.

   A thickness measurement reading appears in large text above the A-scan.

10. When a steady reading has been achieved, select **Auto CAL > CAL Velocity**.

    The screen freezes and the **Enter Value for Velocity Cal** dialog box appears.

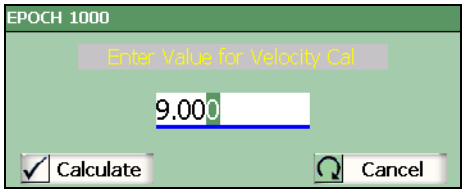


Figure 9-18 The Enter Value for Velocity Cal dialog box

11. Adjust the value to match the known thickness of the gated indication (for this example, 9.000 in. [228.6 mm]), and then press **[CHECK]** to calculate and complete the calibration process.

9.7.4 Calibrating for Sensitivity

The final step in the angle beam calibration is to calibrate for sensitivity. This allows you to set up a reference gain level.

To calibrate for sensitivity

1. Couple the transducer to the IIW calibration block so that the transducer is aiming at the 0.060 in. (1.5 mm) diameter side-drilled hole, used as a reference-reflector.

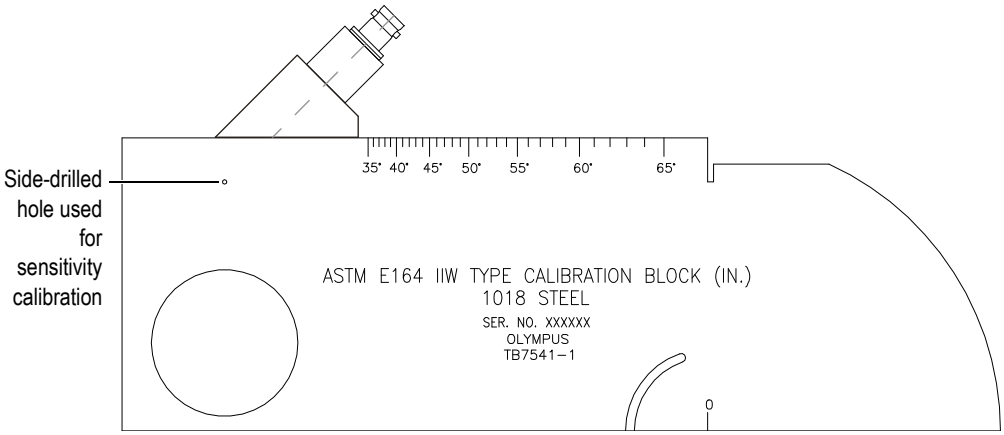


Figure 9-19 The IIW block with probe facing sensitivity hole

2. Move the probe backward and forward to maximize the amplitude of the echo from the hole. Do not confuse the reference-reflector echo from the side of the block.

TIP

Press **[PEAK MEM]** to help find the peak of the signal.

---

3. Once the echo amplitude is maximized, adjust the system sensitivity (gain) to bring the reference-reflector signal to a predetermined reference line on the screen. In this example, the echo is brought to 80 % of full-screen height.
4. Press **[2nd F]**, **[GAIN] (REF dB)** to lock in the reference-gain level and add/subtract scanning gain separately.
5. Use the **Basic > Add, Scan dB**, and **Off** parameters to make scanning gain adjustments once the reference gain (**Ref**) is active. For more information on these functions, see “Setting Reference Gain and Scanning Gain” on page 99.

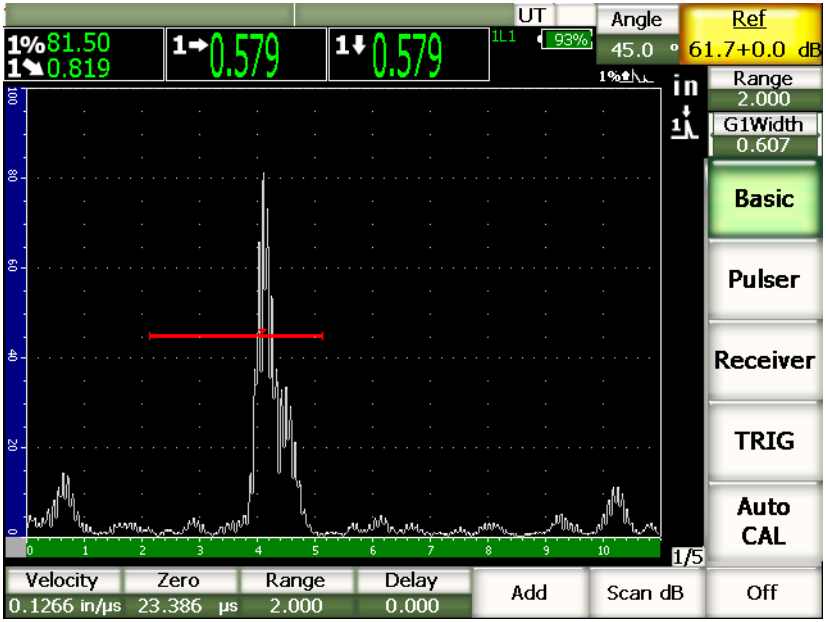


Figure 9-20 The Ref gain with indication

9.8 Calibrating to Known Depth Values with an Angle Beam Transducer

The EPOCH 1000 Series allows you to perform distance calibration with an angle beam transducer based on the known depth of equal sized reflectors (usually side-drilled holes) instead of known sound paths. The following sample angle beam calibration details the procedure for the depth calibration.

As with any angle beam calibration, you must also verify the beam index point (BIP), refracted angle, and perform a sensitivity calibration. It is of particular importance to verify the refracted angle before performing a distance calibration. The acquired depth measurement(s) used in this mode of calibration are based on calculations from the sound path of the reflector (direct measurement) and the value of the manually entered angle parameter. If the angle value is not correct, the distance calibration in depth mode will not be accurate.

The following procedure describes only the depth distance calibration process for the EPOCH 1000 Series. To verify the BIP and the refracted angle, and to calibrate for sensitivity, refer to section "Calibrating to Known Sound Path Values with an Angle Beam Transducer" on page 166. The following sample angle beam calibration is performed using an Olympus transducer, part number, A430S-SB, with a frequency of 2.25 MHz and an element size of 0.625 in. (15.88 mm) × 0.625 in. (15.88 mm). The transducer is mounted on a 45° wedge, part number, ABWS-6-45. An Olympus NAVSHIPS carbon-steel calibration block, part number, TB7567-1, is used.

Calibrating for Distance

The NAVSHIPS block, which has six No. 3 side-drilled holes at various depths (see Figure 9-30 on page 185), produces echoes at various depths on the screen in 0.25 in. (6.35 mm) increments, which are used for distance calibration. This allows you to calibrate for various inspections ranges up to 2.75 in. (69.85 mm). For this sample calibration, the side-drilled holes at depths, 0.5 in. (12.7 mm) and 1.5 in. (38.1 mm) are used.

For information on distance calibration with other standard calibration blocks, see "Common Angle Beam Calibration Block Diagrams" on page 181.

NOTE

If the EPOCH 1000 Series instrument is set to work in metric units, the calibration process is exactly the same, except that the entries are in millimeters rather than inches.

To calibrate for distance

1. Select **Basic > Range**, and then set the value to 4 in. (101.6 mm). This ensures that the echoes from the block are visible on screen.
2. Select **Auto CAL > CAL Mode = Depth**.
3. Couple the transducer to the calibration block and move the probe backward and forward to maximize the reflection from the side-drilled hole at depth 0.5 in. (12.7 mm).

TIP

Press **[PEAK MEM]** to help find the peak of the signal.

4. Use the **[GATE]** key to position gate 1 so that it surrounds the reflection from the first side-drilled hole. This reflection should be close to 0.5 in. (12.7 mm).

Figure 9-21 Example of a gated calibration signal

5. Press **[GAIN]**, and then adjust the gain so that the echo amplitude is at approximately 80 %.

   A thickness measurement reading appears in large text above the A-scan.

6. When a steady reading has been achieved, select **Auto CAL > CAL Zero**.
   The screen freezes and the **Enter Value for Zero Cal** dialog box appears.

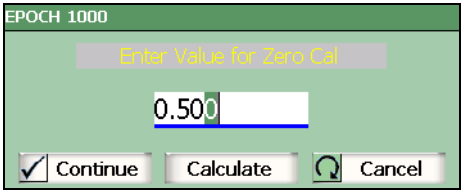


Figure 9-22 The Enter Value for Zero Cal dialog box

7. Adjust the value to match the known thickness of the gated indication (for this example, 0.500 in. [12.7 mm]), and then press **[CHECK]** to continue to the second calibration step.

NOTE

If for any reason you need to exit without acquiring calibration data, press **[ESCAPE]** to exit calibration mode.

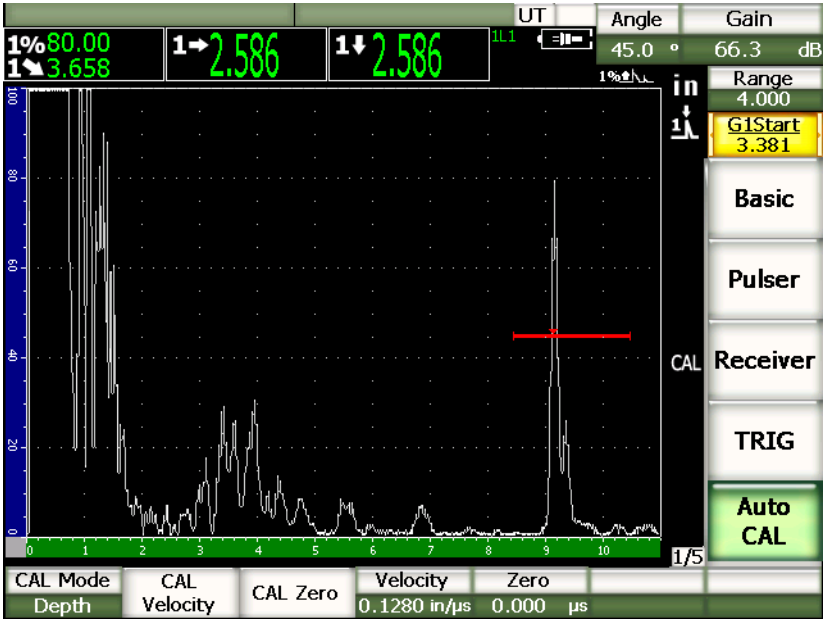


Figure 9-23 The second gated calibration signal

8. Use the **[GATE]** key to position gate 1 so that the reflection from the second side-drilled hole is within the gated region.

   This reflection should be close to 1.5 in. (38.1 mm).

9. Press **[GAIN]** and adjust the gain so that the echo amplitude is at approximately 80 %.

   A thickness measurement reading appears in large text above the A-scan.

10. When a steady reading has been achieved, select **Auto CAL > CAL Velocity**.

    The screen freezes and the **Enter Value for Velocity Cal** dialog box appears.

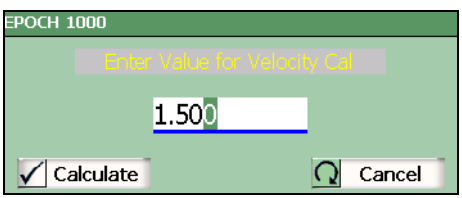


Figure 9-24 The Enter Value for Velocity Cal dialog box

11. Adjust the value to match the known thickness of the gated indication (for this example, 1.500 in. [38.1 mm]), and then press **[CHECK]** to calculate and complete the calibration process.

9.9 Curved Surface Correction

The EPOCH 1000 Series instruments provide surface distance correction when inspecting pipes, cylinders, and other curved surfaces using an angle beam transducer. This applies only to inspections where the surface of the test piece is curved in the direction of the sound path of the transducer. This feature corrects the horizontal distance and depth to reflector measurements based on part thickness and part diameter. The correction is applicable for curved surface inspections where the transducer is placed on the outer diameter of the part, as well as on the inner diameter.

To activate curved surface correction

1. Choose **TRIG > CSC = Outer Dia.** or **Bar** to activate curved surface correction.

NOTE

- **Outer Diameter**: Used for hollow parts. A thickness value must be entered to specify wall thickness.
- **Bar**: Used for solid parts. No thickness value is required.

   The CSC symbol appears in the flag area.
2. Select **TRIG > Diameter**, and then enter the diameter of the inspection piece.
3. Select **TRIG > Thick** to enter the part thickness. If **Bar** is selected, a thickness value is not needed.

NOTE

In cases where the ratio of wall thickness to diameter is large, the sound beam at a given angle may not reflect off the ID, instead, it will continue straight across to the OD without a skip. In such cases, CSC calculations are not valid and the EPOCH 1000 Series instrument will not report dimensional information.

9.10 Common Angle Beam Calibration Block Diagrams

Figure 9-25 on page 181 to Figure 9-31 on page 186 illustrate calibration blocks commonly used with angle beam probes.

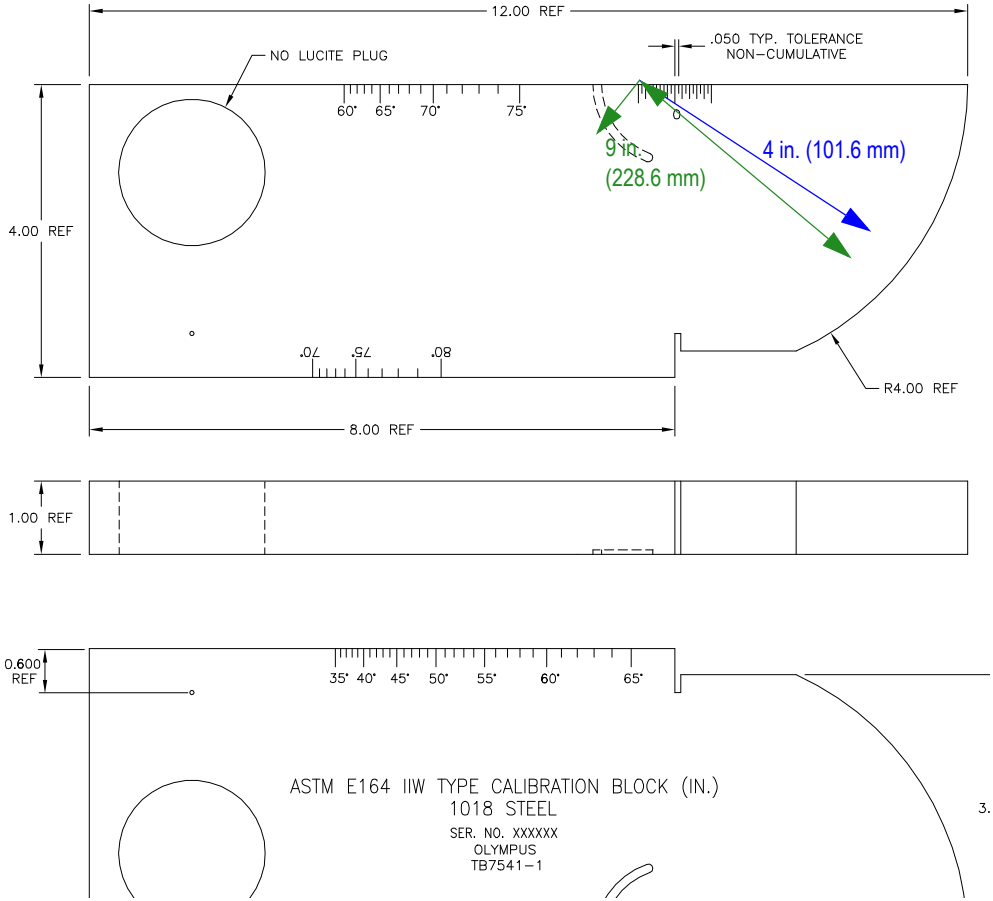


Figure 9-25 The ASTM E164 IIW type calibration block (P/N: TB7541-1)

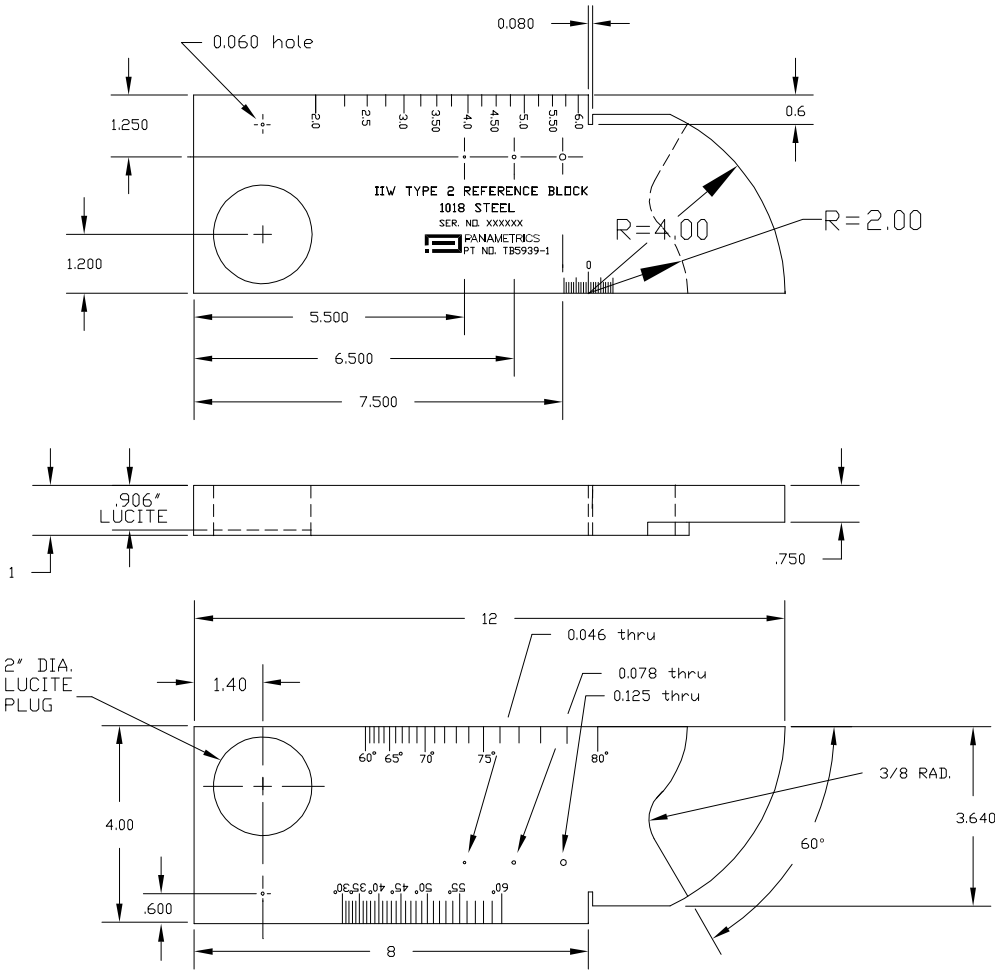


Figure 9-26 The IIW type 2 reference block (P/N: TB5939-1)

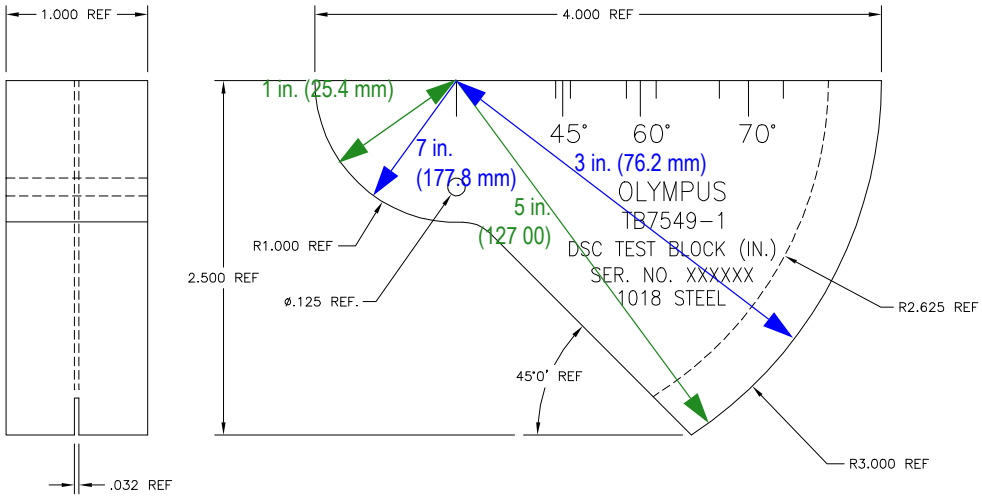


Figure 9-27 The distance and sensitivity calibration (DSC) test block (P/N: TB7549-1)

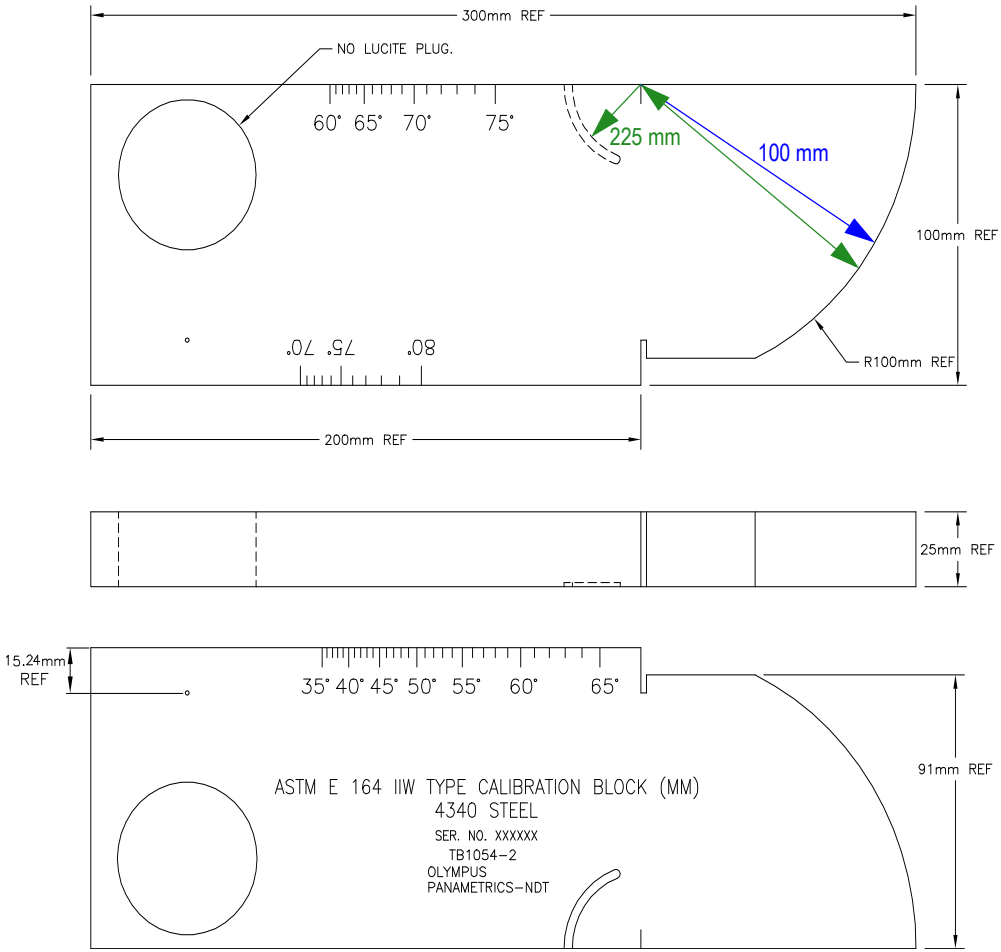


Figure 9-28 The ASTM E164 IIW type metric calibration block (P/N: TB1054-2)

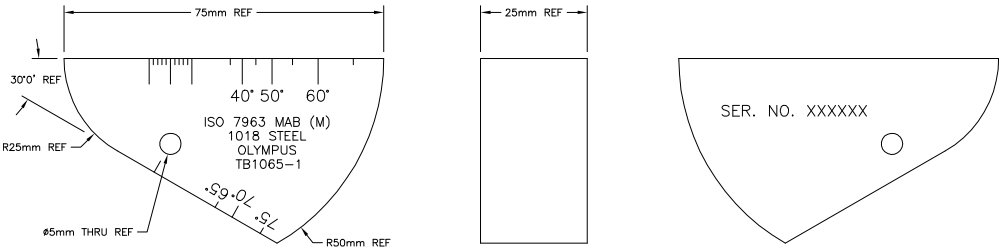


Figure 9-29 The ISO 7963 MAB calibration block (P/N: TB1065-1)

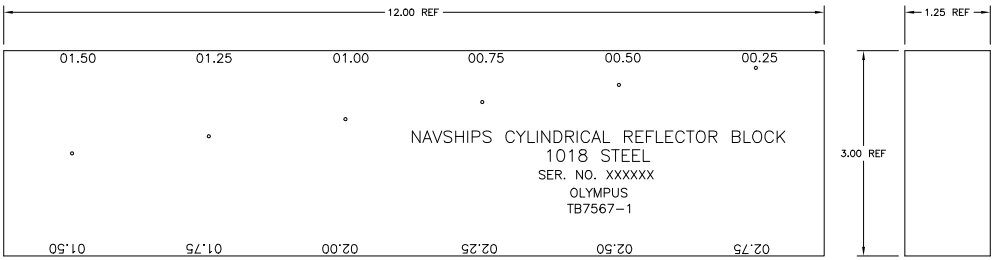


Figure 9-30 The NAVSHIPS cylindrical reflector block (P/N: TB7567-1)

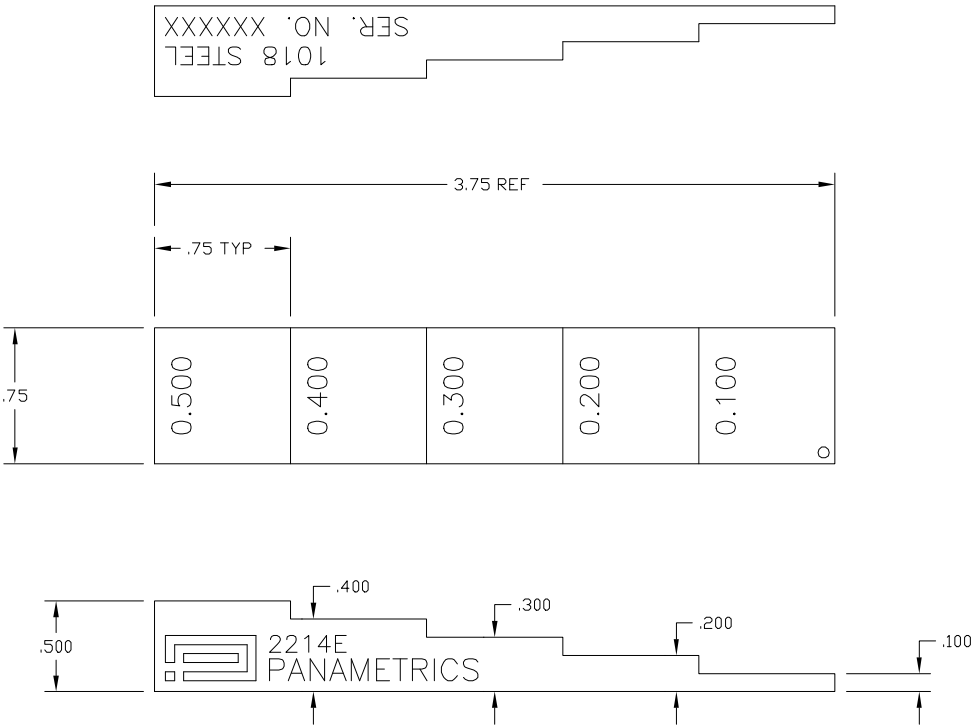


Figure 9-31 The 5-step precision thickness calibration block (P/N: 2214E)

10. Managing the Data Logger

This chapter describes how to manage the EPOCH 1000 Series internal data logger.

10.1 Data Logger Overview

Olympus designed the EPOCH 1000 Series data logger for ease of use. It contains a wide range of file types and features to meet your flaw detection and corrosion thickness gaging requirements. Data logger files and IDs are shared between the UT and PA modes of the instrument (if applicable).

The data logger includes the following features and capabilities:

- Data organized by date created
- Alphanumeric filenames and identifier (ID) codes
- **File Description**, **Inspector ID**, and **Location Note** fields for every file
- File types:
  - Calibration files
  - Incremental files
  - Advanced files
- Ability to edit files and add and delete IDs, rename files, clear file contents, and delete files
- On-screen review of all file contents
- File summary screen for measurement review without images and setup
- Transfer data between the EPOCH 1000 Series and a computer or printer
- Store files, images, and exported data on removable memory
- Generate reports and export to removable media
- Export and import saved files in XML format

10.2 Data Logger Storage Capacity

The EPOCH 1000 Series data logger can store over 10000 IDs with the information listed above. All data is stored for every ID that you choose to save on the instrument's removable 4 GB CompactFlash card (included with purchase).

10.3 Data Logger Menu Functions

The EPOCH 1000 Series data logger is split into two main function sets: **Files** and **Reports**. The **Files** submenu contains the primary data logger functions, while reporting and removable media functions are located in the **Reports** submenu. The available parameters in the **Files** and **Reports** submenus are listed below along with their function. Many of the parameters in the data logger open a menu in addition to their function as adjustable values. Please note that some of the parameters perform more than one function.

10.3.1 Files Submenu

This section presents the **Files** submenu functions.

Open

Used to perform the following functions:

- Select a file as the active storage location
- Review saved data for IDs in a file
- Recall a file ID to bring saved data to the live screen
- View a summary of all saved data in a file
- Flag a specific file or ID for reporting

Create

Used to create a new file.

Reset & Manage

Used to access the instrument database reset, backup, and restore functions.

Export/Import

Used to export or import individual files to removable media in XML format.

Memo

Used to add a memo note to the currently open file and selected ID.

Last ID

Used to jump to the last identifier (ID) in the currently open file.

ID

Indicates which identifier (ID) is currently active for storage. You can also select a specific ID from the currently active file to save to.

10.3.2 Reports Submenu

This section presents the **Reports** submenu functions.

Report

Select to report either full data or summary of file(s).

Image

Enables reporting control of Image/Image and Measurement (I, I-M) files only.

HTML

Enables reporting of Data and Image (D-I) files only.

Report Setup

Enables configuration and viewing of file reports generated onboard the instrument.

Page Setup

Enables configuration of labels, headers, and print functions.

Media

Selects report export destination (USB or CF).

10.4 Data File Types

EPOCH 1000 Series instruments enable you to create many file types based on application requirements. There are two standard file types, calibration and incremental, as well as advanced file types for corrosion-style data logging. The following sections provide information regarding each file type.

10.4.1 Standard File Types

EPOCH 1000 Series instruments contain two standard file types: incremental and calibration. Calibration files are designed for storage of instrument setups (calibrations), and incremental files are designed for on-site data storage during an inspection.

10.4.1.1 Calibration

A calibration (CAL) file is a specific file type designed specifically for storing calibration setups. Calibration files have space to store one single ID with its corresponding waveform and data. Users often create separate calibration files for the different transducers, materials, or test parts being used. The advantage to storing setup data in calibration files is that the data can be quickly recalled to the live screen using the Quick Recall function (see "Quick Recall Function" on page 232 for further information)

10.4.1.2 Incremental

Incremental (INC) files are designed for general inspection data storage, and can contain more than one ID for storing file data. Each time the **[SAVE]** key is pressed, the ID increments using the following incrementing rules (see "Example of automatically generated incremented ID number series"):

- Only the portion of an ID number that consists of digits and letters (no punctuation marks), beginning with the right-most character and extending leftward to the first punctuation mark or to the left-most character (whichever comes first), can increment.
- Digits are cycled 0, 1, 2,..., 9, 0, and so on. The 9 to 0 transition is done only after incrementing the character to the left. Letters are cycled A, B, C,..., Z, A, and so on. The Z to A transition is done only after incrementing the character to the left. In either case, if there is no character to the left or if the character to the left is a punctuation mark, then the ID number cannot increment.
- If an ID number cannot increment, then after a measurement reading is saved, an error beep sounds, and the momentary message "Cannot Increment ID" is shown on the display above the function keys. Subsequent saves overwrite measurement readings if you do not manually change the ID number first.

Example of automatically generated incremented ID number series

1.	Initial	1 2 3 . . .
	Limit	9
2.	Initial	ABC ABD ABE . . . ABZ ACA ACB . . .
	Limit	ZZZ
3.	Initial	ABC*12*34 ABC*12*35 ABC*12*36 . . .
	Limit	ABC*12*99
4.	Initial	0001 0002 0003 . . . 0009 0010 . . .
	Limit	9999

5. Initial 1A
1B
1C
.
.
.
1Z
2A
2B
.
.
.
Limit 9Z

10.4.2 Advanced File Types

EPOCH 1000 Series instruments also feature a full corrosion-style data logger with its advanced file types. These files have specific configurations of IDs, which are designed for use in many corrosion applications.

10.4.2.1 Sequential

A sequential (SEQ) file is defined by a starting and an ending ID number. The resulting file includes the starting and ending points and all points in between (see Table 22 on page 192 and Table 23 on page 193).

Table 22 Example of start ID# = ABC123

```
Start ID# = ABC123
End ID# = ABC135

Resulting file would contain the
    following list of ID numbers:
ABC123
ABC124
ABC125
.
.
.
ABC135
```

Table 23 Example of start ID# = XY-GY

```
Start ID# = XY-GY
End ID# = XY-IB
Resulting file would contain the
    following list of ID numbers:
XY-GY
XY-GZ
XY-HA
.
.
.
XY-IB
```

10.4.2.2 Sequential with Custom Point

A sequential file with custom points (SEQ + CPT) is defined by a starting and ending ID number plus a series of custom points. The resulting file includes the starting and ending points and all points in between. In addition, multiple measurements per ID number location are assigned using the custom points. You can enter up to 20 custom points. The total number of characters of an ID with custom points is 19.

The following example describes measurements along a pipe or tube where at each ID number location you can take a measurement at the top, bottom, left, and right of the pipe (see Table 24 on page 194).

Table 24 Example of starting ID# = XYZ1267

```
Starting ID# = XYZ1267
Ending ID# = XYZ1393

Custom Points = TOP
BOTTOM
LEFT
RIGHT

Resulting file would contain the following
    list of ID numbers:
XYZ1267TOP
XYZ1267BOTTOM
XYZ1267LEFT
XYZ1267RIGHT
XYZ1268TOP
XYZ1268BOTTOM
XYZ1268LEFT
.
.
.
XYZ1393RIGHT
```

10.4.2.3 2-D Matrix Grid

A two dimensional (2-D) file sequence begins with the ID number that refers to the first column and the first row. Then the column (or row) increments one value at a time until the sequence reaches the last column (or row) value while the other dimension stays constant. At this point, the other dimension increases from its first to its next value. This continues until the ID number that refers to the last column and last row is reached.

NOTE

Either the columns or the rows can be selected to increment first (see Figure 10-1 on page 195).

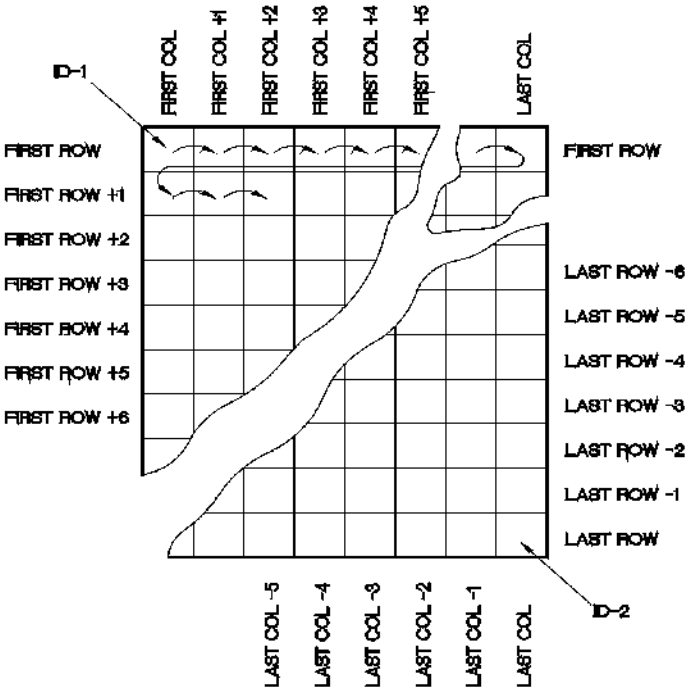


Figure 10-1 2-D matrix grid

How is a grid used? A grid structure may associate one dimension of the grid (for example, the columns) with the physical parts whose wall thickness is to be measured. The particular measurement points on each part are then associated with the other dimension of the grid (for example, the rows) [see Figure 10-2 on page 196].

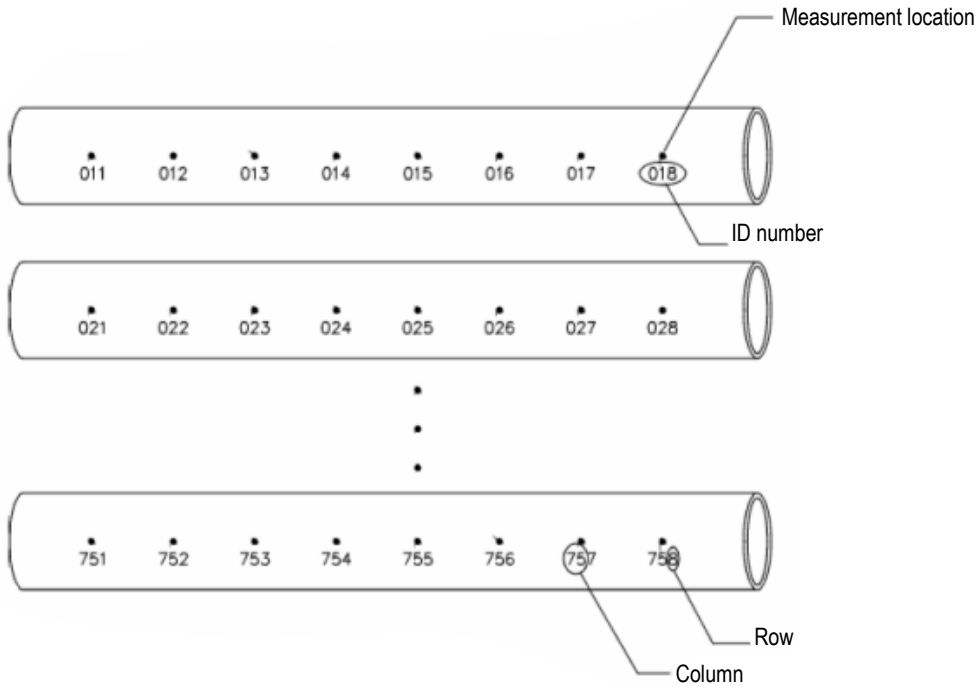
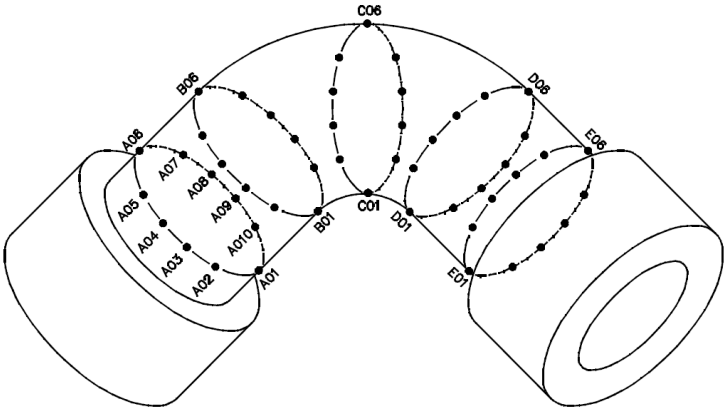
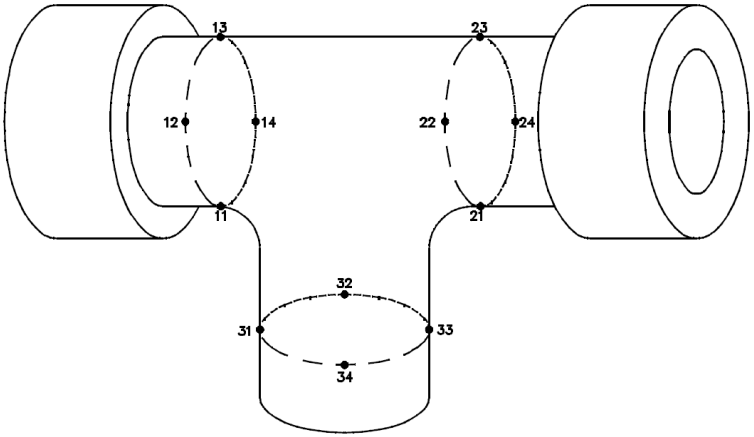


Figure 10-2 One grid for 75 identical parts

Alternatively, the rows and columns of a grid may refer to a 2-D map of measurement points on the surface of one part. In this case, a different grid is made for each part (see Figure 10-3 on page 197).



Name: Elbow
Rows: 01 through 10
Columns: A through E
ID's: Elbow/A0 through Elbow/E10



Name: Tee
Rows: 1 through 4
Columns: 1 through 3
ID's: Tee/11 through Tee/34

Figure 10-3 Different named grid for each part

10.4.2.4 2-D Matrix Grid with Custom Point

A 2-D grid with custom points (2D + CPT) file is the same as a standard 2-D grid file with the addition of custom points. Custom points allow multiple readings per grid ID number to be assigned (see Table 25 on page 198).

Table 25 Example of 2-D matrix grid with custom point

```
Start Column A
End Column J (Start Grid Coordinate = A01)
Start Row 01
End Row 17 (End Grid Coordinate = J17)
Custom Points = LEFT
CENTER
RIGHT
Resulting file would contain the following
    list of ID Numbers:
A01LEFT
A01CENTER
A01RIGHT
A02LEFT
.
.
.
J17RIGHT
```

10.4.2.5 3-D Matrix Grid

A three-dimensional (3-D) grid file sequence begins with the ID number that refers to the first column, the first row, and the first point. Then the point (or column, or row) increments one value at a time until the sequence reaches the last point (or column, or row) value while the other two dimension values stay constant. Then, another dimension increments from its first to its next value. This continues until the ID number that refers to the last column, last row and last point is reached. You can select either columns, rows, or points to increment first and one of the remaining two selections to increment second.

How is a 3-D grid used? A 3-D grid structure may associate two dimensions of the grid (for example, the columns and rows) with the physical coordinates on the part whose wall thickness is to be measured. The particular measurement points on each part are then associated with the third dimension of the grid. This scenario enables multiple readings to be stored at each grid coordinate (see Table 26 on page 199).

Table 26 Example of 3-D grid

```
Start Col = A
End Col = F
Start Row = 1
End Row = 4
Start Point = X
End Point = Z

Resulting file would contain the following
    list of ID numbers:
A1X
A1Y
A1Z
A2X
.
.
.
A4Z
B1X
B1Y
.
.
.
F4Z
```

10.4.2.6 Boiler

A boiler (BOILER) file is a special file type designed specifically for boiler applications. A common method for identifying a thickness measurement location is by a 3-D approach. The first dimension is **Elevation**, which refers to the physical distance from the bottom to the top of the boiler. The second dimension is **Tube Number**, which refers to the number of boiler tubes that need inspection. The third dimension is the **Custom Point**, which refers to the actual thickness reading location at the specified elevation on the specified tube. When these three dimensions are combined, a single ID number is formed to precisely identify the exact location of each thickness reading. For example (see Table 27 on page 200):

Table 27 Example of a BOILER file

```
Elevations = 10ft-, 20ft-, 45ft-. 100ft-
Start Tube = 01
End Tube = 73
Custom Points = L,C, R (left, center, right)

The resulting file would contain the following list of ID numbers:
10ft-01L
10ft-01C
10ft-01R
10ft-02L
.
.
.
10ft-73R
20ft-10L
.
.
.
100ft-73C
100ft-73R

(This example assumes that you have chosen to increment the custom
   points first, tube number second, and elevation third. You can
   choose alternate incrementing methods.)
```

10.4.2.7 2-D EPRI

The 2-D EPRI file type is the same as the standard 2-D grid file type except for a minor change in the way alpha characters increment:

- Standard 2-D grid file: Refers to the standard incrementing columns that start at A and extend past Z. (Example: Start Column: A; End Column: AD; Column Result: A, B, C...X, Y, Z, AA, AB, AC, AD.)
- EPRI 2-D grid file: Refers to custom incrementing columns that start at A and extend past Z. (Example: Start Column: A; End Column: CC; Column Result: A, B, C...Z, AA, BB, CC.)

10.5 Files Submenu

As previously stated, each of the data logger parameters in the **Files** and **Reports** submenus performs specific functions. The following sections will describe the procedures for each of the parameters in the **Files** submenu.

10.5.1 Open Function

The **Open** parameter performs multiple functions for saved files in the data logger. Each of these functions is described in detail in the sections that follow.

Open

Sets highlighted file as active storage location.

Summary

Opens summary table of all digital measurements and IDs from highlighted file.

Rename

Enables renaming of highlighted file.

Clear

Deletes data content of highlighted file (file name remains).

Delete

Deletes entire highlighted file.

Flag for Report

Flags file and contained IDs for reporting.

Sort By

Enables sorting of files by various attributes.

After highlighting a particular ID, the parameter functions change to accommodate review of that ID.

Open

Opens ID as active storage location.

Review

Opens review window of all information for that ID, including waveform, digital measurements, calibration data, etc.

Flag for Report

Flags ID for reporting.

Cancel

Exits the **Open** page.

10.5.1.1 Setting a File as the Active Storage Location

An EPOCH 1000 Series instrument maintains a list of all files that have been created or downloaded to the instrument. To save information to a file, you must first open a specific file to select it as the active storage location.

The **Open** parameter allows you to use calibration files and inspection storage files at the same time within a procedure while minimizing required button presses. For example, a particular inspection may require the use of three separate transducers and therefore three calibrations, but you may wish to store all inspection data in one inspection file. In this situation, open the desired inspection file first.

To open a file and set it to the active storage location

1. Select **Files > Open** to enter the **Open** page (see Figure 10-4 on page 202).

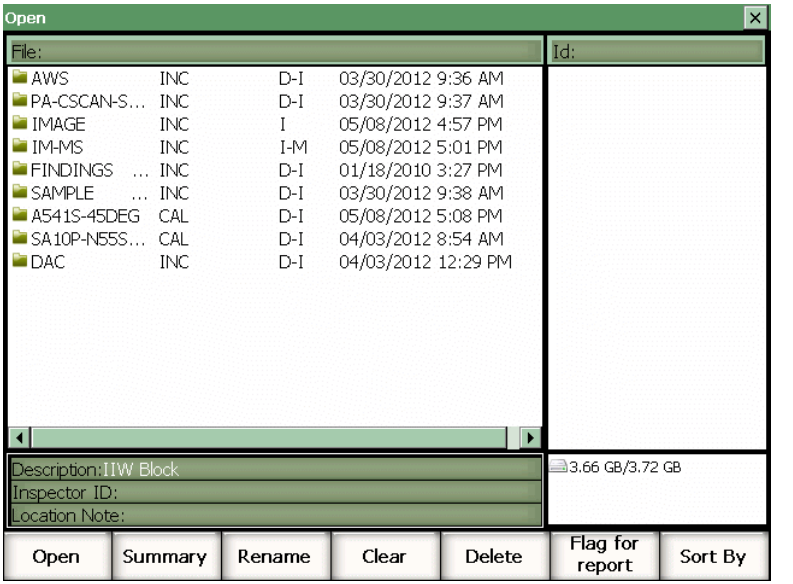


Figure 10-4 The Open page

2. Select the specific file that you want to open.
3. Select **Open** to open the selected file and return to the live screen.

   The first empty ID of the opened file is now displayed on the top-left corner of the display.

10.5.1.2 Reviewing Saved Data for IDs in a File

Once data has been saved into a file, you are able to view contents of the saved data.

To review saved data for IDs in a file

1. Select **Files > Open**, and then choose the specific file that you want to view (see Figure 10-5 on page 203).
2. Press the **[RIGHT]** arrow key, and then choose the desired ID from the list of all available IDs in the file.

   IDs with saved data will display with the Save ( ) icon.

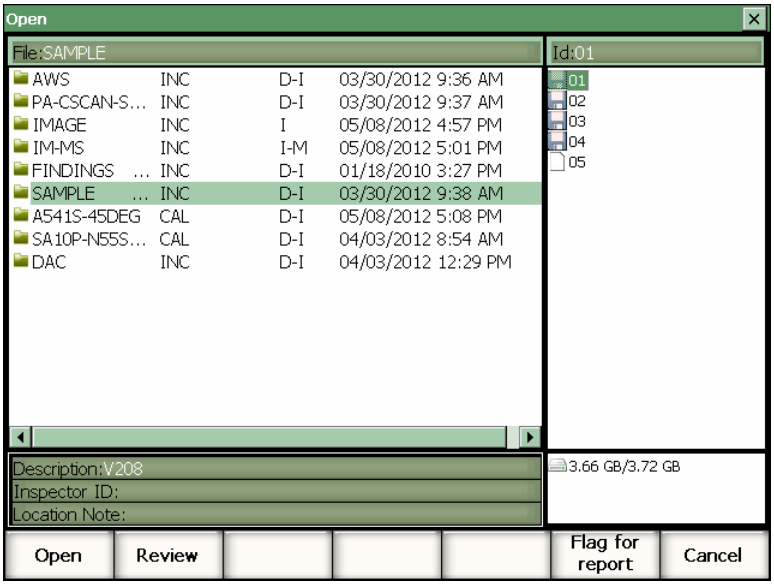


Figure 10-5 Selecting an ID for review

3. Press **Review** to enter the **Review** mode for that selected ID.

The waveform and data that is saved in the selected ID will display on screen. You can use the adjustment knob or the arrow keys to scroll and view the saved data. When in **Review** mode, you have additional parameter options as described below:

Previous

Selects the previous identifier (ID) in the currently open file.

Next

Selects the next ID in the currently open file.

First ID

Jumps to the first ID in the currently open file.

Last ID

Jumps to the last ID in the currently open file.

Recall

Used to recall the contents of the selected ID to the live screen (see "Recalling a File ID to Bring Saved Data to the Live Screen" on page 205).

Clear

Clears the contents of the currently selected ID.

Cancel

Exits the **Review** mode and returns to the **Open** page (see Figure 10-6 on page 205).

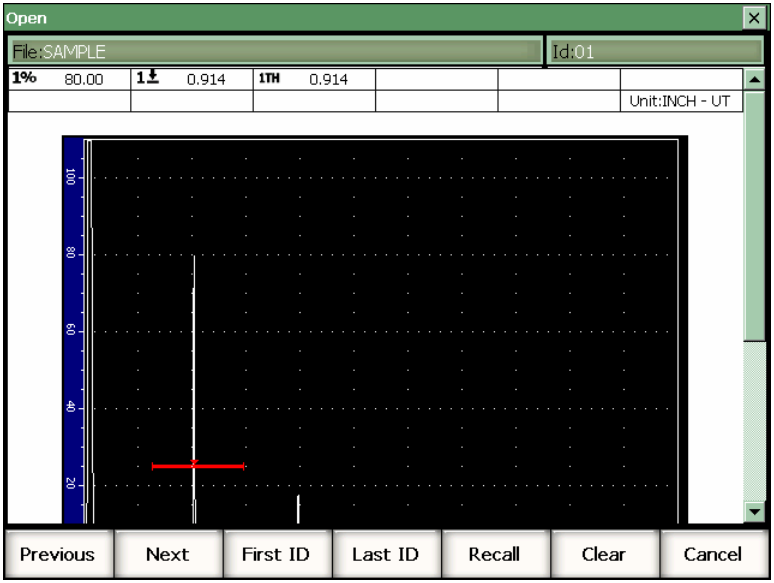


Figure 10-6 The Review mode

10.5.1.3 Recalling a File ID to Bring Saved Data to the Live Screen

To bring saved data to the live screen, you must recall that particular file ID. For incremental (INC) and advanced files, you must choose the specific ID to be recalled. For calibration (CAL) files, recalling the file automatically recalls the parameters in the single ID saved in that file. Calibration (CAL) files can also be recalled using the Quick Recall function (see "Quick Recall Function" on page 232).

To bring saved data to the live screen

1. Select **Files > Open**, and then choose the specific file that you want to view.
2. Press the **[RIGHT]** arrow key, and then choose the desired ID from the list of all available IDs in the file.

   IDs with saved data will display with the Save ( ) icon.
3. Press **Review** to enter the **Review** mode for that selected ID.

4. Press **Recall** to bring the saved data in the selected ID to the live screen.

   When the data has been recalled, you will be returned to the live screen with an "R" flag displaying to the right of the waveform. This indicates that a setup has been recalled
5. To unfreeze the display and proceed with the newly recalled parameters, press **[ESCAPE]**.

NOTE

Recalling data will only recall the saved parameters and will not change the currently active file and ID that display on the screen. Refer to the **Recall** and **Open** commands for information about how to combine these functions.

10.5.1.4 Viewing a Summary of All Saved Data in a File

After you have completed saving data to a file, you may want to simply view a summary of the different measurements saved in the different IDs within the file. (These measurements are selected from **Meas Setup > Reading Setup**.)

To view a measurement summary of all saved data in a file

1. Select **Files > Open**, and then choose the specific file that you want to view.
2. Press **Summary** to view a measurement summary for all the saved IDs in the selected file (see Figure 10-7 on page 207).

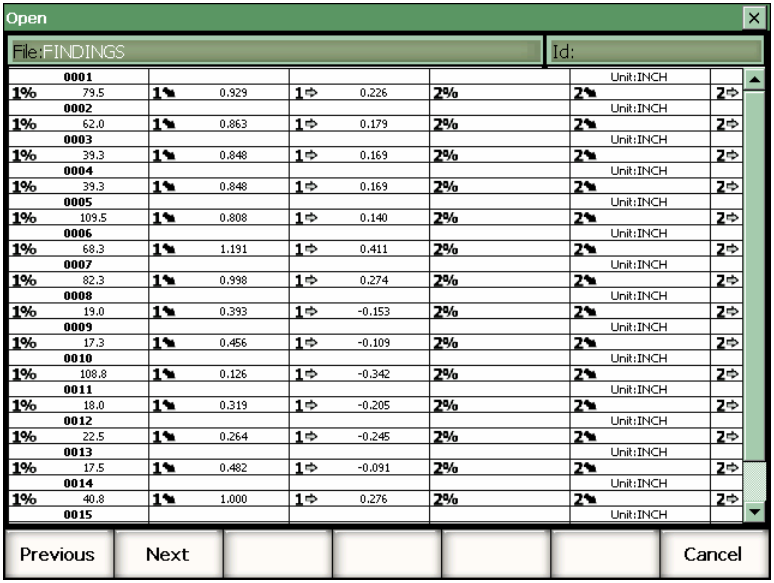


Figure 10-7 File summary

10.5.1.5 Renaming a File

If desired, you can rename a file once you have saved data into it.

To rename a file

1. Select **Files > Open**, and then choose the specific file that you want to rename.
2. Enter the new file name using the virtual keypad (see Figure 10-8 on page 208).
3. Press **[CHECK]** to confirm the new name.

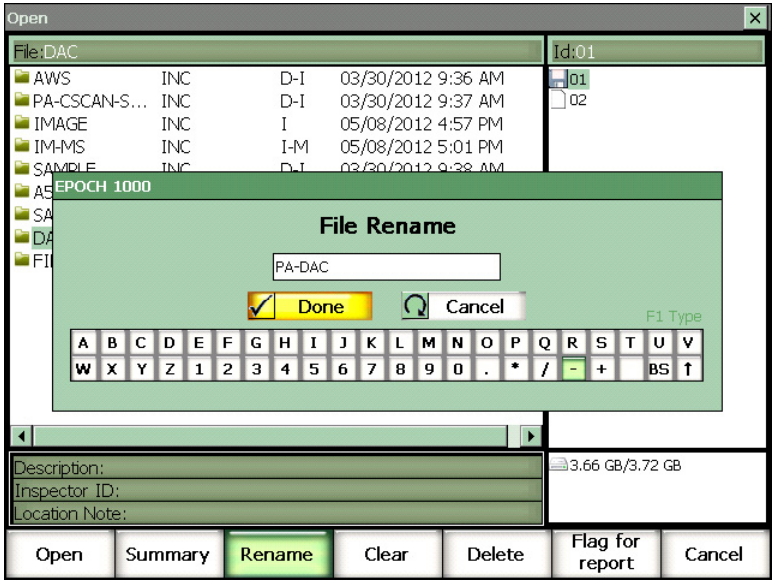


Figure 10-8 Renaming a file

NOTE

A currently active (open) file cannot be renamed.

10.5.1.6 Clearing Data from a File

You can use the Clear function to erase all data from a file. The Clear function will keep the file name and description information stored in the data logger, but will erase all stored IDs and associated data.

To clear data from a file

1. Select **Files > Open**, and then choose the specific file that you want to erase.
2. Press **Clear**, and then select **[CHECK]** to confirm.

10.5.1.7 Deleting a File

You can use the Delete function to erase a file from the data logger. Deleting a file will remove the entire file, including file name as well as stored data.

To delete a file

1. Select **Files > Open**, and then choose the specific file that you want to rename.
2. Press **Delete**, and then select **[CHECK]** to confirm

10.5.1.8 Flagging a File or ID for Report

The EPOCH 1000 Series data logger allows you to flag specific file(s) or ID(s) for later reporting. When a file or ID is flagged, it will be marked with a star icon ( ) in the **Open** page (see Figure 10-9 on page 210). Depending on the capture type, the flagged file(s) or ID(s) will be already checked in the Image or HTML report screens.

To flag a file or ID for report

1. Select **Files > Open**, and then choose the specific file that you want to flag.
2. Press **Flag for Report** to flag the file and all contained IDs for report.
3. Optional: You can also flag only certain IDs in a file by pressing the **[RIGHT]** arrow key, choosing the desired IDs, and then pressing **Flag for Report**.

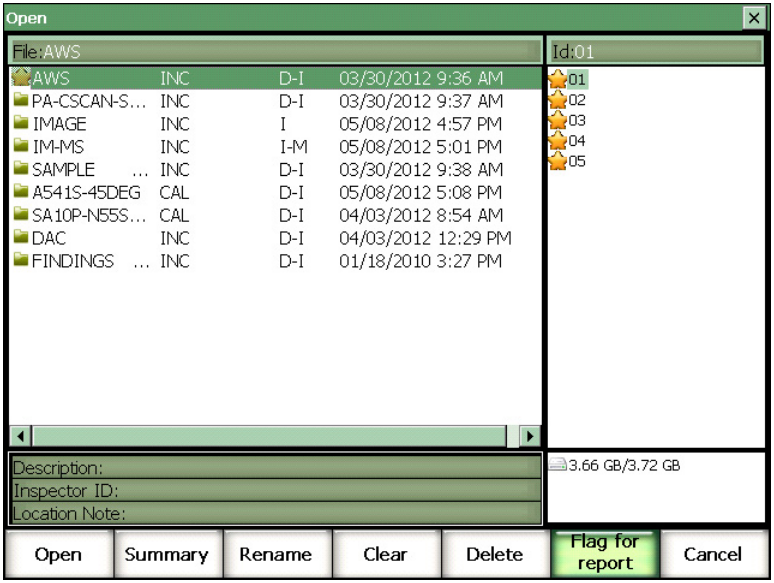


Figure 10-9 Flagging a file for report

10.5.1.9 Sorting Files

You can now choose how stored files are listed in the **Open** menu. This allows for easier navigation through the data logger to find desired files for recalling and reporting. Files stored in the instrument data logger can now be sorted by one of three parameters:

- Name
- Type
- Date Created (default setting)

To sort the data logger files

1. Select **Files > Open**.
2. Press **Sort By** to bring up the sorting options, and then choose the desired sort parameter.
3. Press **[CHECK]** to switch between descending and ascending sort order.
4. Press **[ESCAPE]** when complete.

10.5.2 Create Function

In order to save file data on EPOCH 1000 Series instruments, you must first create a file. These files are intended for storage of calibration data or standard inspection data. Not all items are mandatory to properly set up a file for data storage.

Each time you press the **[SAVE]** key, file data is saved in a file identifier (ID). The number of IDs in a file depends on the file type selected and the number of data sets that you have saved. On the main screen of EPOCH 1000 Series instruments, the currently open file ID is displayed at the top left corner.

10.5.2.1 File Creation

This section explains how to create files onboard the instrument.

To create files onboard the instrument

1. Select **Files > Create** to open the **Create** setup page (see Figure 10-10 on page 212).

NOTE

Required files in the **Create** setup page are marked with an " * ".

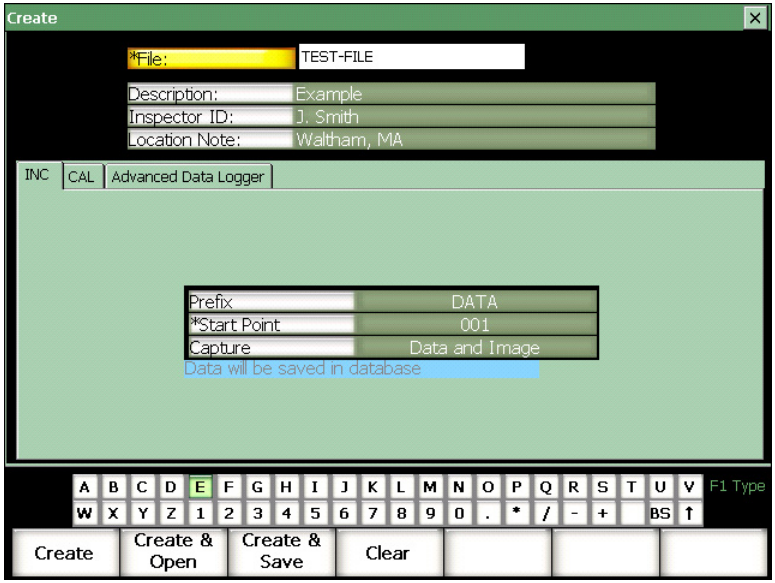


Figure 10-10 The Create setup page

2. In the **Create** setup page, select the file type: **INC**, **CAL**, or **Advanced** (see "Data File Types" on page 189 for additional information on file types).
3. In the **File** box, enter a file name (up to 32 characters long) using the virtual keyboard.

NOTE

Special characters such as spaces, decimals, slashes, and punctuation are not permitted in the **File** box.

---

4. You can also add the following optional information:
   - In the **Description** box, enter a file description.
   - In the **Inspector ID** box, enter identification information for the inspector.
   - In the **Location Note** box, enter information regarding the inspection location.
   - Enter an **ID Prefix**.

   This prefix will save as part of the ID but will not increment.

5. Enter a **Start Point** for the file.

   If a CAL file type has been selected, this field will automatically be set to **Calibration**. (Since the ID in a CAL file does not increment, significant digits are not of concern for the ID.)

6. For INC and Advanced files, select a **Capture Type** for the file.

   This will determine what data is saved for the specific file. There are three capture types to choose from:

   - Data and Image (D-I): all file setup data, calibrations, measurements, and waveforms are saved with each ID.
   - Image Only (I): only the waveform image is saved with each ID.
   - Image and Measurement (I-M): waveform image and displayed on-screen measurements are saved with each ID.

7. When you have completed the file setup, select **Create** to exit the setup page and create the desired file.

   OR

   Select **&Open** to create and open the file in a single step.

   OR

   Select **&Save** to create, open, and save the current settings to the current file in a single step.

NOTE

When a file has been created, you must open the file before trying to save information. This is a separate function from **Create**. See "Setting a File as the Active Storage Location" on page 202 for instructions on how to open a file.

10.5.2.2 Saving Data to Files

EPOCH 1000 Series instruments allow you to save data whenever there is an active file and an ID has been entered. Files are created by selecting **Files > Create**, as described in section "File Creation" on page 211, or using GageView Pro and then transferring them to the instrument. Pressing **[SAVE]** saves the data to the currently active (open) file and ID.

NOTE

If there is no active ID, the instrument displays the error message "No ID Selected" at the top of the display. You must have an active file (survey) and an ID entered before saving data. For more information, see "Setting a File as the Active Storage Location" on page 202.

When you press **[SAVE]**, the EPOCH 1000 Series instrument saves the following information:

- File name
- Identifier (ID) code
- Alarm conditions
- Gate measurement modes
- Sound path leg for each gate
- Up to six measurement reading box values (all active user-selected measurements on the instrument screen)
- A-scan waveform (UT mode)
- S-scan and A-scan waveform as viewed on screen (PA mode only)
- Peak memory envelope or peak hold waveform, if active
- Complete setup parameters
- Flag status (**[FREEZE]**, zoom, **[PEAK MEM]**, etc.)
- Active software feature(s) [DAC/TVG, DGS/AVG, AWS D1.1/D1.5]
- Phased array calibration data and calibration flags (PA mode only)
- Custom PA probes/wedges (PA mode only)
- Weld Overlay templates (PA mode only)

10.5.3 Reset & Manage Function

EPOCH 1000 Series instruments allow you to reset current settings to default values, when necessary. The instrument reset parameters are available in the **Resets** setup page accessible by selecting **Files > Reset & Manage** (see Figure 10-11 on page 215). Use the arrow keys or the adjustment knob to highlight the desired reset type, and then press **Reset**.

Master/Database

Resets the current on-screen parameters to system default values and erases all saved files in the instrument data logger. All files in the current database can be backed up and restored to/from a USB memory stick using the **Backup** and **Restore** functions.

Parameters

Resets only the current on-screen parameters to system default values.

Datalogger

Erases all saved files in the data logger.

Probe Library

Erases all custom DGS/AVG probes stored in the DGS/AVG probe library.

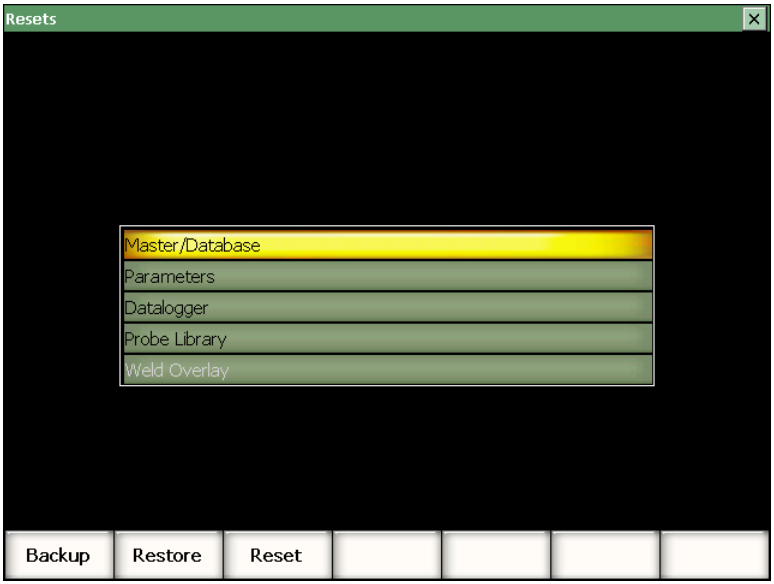


Figure 10-11 The Resets page

10.5.4 Export and Import Function

The **Export** and **Import** features allow users to share individual files and/or IDs between EPOCH 1000 Series instruments without the need for completely backing up or restoring all the files on the unit. Files are exported and imported to and from a USB memory stick, in XML format.

In addition to allowing export and import of individual files, the XML file type has broader uses. EPOCH 1000 Series files output in a standard XML format, which can easily be interpreted by a third party reporting or data storage program. Blank XML files can easily be generated by a third party program for import to an EPOCH 1000 Series instrument. Upon request, Olympus can provide XML Schema with additional information on the format and usage of EPOCH 1000 Series exported files.

To export a set of files

1. Insert a USB memory stick into one of the USB host ports in the EPOCH 1000 Series instrument.
2. Select **Files > Export/Import**.
3. Use the **[UP]** and **[DOWN]** arrow keys to navigate through the list of file names (see Figure 10-12 on page 217).
4. Press **[CHECK]** to choose a file name for exporting.

   All IDs within the file will automatically become checked for exporting.

   It is also possible to export only selected IDs by using the **[RIGHT]** arrow key to enter the ID list and selecting the desired IDs using the same procedure as above.
5. Once completed, press **Export** to send each checked file to the inserted USB drive.

NOTE

Exporting files to USB can take several minutes

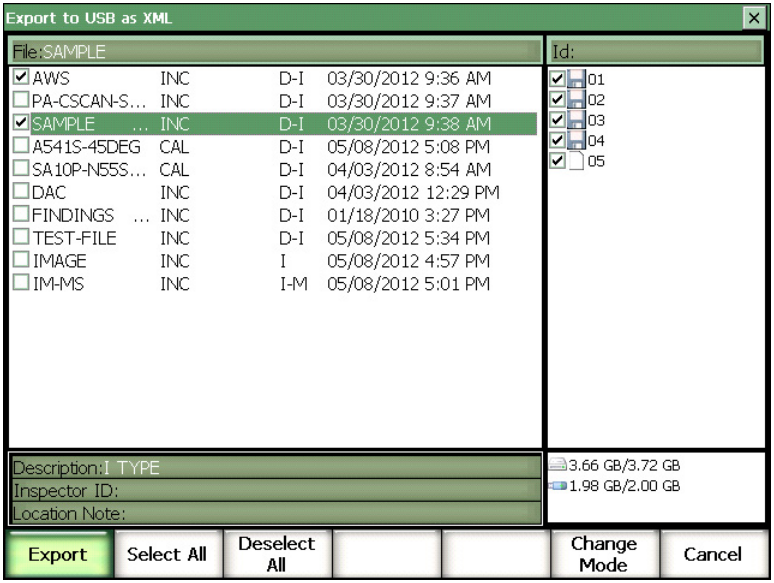


Figure 10-12 The Export page

To import a set of files

1. Insert a USB memory stick that contains previously exported XML files into one of the USB host ports in the EPOCH 1000 instrument.
2. Click **Change Mode** to switch to Import mode (see Figure 10-13 on page 218).
3. Use the **[UP]** and **[DOWN]** arrow keys to navigate through the list of file names.
4. Press **[CHECK]** to choose a file name for importing.

   All IDs within the file will automatically become checked for exporting.

   It is also possible to import only selected IDs by using the **[RIGHT]** arrow key to enter the ID list and choose the desired IDs using the same procedure as above.
5. Once completed, press **Import** to copy each checked file to the EPOCH 1000 Series data logger. If a file name already exists on the EPOCH 1000 Series instrument, you will be prompted to provide a new file name before completing the import.

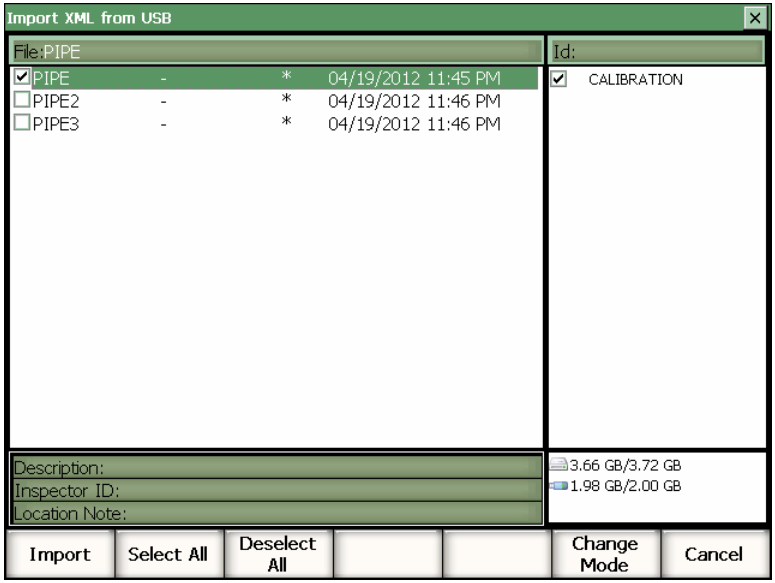


Figure 10-13 The Import page

10.5.5 Memo Function

Use the Memo function to enter descriptive comments to include with stored data. Memos are usually used to provide further details about a measurement condition or calibration. Memos can only be entered from the live screen. To place a memo in the database prior to a particular reading, enter it prior to saving the reading. To place a memo in the database after saving an ID, enter it afterwards.

10.5.5.1 Adding a Memo

Memos can be added to the currently active file and ID from the live screen. The memo text will be stored with the file and displayed with any reports.

To add a memo

1. Open the file and ID to which you want to add a memo.
2. Select **Files > Id** or **Files > Last ID** to choose the desired ID from the open file.

3. After the proper ID has been selected, press **Files > Memo** to enter the **Memo** page (see Figure 10-14 on page 219).

   The file and ID that the memo will be saved to are displayed at the top of the menu.

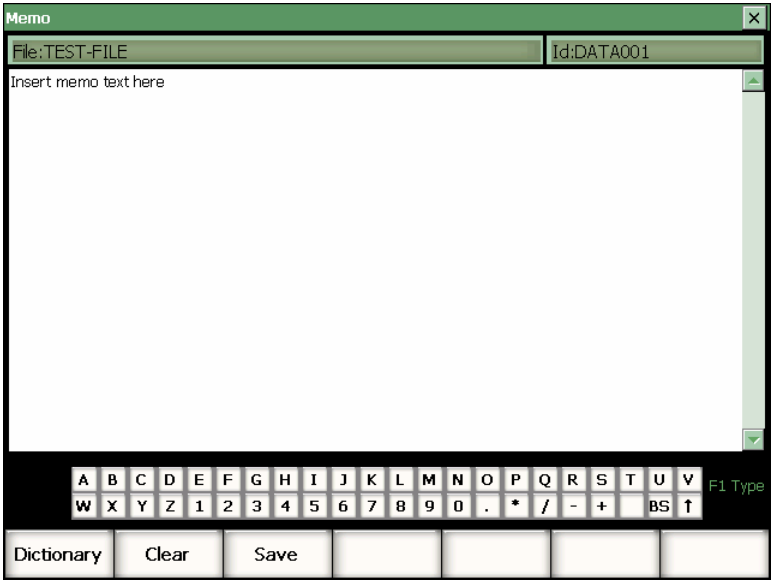


Figure 10-14 The Memo page

4. Enter the desired memo in the text box. You may freely type in this space, using the instrument's keypad or external USB keyboard.

The **Memo** page contains the following functions:

- **Dictionary**: Enters the **Preset/Custom** page (see Figure 10-15 on page 220).
- **Clear**: Clears the entire memo; operator must confirm the action.
- **Save**: Saves memo to the ID and returns to the live screen.

You may also select preset/custom text to add to this space using the **Dictionary** function. These text threads can be selected and directly dropped into the memo text box in the **Memo** page. Custom preset text can be added onboard the EPOCH 1000 Series instrument or from a USB drive.

The **Preset/Custom** page (see Figure 10-15 on page 220) contains the following functions:

- **Insert**: Inserts preset/custom text into the Memo page.
- **Add**: Enables you to add preset/custom text to the list.
- **Edit**: Enables you to edit the highlighted preset/custom text.
- **Delete**: Deletes the highlighted preset/custom text from the list.
- **Import**: Imports a set of preset/custom text from USB drive.
- **Export**: Exports list to USB drive.
- **Cancel**: Returns to the **Memo** main page.

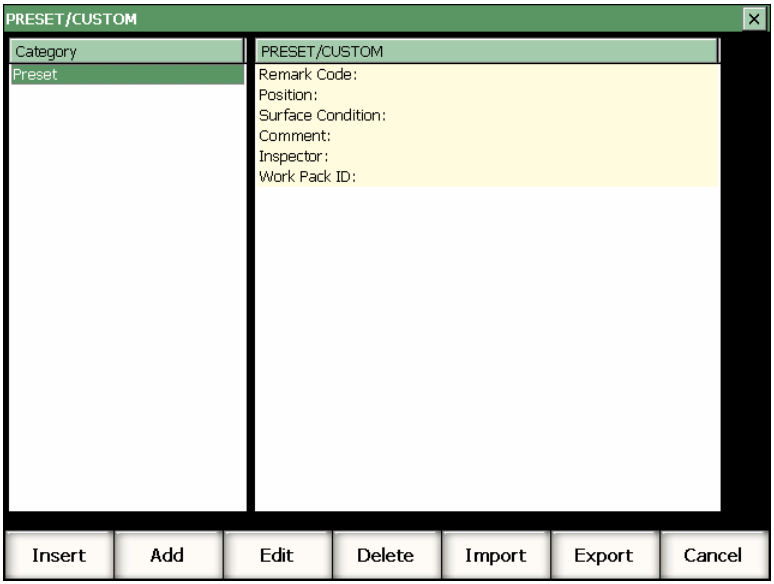


Figure 10-15 The Preset/Custom page

To add a custom memo directly on the EPOCH 1000 Series instrument

1. In the **Category** column of the **Preset/Custom** page (see Figure 10-16 on page 221), press **Add**.
2. Enter the Category name, and then press the **[RIGHT]** arrow key to move to the **Preset/Custom** column.
3. Press **Add** to add custom text, and then press **[CHECK]** when complete.

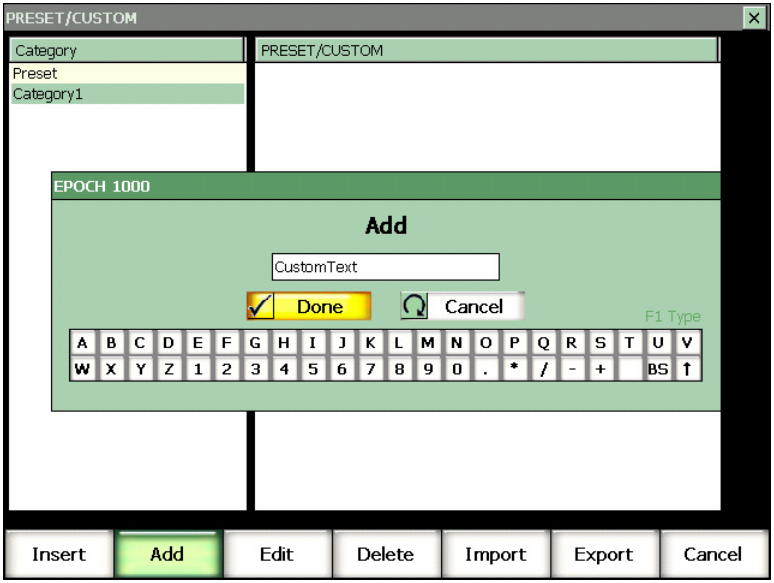


Figure 10-16 Adding a custom memo

10.5.5.2 Exporting and Importing Custom Memos

The easiest way to add or modify custom memos on EPOCH 1000 Series instruments is to first export the current memos to a USB memory stick. This will provide the base formatting for the custom memos.

To export all custom memos to a USB memory stick

1. Select **Files > Memo**, and then press **Dictionary** to enter the **Preset/Custom** page.
2. Press **Export**.

To import a custom preset text from a USB memory stick

1. Create an XML text file in the root directory of a USB memory stick called "CustomWords.xml".
2. Save all custom text in this file in the format shown in Figure 10-17 on page 222.

   Each new custom entry should match the format of the "Dictionary Name" and "Entry" formats. All custom memos must be saved in this single XML file for import.

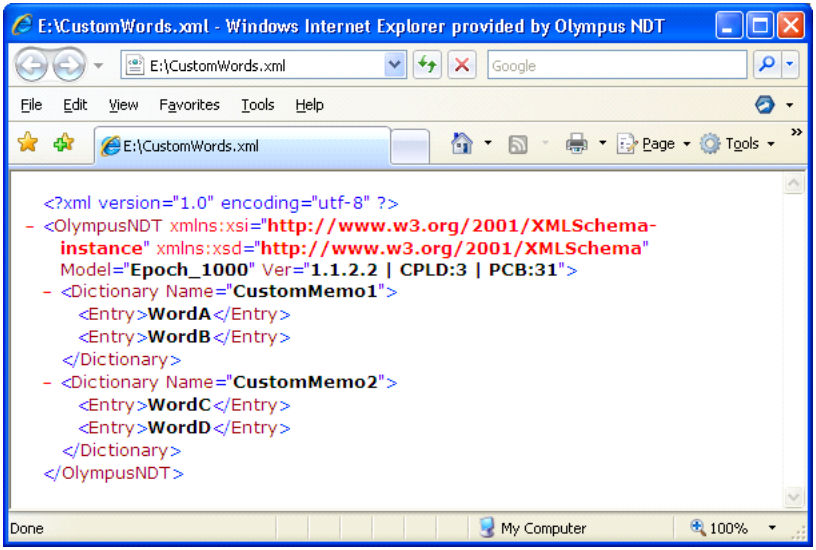


Figure 10-17 Custom memo import file

3. In the **Preset/Custom** page, use the **Import** function to load all words from the USB stick.

NOTE

In order to add to default text preloaded on the instrument, use the **Export** feature on the **Preset/Custom** page to create the CustomWords.xml file on a USB stick. When importing a file with custom memo information, this imported file will replace all custom memos that have been stored in the dictionary.

10.5.6 Last ID Function

Pressing **Files > Last Id** will automatically select the last ID in the currently active file. This allows you to automatically jump to the ID location where you were previously saving data. You can select the **Files > Id** function to select a specific ID within a file and set it as the active saving location.

10.6 Reports Submenu

The reporting capabilities of the EPOCH 1000 Series have been enhanced to allow more dynamic outputs of information in a variety of formats:

- HTML report
- Image output as .png image file
- Custom report header and logo import

10.6.1 Report Function

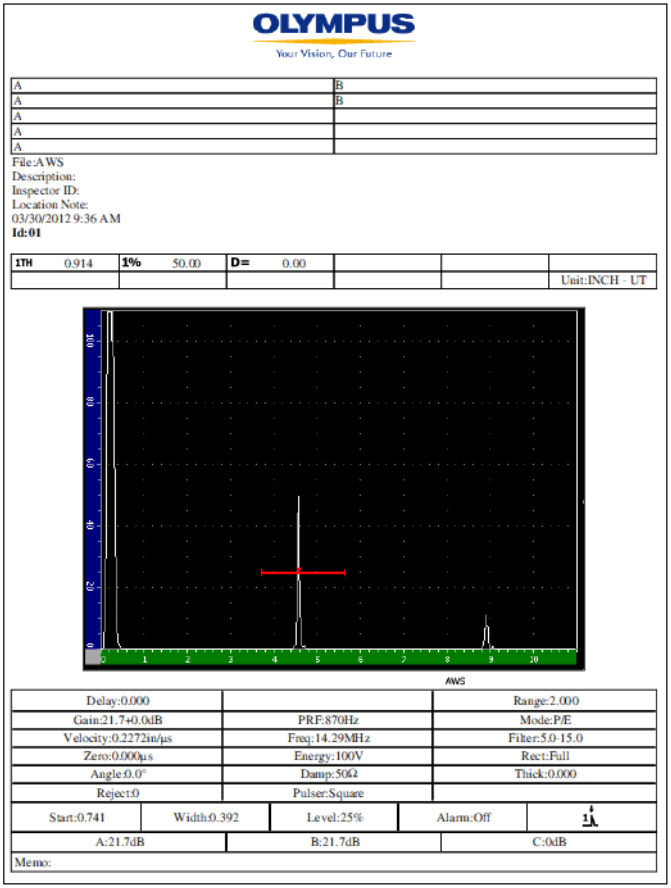
The Report function allows you to choose the desired format for HTML data export (see "HTML Function" on page 227 for additional information).

To change the report format

1. Select **Reports > Report**.

   The two formats are as follows:

   - **Data**: HTML report will contain all saved data that was stored with the file (parameters, gate placements, waveform image, calibrations, etc). A separate data sheet will be generated for each ID (see Figure 10-18 on page 224).



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A	B
A	B
A	
A	
A	

File:AWS
Description:
Inspector ID:
Location Note:
03/30/2012 9:36 AM
Id:01

1TH 0.914	1% 50.00	D= 0.00			
					Unit:INCH - UT

AWS

Delay:0.000		Range:2.000
Gain:21.7+0.0dB	PRF:870Hz	Mode:P/E
Velocity:0.2272in/µs	Freq:14.29MHz	Filter:5.0-15.0
Zero:0.000µs	Energy:100V	Rect:Full
Angle:0.0°	Damp:50Ω	Thick:0.000
Reject:0	Pulser:Square	

Start:0.741	Width:0.392	Level:25%	Alarm:Off	

A:21.7dB	B:21.7dB	C:0dB

Memo:

Figure 10-18 Data report example

- **Summary**: HTML report will contain only a measurement summary for all saved IDs in the selected file. Only the measurements that were displayed on-screen when the file was saved will display with the measurement summary (see Figure 10-19 on page 225).

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A	B
A	B
A	
A	
A	

File:SAMPLE

	01						Unit:INCH
1%	80.00	1	0.914	1TH	0.914		
	02						Unit:INCH
1%	79.50	1	1.781	1TH	1.781		
	03						Unit:INCH
1%	79.75	1	0.914	1TH	0.914		
	04						Unit:INCH
1%	80.00	1	3.512	1TH	3.512		

Figure 10-19 Summary report example

10.6.2 Image Function

The EPOCH 1000 Series Image function exports stored images to a removable memory device. Only files created as either Image Only (I) or Image and Measurements (I-M) are viewable on this export page (see Figure 10-20 on page 226 and Figure 10-21 on page 226).

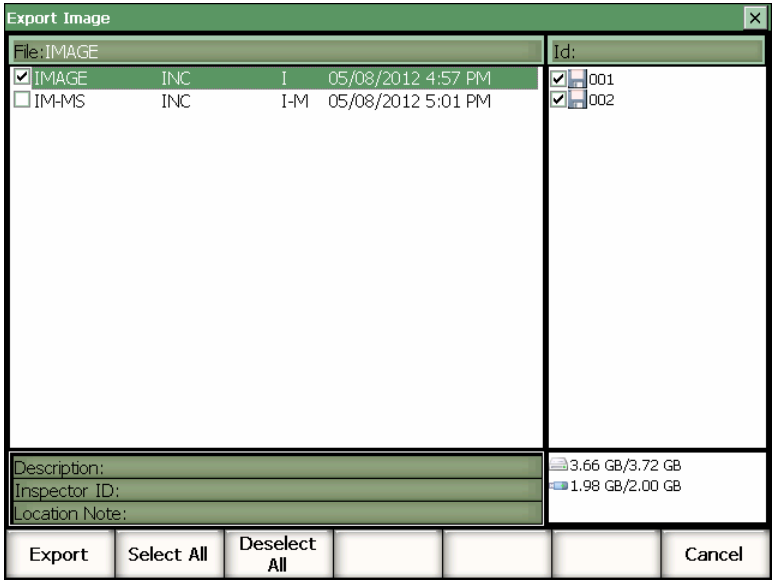

Figure 10-20 Image export page

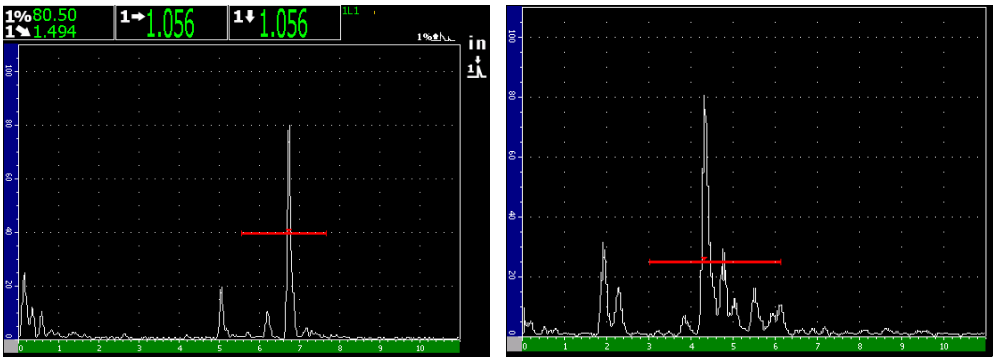

Figure 10-21 Image and Measurements (I-M) and Image Only (I) export examples

To export Image file reports

1. Select **Reports > Image**.
2. Use the **[UP]** and **[DOWN]** arrow keys to highlight the desired file name(s) for export.
3. Press **[CHECK]** to select the highlighted file.
4. Press **Export** to send the image files to removable media.

10.6.3 HTML Function

The EPOCH 1000 Series HTML function exports stored data files to a removable memory device. HTML files are created based on Report Setup configuration. Only files created as Data and Image (D-I) are viewable on this export page (see Figure 10-22 on page 227).

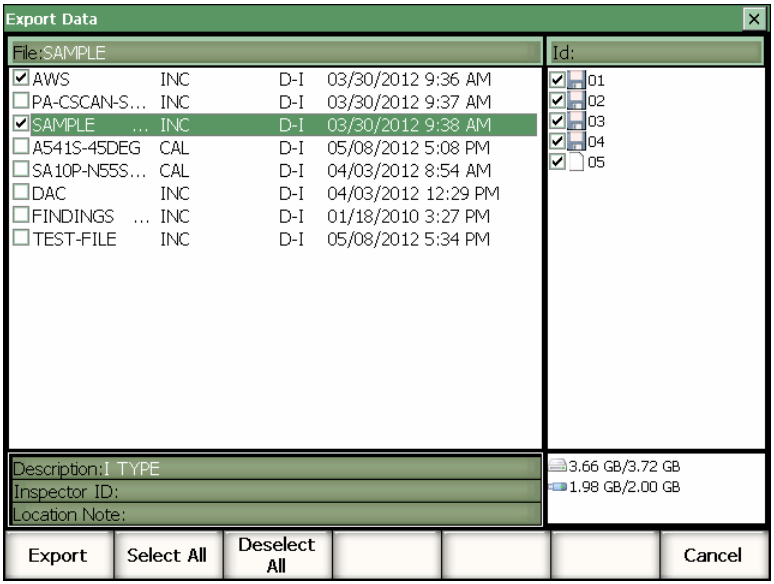

Figure 10-22 HTML export page

To export HTML file reports

1. Select **Reports > HTML**.
2. Use the **[UP]** and **[DOWN]** arrow keys to highlight the desired file name(s) for export.
3. Press **[CHECK]** to select the highlighted file.
4. Press **Export** to send the image files to removable media.

While exporting HTML files, it is possible to only export certain IDs instead of the entire file

To export individual IDs

1. Select the desired file in the HTML export page, and then use the **[RIGHT]** arrow key to jump to the ID menu.
2. Press **[CHECK]** to select the desired IDs for export.

   File names that are exporting only partial IDs are highlighted in grey on the list and do not show the check box.

   The one or more selected files or IDs will export in the selected report format (see "Report Function" on page 223 for more information.)

10.6.4 Report Setup Function

The **Report Setup** function allows you to configure the HTML report components for export. You can import a custom logo for the top of the report, and select sections of the report to include or remove, such as header, logo, waveform/image, etc.

10.6.4.1 Add and Remove Sections of the HTML Report

You can choose which specific sections and data to include in your HTML reports from the **Report Setup** page.

To add or remove section of the HTML report

1. Select **Reports > Report Setup** to enter the **Report Setup** page (see Figure 10-23 on page 229).
2. Use the **[UP]** and **[DOWN]** arrow keys to scroll through the list of HTML report sections.
3. Use the **[CHECK]** key to select or deselect components of the report.

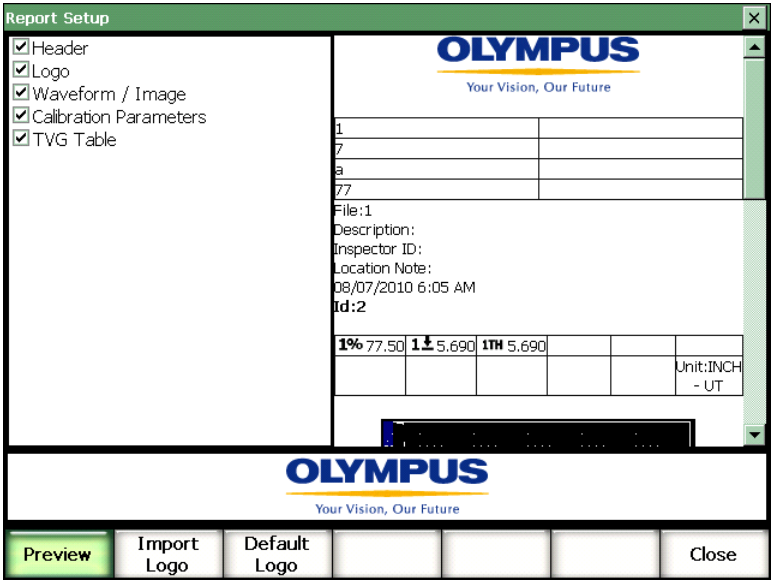

Figure 10-23 The Report Setup page

10.6.4.2 Preview HTML Report

EPOCH 1000 Series instruments allow you to view a generic preview of the HTML report to be generated based on the section configuration.

To view a generic preview of the HTML report

1. Select **Reports > Report Setup** to enter the **Report Setup** page.
2. Press **Preview** to view a generic preview of the HTML report to be generated based on the section configuration.
3. Use the adjustment knob to scroll up and down through this preview.

10.6.4.3 Importing a Custom Report Logo

The **Report Setup** page allows the user to import a custom logo to use as their report header.

To import a custom report logo:

1. Copy the logo file onto the root directory of a a USB memory stick. The logo file must be a standard Windows image file, such as .png, .jpeg, .bmp, etc.
2. Select **Reports > Report Setup** to enter the **Report Setup** page (see Figure 10-24 on page 230).
3. Press **Import Logo** to show a list of all image files available on the connected USB device.
4. Select the desired logo from the list, and then press **[CHECK]** to import.
5. To return to the default Olympus logo, press **Default Logo**.

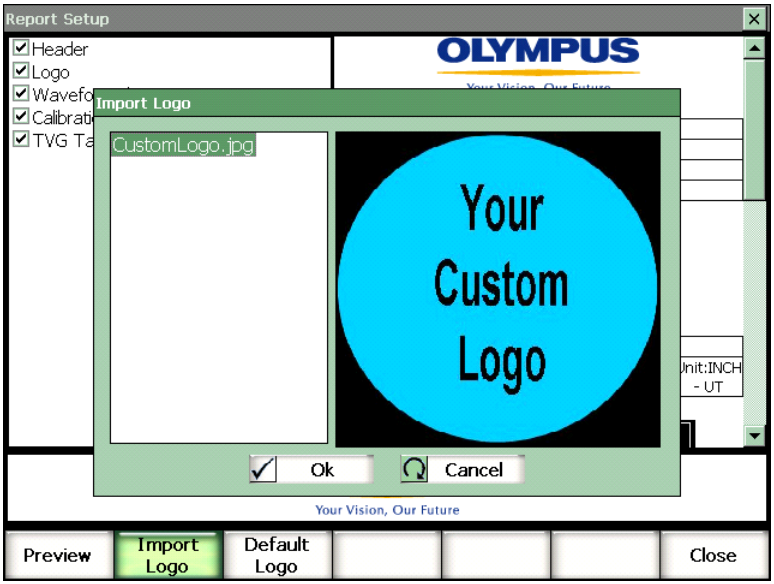

Figure 10-24 Importing a custom logo

10.6.5 Page Setup Function

The **Page Setup** function allows the user to define report labels and header information, as well as make global print function adjustments. The **Report Label** and **Report Header** will display at the top of the printed HTML report (see Figure 10-25 on page 231).

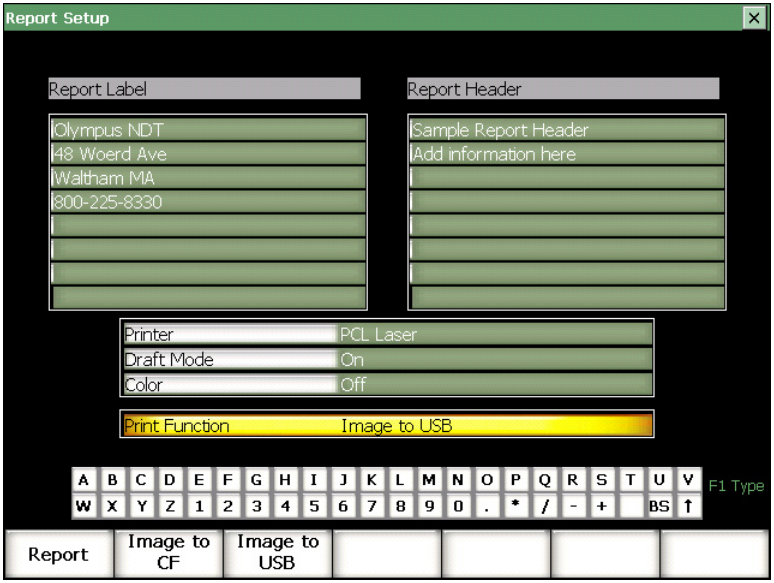

Figure 10-25 The Page Setup page

Accessed by selecting **Reports > Page Setup**, this page contains the following print function parameters. These parameters relate to the **[2nd F] [PRINT]** key on the front panel of the instrument.

- **Printer**: Type of USB (PCL 5) printer connected to the unit (Laser or Inkjet)
- **Draft Mode**: Quality of print
- **Color**: Black and White (Off) or Color (On)
- **Print Function**: Allows user to have the **[2nd F] [PRINT]** key press perform one of three functions:
  - **Report**: Print a HTML report to a USB printer
  - **Image to CF**: Send a full screen capture to the CompactFlash card
  - **Image to USB**: Send a full screen capture to the USB memory stick

10.6.6 Media Function

The **Reports > Media** function selects the removable media destination for exporting Image and HTML files. Set the **Media** parameter to either **CF** or **USB** to export to the desired destination.

10.7 Saving Screen Captures

You can save the screen captures of the EPOCH 1000 Series instruments to the either the CompactFlash card or a USB memory stick. This function, similar to the print screen function on a PC, allows you to quickly capture live inspection data information for use in reports. The saved screen captures will be saved as a portable network graphics (.png) file type.

To save a screen capture

1. Set the **Print Function** parameter to **Image to CF** or **Image to USB** (see "Page Setup Function" on page 230).
2. Make sure that the USB memory stick or CompactFlash card is properly inserted in the EPOCH 1000 Series instrument.
3. Press **[2nd F], [RECALL SETUP] (PRINT)**.

   The on-screen image will then save to the removable media and a notification will display on the top of the screen to confirm that the image is saved.

The saved screen shots are titled starting with "ScreenCapture0.png" and increases in number as each screen shot is saved. The files will be located on the removable media in an **Olympus-NDT > EPOCH1000** folder by software serial number of the instrument.

10.8 Quick Recall Function

EPOCH 1000 Series instruments allow you to quickly recall a calibration file without the need to go into the **File Review** submenu. The quick calibration recall feature is accessed by pressing the **[RECALL SETUP]** key. The **Quick Recall** menu shows a list of all CAL files with stored data saved on the EPOCH 1000 Series instrument.

NOTE

Only files created using the CAL file type that contain stored data are displayed in the quick recall setup window. If no CAL files with stored data are present on the instrument, pressing **[RECALL SETUP]** will display an "No CAL files available for Recall" error.

To quickly recall a file using the recall setup

1. Press **[RECALL SETUP]** to enter the **Quick Recall** dialog box (see Figure 10-26 on page 233).
2. Select the desired calibration file.
3. Press **[CHECK]** to recall the desired file and recall its settings as the live instrument parameters.

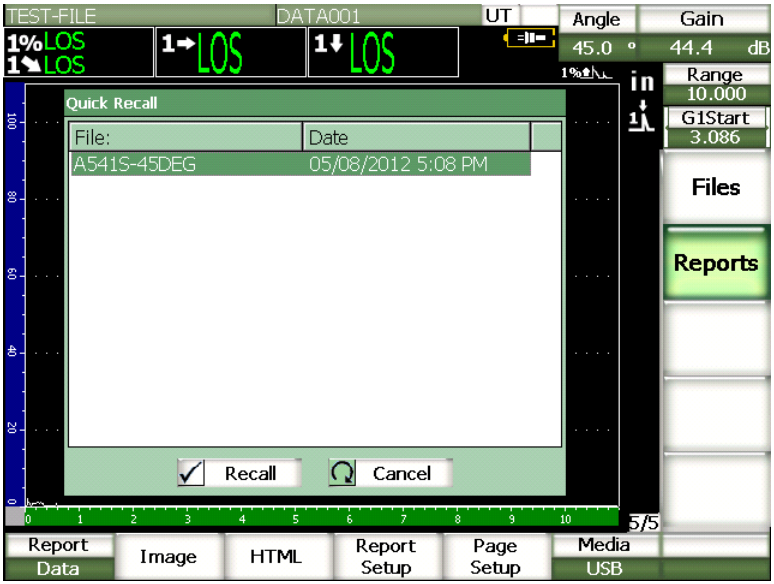

Figure 10-26 The Quick Recall dialog box

11. Software Features and Options (Conventional UT Mode)

This chapter discusses the activation and operation of software features and options for the EPOCH 1000 Series conventional UT mode.

11.1 Defining Licensed and Unlicensed Software Features

The EPOCH 1000 Series include many software features that expand the instruments' capabilities beyond standard flaw detection.

The following software features are standard components of the EPOCH 1000 Series conventional UT flaw detector instrument:

- Dynamic DAC/TVG
- DGS/AVG
- AWS D1.1/D1.5 Weld Rating Software

There are also four software options available. These options are not standard inclusions of the base EPOCH 1000 model, and must be purchased and added to the instrument. These options, interface gate, floating gate, B-scan, and back wall echo attenuator, can be activated at the time of purchase of the instrument, or can be activated remotely after purchase of the instrument.

If a software option is not activated, you do not have access to the submenu that controls this function. Olympus can provide an activation code that is entered in the instrument and allows access to the option. Using this method, you can activate the software without having to return the instrument to a service center.

To activate a software option

1. Select **Inst Setup > Status** to open the **Status** setup page shown in Figure 11-1 on page 236.

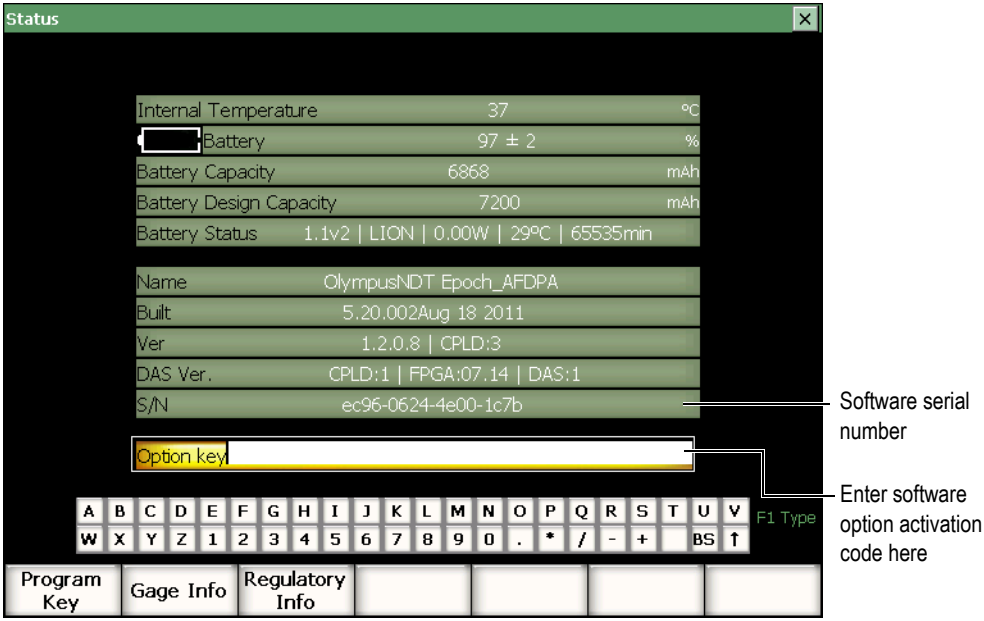

Figure 11-1 The Option key entry dialog box

2. Note the 16-character software serial number for your instrument that appears in the **S/N** parameter.
3. Contact Olympus to purchase the software option, providing the software serial number.

   Olympus provides you with an activation code.
4. After you have been given the remote activation code, open the **Status** setup page.
5. Using the virtual keyboard, enter the activation code in the **Option key** box (see Figure 11-1 on page 236).
6. When you have finished entering the activation code, select **Program Key** to activate the option and return to the live screen.

11.2 Dynamic DAC/TVG

A distance amplitude correction (DAC) curve is used to plot amplitude variations of signals from reflectors of the same size but at different distances from the transducer. Normally, these reflectors produce echoes of varying amplitude due to material attenuation and beam spread as the sound beam travels through the part. The purpose of the DAC curve is to graphically compensate for material attenuation, nearfield effects, beam spread, and surface roughness.

After a DAC curve is plotted, reflectors that are the same size as those used for creation of the curve will produce echoes that peak along the curve despite their different locations within the test piece. Similarly, reflectors that are smaller than those used to create the curve fall below the level, while larger reflectors exceed the curve level.

When a DAC curve is created in an EPOCH 1000 Series instrument, the instrument also creates a time-varied gain (TVG) setup. TVG is used to compensate for the same factors as DAC, but the presentation is different. Instead of drawing a curve across the display that follows the reference-reflector peaks downward as sound is attenuated, the TVG setup amplifies the gain as a function of time (distance) to bring the reference-reflectors to the same screen height (80 % FSH).

The EPOCH 1000 Series conventional DAC/TVG feature allows you to toggle between DAC and TVG views in many of its modes, giving you the freedom to use both techniques during a single inspection. When you switch from the DAC to TVG view, the DAC curves are displayed as TVG lines across the screen. The time-varied gain effectively amplifies the signals across the time base to make the DAC curves appear as straight lines across the screen.

You can customize DAC/TVG setups for your unique application requirements using the flexible DAC/TVG software feature for the EPOCH 1000 Series. The DAC/TVG feature incorporates several DAC/TVG modes that adhere to ASME, ASME III, and JIS sizing codes. The software offers direct control of gain, range, zero offset, and delay, as well as scanning gain and transfer correction. In addition, the DAC/TVG option provides new features such as **20 %-80 % DAC** curves, customizable DAC curves, and a user-defined TVG table to meet advanced and unique inspection needs.

11.2.1 Feature Activation and Reference Correct

Prior to the activation of any options associated with DAC/TVG, the instrument must be properly calibrated to the material being inspected. DAC/TVG can be activated in the **DAC/TVG** setup page accessible by selecting **Sizing Option > DAC/TVG** (see Figure 11-2 on page 238).

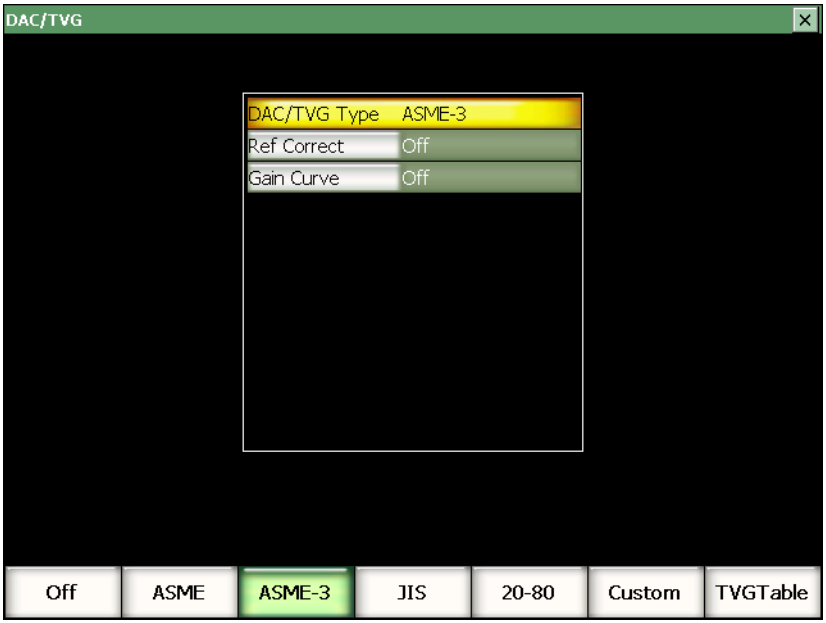

Figure 11-2 The DAC/TVG setup page

You may also choose to apply a feature known as **Ref Correct** (reference correction) to the digital analysis of the live A-scan and DAC/TVG option. When activated, the reference correction feature allows full gain manipulation of either the live echo peaks or the DAC curve while providing the % amplitude or dB comparison of the actual peak-to-curve ratio. In this way, you can use scanning gain, while maintaining an accurate measurement reading of the ratio of the gated peak to the DAC curve for sizing purposes. The gated echo amplitude is corrected back to the reference gain level for amplitude evaluation compared to the DAC curve.

You can also turn on a visual **Gain Curve** to show how the gain changes on standard TVG. With this feature turned on, switch to the TVG view, after the DAC curve has been created, to view the TVG curve together with the **Gain Curve**.

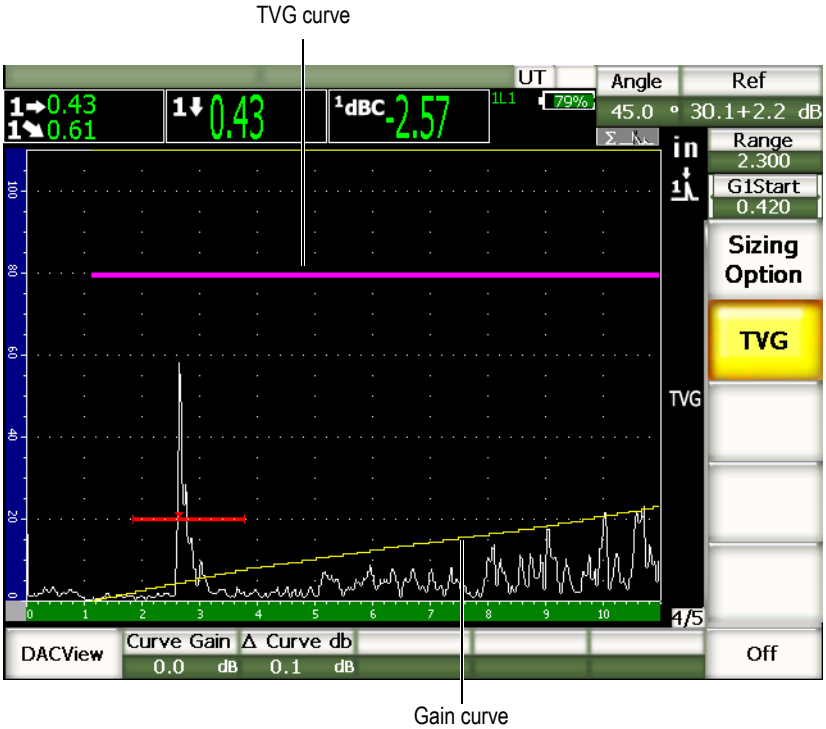

Figure 11-3 TVG view showing TVG curve and Gain curve

After the proper selection of DAC/TVG has been made (including activation of **Ref Correct** and **Gain Curve** where applicable), press the **[ESCAPE]** key to return to the live A-scan screen and begin DAC/TVG setup.

When in the live A-scan mode, a new **DAC Setup** submenu appears in menu 4, dedicated to DAC/TVG features. This submenu allows access to several important functions that control DAC/TVG setup and operation.

To deactivate a DAC/TVG feature, press **DAC Setup = Off**.

In the following sections, all DAC/TVG modes are covered. The DAC/TVG setup procedure is the same for all modes with the exception of TVG table. The setup is covered in detail in the ASME/ASME III section to follow. Any differences in the procedure to set up other DAC/TVG modes are discussed in the pertinent section for that particular mode.

11.2.2 ASME/ASME III DAC/TVG

The ASME DAC mode is a single DAC curve drawn from peak-to-peak on reference-reflectors. The ASME III mode draws three DAC curves: one main curve from peak-to-peak on the reference-reflectors and two warning curves at −6 dB and −14 dB compared to the main curve.

11.2.3 ASME III DAC Setup Example

After you have selected the desired DAC mode, the live A-scan display should appear as shown in Figure 11-4 on page 240.

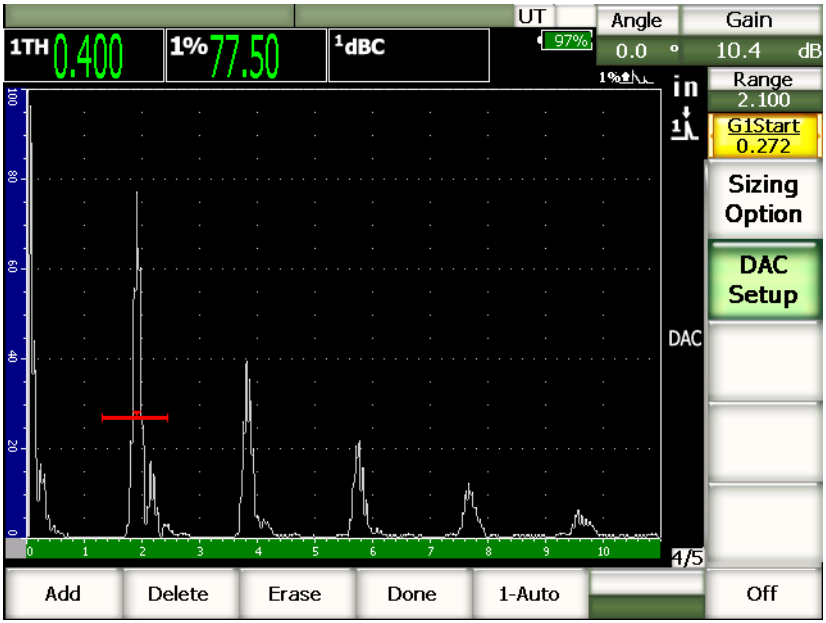

Figure 11-4 First DAC setup step

To capture DAC points, you must move gate 1 to the echo, and then select **DAC Setup > Add**.

TIP

EPOCH 1000 Series instruments allow you to bring each echo used to create a DAC curve to 80 % FSH before acquiring the point. This feature can help create a more precise DAC curve, especially in the far-field. Select **DAC Setup > 1-Auto** or **[2nd F], [GATE]** to activate auto-80 % for each indication, before capturing the point.

After a point has been captured, the peak amplitude of that point is marked using an **X**. Figure 11-5 on page 241 shows one DAC point captured using **Add**.

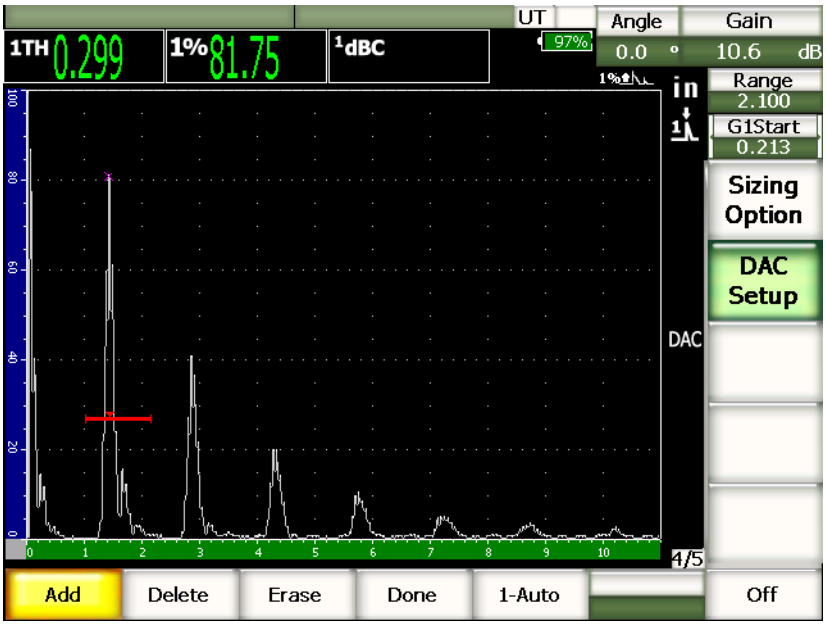

Figure 11-5 DAC Setup one point

Figure 11-6 on page 242 shows the EPOCH 1000 Series display when the second point has been captured.

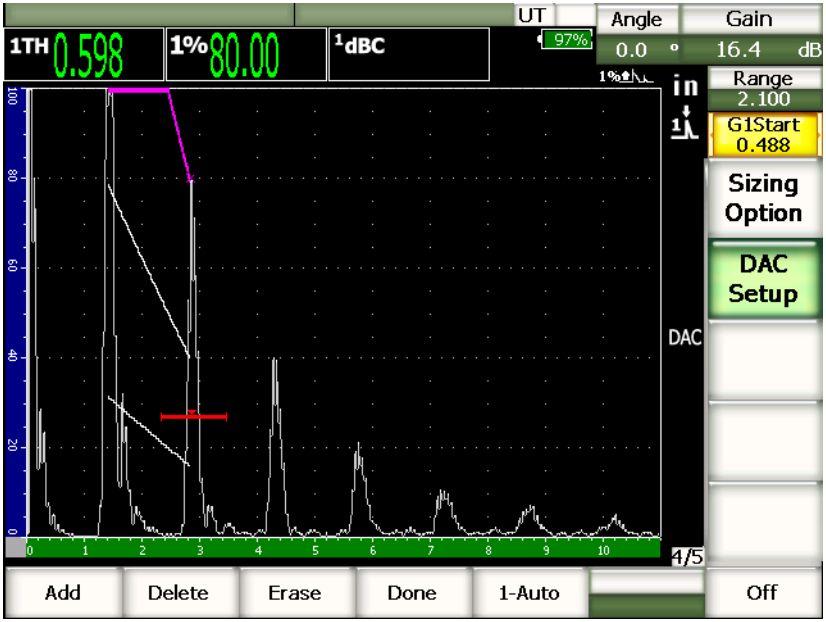

Figure 11-6 DAC setup two points

The instrument has drawn a DAC curve with three levels from the first point to the second. You have used the auto-80 % function to bring the second point to 80 % full-screen height. This assures that the point is captured accurately because amplitude resolution is better at greater echo heights. This also pushes the first captured echo over 110 % FSH so the main DAC curve and the −6 dB warning curve extend downward to the second point from off-screen.

While acquiring DAC points, you have three other choices besides **Add** and **1-Auto**:

Delete

Deletes only the point(s) within the gated region.

Erase

Erases the entire DAC curve acquired.

Done

Completes curve acquisition and switches to inspection mode.

Figure 11-7 on page 243 shows a DAC curve after 5 points have been acquired. In this example, every point was automatically adjusted to 80 % FSH prior to capture.

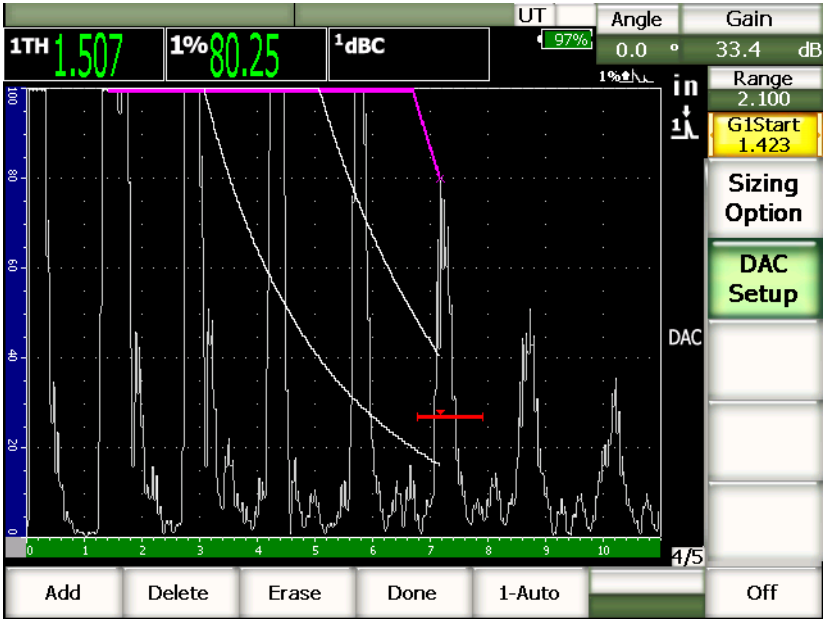

Figure 11-7 DAC Setup five points

TIP

If you need to continue capturing points, you may increase the instrument range or increase the display delay to view echoes further out in time.

After the correct number of points have been captured, select **DAC Setup > Done** to complete the DAC curve and switch to the DAC inspection mode.

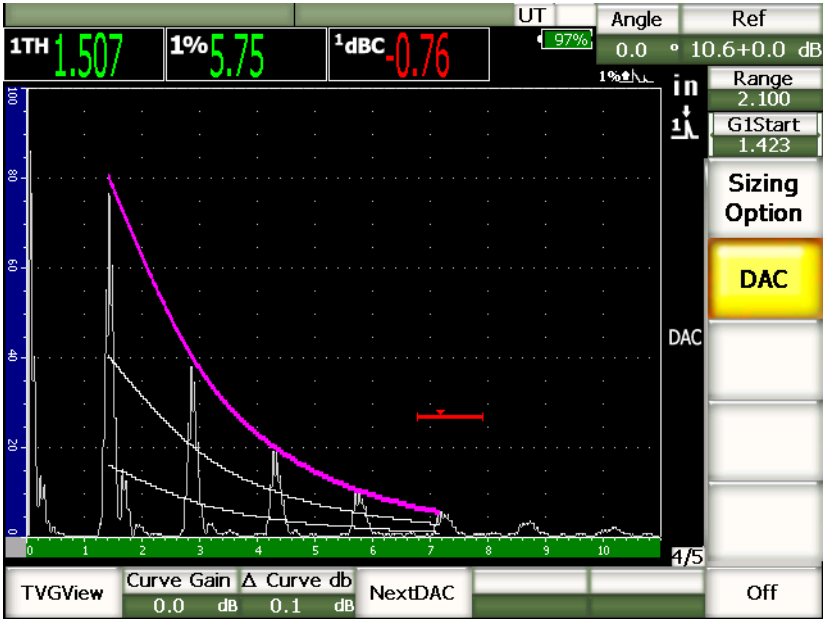

Figure 11-8 The completed DAC curve

When the DAC curve is complete and the instrument is in inspection mode, the instrument provides a new set of parameters:

TVGView (DAC View)

This function allows you to toggle between the DAC curve acquired and the corresponding TVG setup based on the DAC curve information.

Curve Gain

This adjustment allows you to manipulate the screen height/gain of both the DAC/TVG curve as well as the echoes on screen. This allows for amplitude-to-curve comparison at code compliant screen levels across the time base.

Δ Curve dB

This setting controls the steps by which **Curve Gain** is adjusted. Possible steps are 0.1, 1.0, 2.0, 3.0, 6.0, and 12.0 dB.

Next DAC

This function cycles through the available DAC curves (if more than one is available) for amplitude comparison with on-screen echoes. The selected DAC or TVG curve appears as a double thickness line.

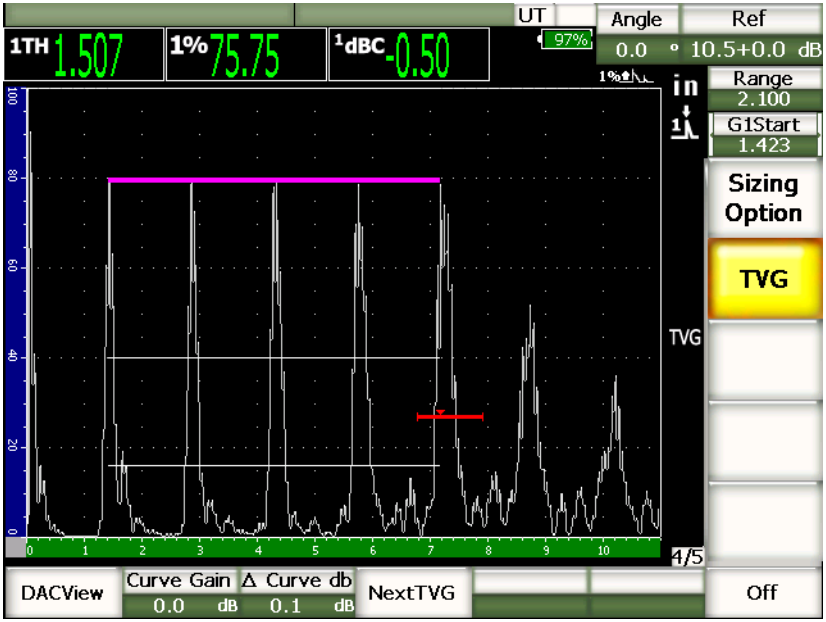

Figure 11-9 Completed TCG curves in TVG view mode

While DAC/TVG is active, you have full control of the **Range**, **Delay**, and **Zoom** settings. With this you can focus on areas of interest within the DAC setup. Figure 11-10 on page 246 shows a reduced range with delay.

Figure 11-10 A small range DAC

11.2.4 Gain Adjustment Options

The EPOCH 1000 Series DAC/TVG software features three separate types of gain adjustment for each DAC/TVG setup. These gain adjustments allow for better inspection precision, easy manipulation of curves and live peak information, and transfer correction.

11.2.4.1 Scanning Gain

To quickly find and identify potential defects, it is commonly required by code to increase the gain (scanning gain) on the EPOCH 1000 Series instrument from the reference (calibration) gain for scanning purposes. However, once a potential defect is identified, this gain is usually removed to view the reflector at **Ref** gain level, set at calibration. The DAC/TVG software for the EPOCH 1000 Series is fully capable of adding temporary scanning gain for inspection purposes. This scanning gain only affects the live A-scan and does not adjust the level of the DAC curve(s) set up on screen.

To add temporary scanning gain

1. Press **[GAIN]**.
2. Increase or decrease the scanning gain.
3. Press **[ESCAPE]** twice to return to the **Basic** submenu.
4. Select **Basic > Scan dB** to toggle between the base (reference) gain and the adjusted scanning gain.
5. Select **Basic > Off** to turn scanning gain off completely.

Figure 11-11 on page 247 shows an ASME DAC setup with 3 dB of scanning gain added.

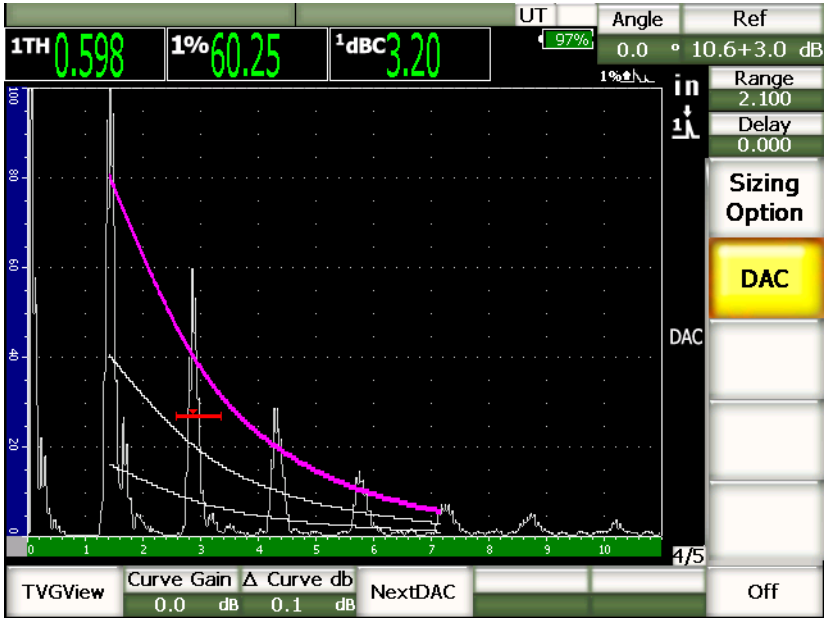

Figure 11-11 ASME DAC with 3 dB scanning gain

NOTE

When reference correction is active, the digital comparison between a captured reflector and the DAC curve is accurate even with the scanning gain applied to the inspection, provided that the gated echo is not saturated. Figure 11-12 on page 248

shows the same setup as above but with **Reference Correction** active. Notice that the scanning gain has been removed from the dB-to-curve measurement in location 5. The instrument compares the echo height to the DAC curve, compensates for the added scanning gain, and reports the true-amplitude comparison.

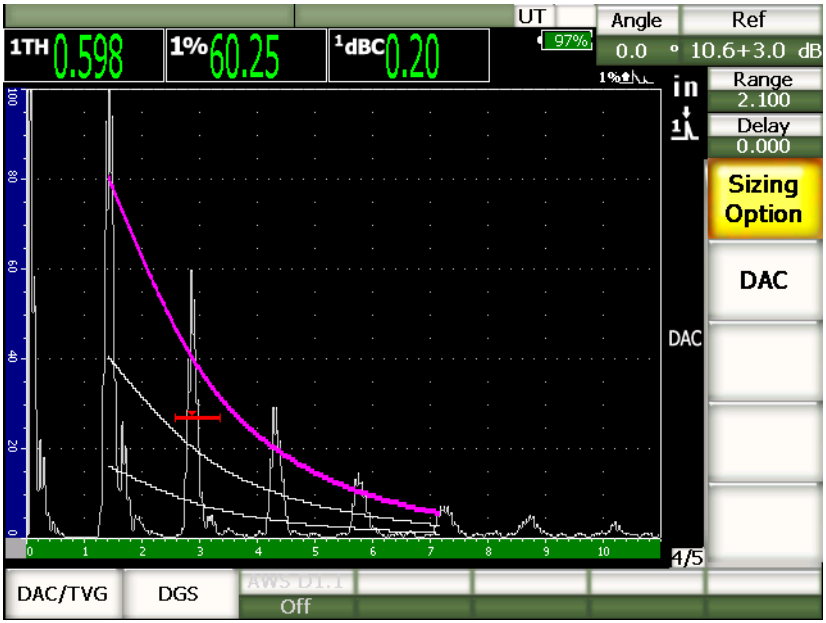

Figure 11-12 ASME DAC with 3 dB scanning gain and reference correction active

11.2.4.2 Curve Adjustment Gain (DAC Gain or TVG Gain)

The overall gain level of the entire DAC curve and TVG line setup can be adjusted higher or lower from the Reference Gain. Most inspection codes do not permit reflectors to be sized below 20 % FSH. Therefore, to inspect beyond a certain depth/sound path time within a part, it is necessary to raise the gain of both the live A-scan and the DAC curve to continue the inspection. This is accomplished on the EPOCH 1000 Series using the curve gain (DAC curve adjustment gain).

To adjust the Curve Gain

1. Select **TVG > Δ Curve dB**, and then choose the desired increment of the gain adjustment.
2. Select **TVG > Curve Gain**, and then adjust the curve gain by the selected increment either positive or negative.

Figure 11-13 on page 249 shows a DAC setup with DAC gain in use to provide accurate echo amplitude measurement by placing the echo close to 80 % FSH.

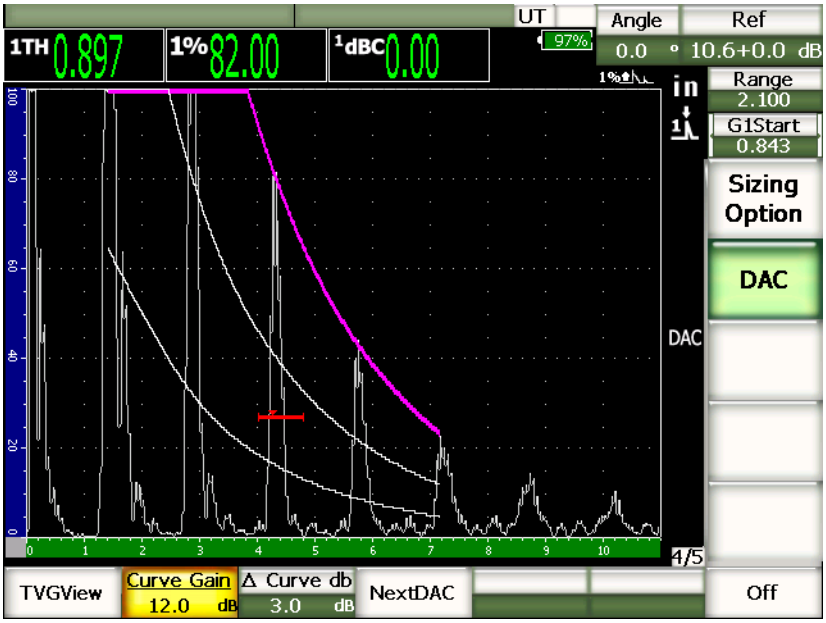

Figure 11-13 DAC curves with adjusted gain

11.2.4.3 Transfer Correction

Transfer Correction is an adjustment in the reference gain setting during calibration of the instrument, and is typically added when the surface conditions of a calibration block and the test piece are different. The coupling conditions on the test surface can often cause signal loss after calibrating a DAC curve, which results in inaccurate comparisons of the test reflectors with the calibrated DAC curve. You can easily adjust EPOCH 1000 Series instruments for this potential difference by adding transfer correction to the calibrated base gain after completing the DAC curve setup.

To add transfer correction to a completed DAC curve

1. Select **Basic**.
2. Press **[GAIN]**.
3. Bring the scanning gain to the desired level for transfer correction.
4. Once the desired scanning gain is displayed, select **Basic > Add** to add the scanning gain to the base gain and to apply the transfer correction.

11.2.5 JIS DAC

The Japanese Industrial Standard (JIS) DAC mode meets the requirements of JIS Z3060. The JIS DAC curve setup is identical to the standard DAC/TVG setup. However, there are some minor functionality differences when compared to other DAC/TVG modes:

- Only the main DAC curve is viewable in TVG mode
- Any of the six curves can be used to trip the alarm when in the JIS DAC mode. Additionally, you can set the alarm to positive or negative. To select the curve to be used as the alarm reference level, first activate JIS DAC and then select **TVG > Next DAC**. The selected curve appears as a double thickness line. Once a curve has been selected, an alarm can be activated and set to be either a positive or a negative threshold detection.

11.2.6 Custom DAC Curves

The DAC/TVG software option for the EPOCH 1000 Series features a customizable DAC curve setup that allows you to define up to six additional reference curves from the primary curve at varying levels from −24 dB to +24 dB. The Custom DAC Curves option is ideal for unique sizing inspections and procedure development. The Custom DAC Curve function also allows the option of either a straight-line connection or a curved, polynomial connection of each point of the DAC curve to meet various international or customer-specific requirements.

To activate and set up the customized curves

1. Open the **DAC/TVG** setup page by selecting **Sizing Options > DAC/TVG**.
2. Select the **Custom** DAC mode.
3. Select **Curve Type** (polynomial [curved] or straight-line segments).

4. Select the **No Of Curves** to be used in addition to the main curve (for example, if six (**6**) curves are activated, you see seven curves in total).
5. For each warning curve, select **Curve<*n*> dB**, and set the value compared to the main curve.
6. Press **[ESCAPE]** to return to the live screen to begin capturing DAC points.

Figure 11-14 Custom DAC setup

The custom DAC setup and functionality are the same as the ASME and ASME III discussed earlier in this section. Figure 11-15 on page 252 shows a completed custom DAC setup.

Figure 11-15 Completed custom DAC

After the custom DAC curve points have been captured and completed, you have the full capability to toggle between DAC and TVG views, to manipulate **Range**, **Delay**, **CAL Zero**, and **Angle**, and also to add necessary scanning gain, curve gain adjustment or transfer correction. The TVG view of any custom DAC curve includes the user-defined reference curves as well as the primary DAC curve. The custom DAC curves option also incorporates the reference correction functionality, if desired.

11.2.7 20 % - 80 % DAC

The 20 % - 80 % DAC function incorporates a combination of the DAC curve and TVG techniques. For most sizing and inspection codes that use a DAC curve, the inspector cannot interrogate a potential defect that does not rise above 20 % FSH. In the past, scanning gain was added to inspect defects that appear further into a part and only reflect below 20 % FSH. The necessary gain adjustment was then noted to calculate the flaw size.

The **20 %-80 % DAC** feature takes advantage of the TVG functionality of DAC/TVG to create a DAC curve that only falls between 20 % and 80 % screen height. Any echo that falls below 20 % FSH during setup has 12 dB added to it automatically. A new DAC curve section starting at 80 % FSH is created. This setup divides the screen into 12 dB DAC gain regions. The DAC gain is displayed based on the location of the gated echo in time.

Figure 11-16 Completed 20-80 DAC

The setup procedure for the **20 %-80 % DAC** is the same as the ASME & ASME III setup described earlier. The only difference is that you cannot use the auto-80 % function during the setup. The instrument automatically compensates for falling-echo amplitude once an echo is captured below 20 % full-screen height.

When the **20 %-80 % DAC** curve is completed, you can toggle between DAC and TVG views, manipulate **Range**, **Delay**, **CAL Zero** and **Angle**, and also add necessary scanning gain or transfer correction. **20 %-80 % DAC** also incorporates the reference correction functionality, if desired.

11.2.8 TVG Table

The TVG table option for the EPOCH 1000 Series is a powerful tool designed to facilitate manual definition of TVG setups, including gain manipulation, fine gain adjustment, and TVG point addition or deletion. The TVG table option only applies to TVG curves. With the TVG table displayed, you cannot toggle between the DAC and the TVG views. The TVG table function of the EPOCH 1000 Series visually displays the slope of the change in gain across the defined screen range using a line. This allows you to easily visualize the relationship between the indications and any custom gain modifications made during the TVG table setup. The EPOCH 1000 Series TVG table function has a number of primary uses discussed below.

Immersion Inspection

One of the main uses for the TVG table function is for immersion setups. A standard TVG curve can be created using a reference block to aid in flaw sizing prior to immersion inspections. However, the interface echo during an immersion inspection can be very high in amplitude, which can severely decrease the near-surface inspection capabilities of the instrument. Using a TVG table, you can manually adjust the gain in the screen range right around the interface echo to suppress the effects of the interface echo. Other echoes near the surface are then easier to see and size.

NOTE

The EPOCH 1000 Series TVG table can be used at full PRF (6000 Hz) in conjunction with the optional interface gate. This allows EPOCH 1000 Series instruments to be used as true immersion scanning instruments.

Manual TVG Setup

In many circumstances, a part must be inspected for flaws using a TVG curve to determine the rejectability of any flaws found within the part, but the part is too large or expensive to have a reference block of equal size and composition. The TVG table feature allows you to manually add points along the TVG curve and manipulate the gain slope across the screen range to create an accurate TVG curve without a reference block (typically this is accomplished using the DGS diagram that corresponds to the particular material and transducer being used).

Highly Attenuating Material

In many highly attenuating materials, such as many composites, it takes a large amount of gain to successfully penetrate to the back wall of a particular part. This high level of gain can cause significant noise in nearer areas of the part and completely obscure any potential defects in the first half of the inspected material. A TVG table can be used to modify the gain throughout the part to allow for clear visibility of the back wall for thickness measurement and clearer inspection of near-surface reflectors. An initial gain can be established and a slope defined to ramp the gain up from the interface of the part to the back wall.

11.2.8.1 TVG Table Setup

The TVG table option can be used to define a TVG curve using a test block and size reflectors without ever entering and/or editing specific TVG points. This operation is similar to any of the DAC setups described earlier in this section. After the TVG table has been turned on in the **Sizing Option > DAC/TVG** submenu, select **TVG Mode > G1 Setup** to access the following parameter functions:

Add

Add a TVG point.

Delete

Delete only gated point(s) of the TVG (used to correct errors during setup).

Erase

Erase the entire TVG setup and start over.

11.2.8.2 Customized TVG Table Setup

To customize a TVG setup using the TVG table function, use the **TVG Table > TVG Mode = Table Setup** parameters.

Edit

Enter the TVG table to enable point-by-point editing.

Add

Add a row to the end of the TVG table for new points.

Insert

Add a row before the current highlighted row.

Delete

Delete the highlighted row from the TVG table.

Erase

Erase all points from the TVG table.

11.2.8.3 Building a TVG with the TVG Table

The TVG table is set up to display all information regarding the variable gain applied to the echo signal along the screen range of the instrument. Each row of the TVG table represents a single point along the screen range and the gain associated with that point. The EPOCH 1000 Series instrument uses these points as a reference and draws a straight line, which represents change in gain across the screen range, to connect each point.

The TVG table has four columns:

No

A running count of the number of points that contribute to the TVG setup. The maximum number of points is 50.

Depth (TOF)

The exact depth, in microseconds, along the screen range where a gain adjustment is defined.

Depth (Unit)

The corresponding exact depth, in the chosen units (in. or mm), along the screen range where a gain adjustment is defined.

dB

The gain value of the exact point defined along the screen range.

To build a TVG setup with TVG Table

1. Select **TVG Table > TVG Mode = Table Setup** to view the current TVG table.
2. Select **Edit** to edit points within the table.
3. Select **Add** to add a new point to the table.
4. Select **Depth** (either TOF or units), and adjust the value of the point depth.
5. Select the **dB** column and vary the gain value.
6. Repeat steps 3 to 5 to continue adding points and adjusting the gain across the screen range using TVG table.

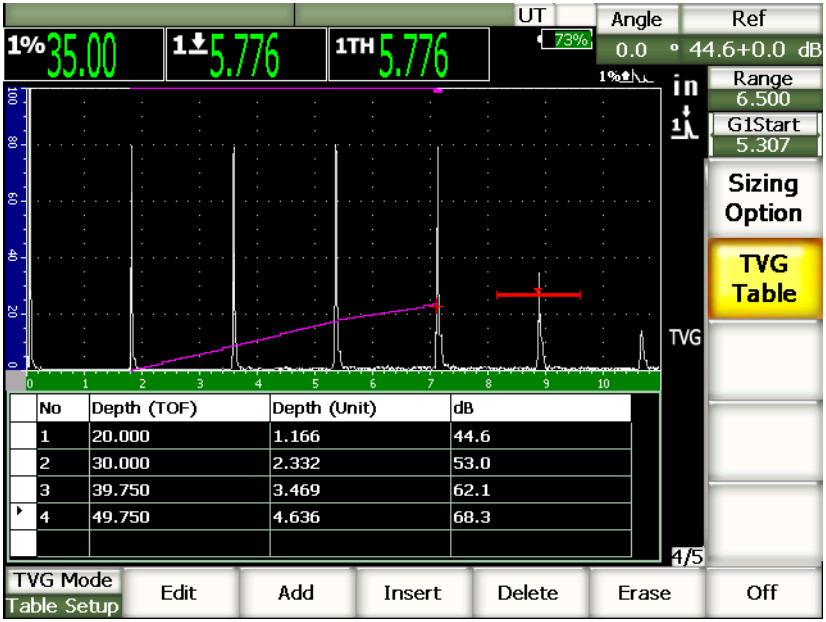

Figure 11-17 TVG table being set up (Table Setup mode)

7. Use the **[UP]** and **[DOWN]** arrow keys to move up and down between rows to edit previously adjusted points.
8. When finished, select **TVG Table Off > TVG Mode = Inspection** to hide the setup table and inspect using a full-screen A-scan view.

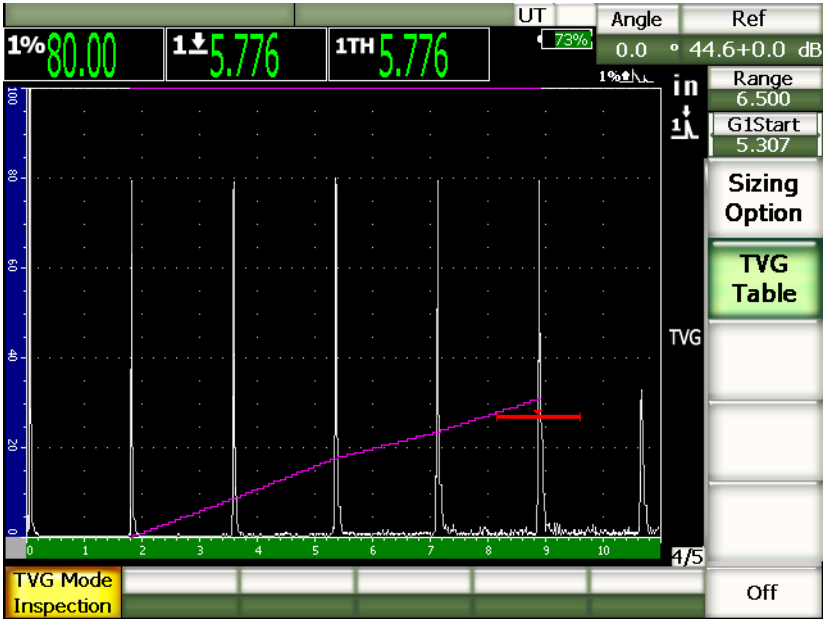

Figure 11-18 A-scan inspection with TVG table (Inspection mode)

11.3 DGS/AVG

The EPOCH 1000 Series onboard DGS/AVG option permits complete DGS/AVG setups to be performed on the instrument. With the DGS/AVG method, you can size defects based upon a calculated DGS/AVG curve for a given transducer, material, and reflector size. This method only requires that you have one reference-reflector in order to create a DGS curve for flaw sizing. This is much different than the DAC or TVG method that requires that you have representative defects at various depths within a part in order to create a curve for flaw sizing.

To setup DGS/AVG curves on the instrument very quickly, Olympus has developed a transducer library that is stored in the instrument's memory. This library contains the entire Atlas Series European specification conventional transducers as well as several other transducers that are commonly used by inspectors. The library includes five categories:

1. **Straight Beam** contact (includes protected face)
2. **Angle Beam** transducers

3. **Dual** transducers
4. **Custom Straight** contact
5. **Custom Angle** beam

All required data for building DGS/AVG curves is stored in the instrument's memory for each transducer in the library. If you want to use a probe that is not in the default library, you can enter the required transducer characteristics in the GageView Pro computer interface program and download them to the EPOCH 1000 Series instrument. Probes that are downloaded to the instrument appear in the custom transducers section of the transducer library.

The onboard DGS/AVG option provides you with rapid setup times and easy flaw-size evaluation. This software option has been designed to meet EN 583-2:2001 requirements. It is extremely important that you are familiar with this specification and others, and qualified according to local standards, to properly use this instrument function. Since the curves used for defect sizing are calculated based upon many variables, a proper instrument setup is required for accurate results.

11.3.1 Feature Activation and Setup

Prior to activation of the DGS/AVG option, the instrument must be properly calibrated to the material being inspected. You then activate the DGS/AVG option in the **DGS/AVG** setup page (shown in Figure 11-19 on page 260) by selecting **Sizing Option > DGS/AVG**.

Figure 11-19 The DGS/AVG setup page

This screen allows you to define the exact probe being used for the inspection and set up the DGS/AVG curve to be drawn. There are several adjustments that can be made from this setup page:

DGS/AVG

Activate/deactivate the DGS/AVG function.

Probe Type

Select the type of probe to be used (Straight Beam, Angle Beam, Dual, or Custom).

Probe Name

Select the actual probe to be used.

Reflector Type

Define the type of reflector to be used to acquire a reference indication to build the DGS/AVG curve:

- For straight beam and dual probes, the available reflectors are:
  - Back wall
  - Side-drilled hole (SDH)
  - Flat-bottom hole (FBH)
- For angle beam probes, the available reflectors are:
  - K1-IIW block arc
  - K2-DSC block
  - Side-drilled hole (SDH)
  - Flat-bottom hole (FBH)

Reflector Dia.

Used for FBH and SDH reflector types only. This allows you to define the diameter of the flat-bottom hole (FBH) or side-drilled hole (SDH) used as a reference-reflector. This size is required to properly position the DGS/AVG curve.

DeltaVk

Used for angle beam inspections with reference-reflector K1-IIW or K2-DSC blocks only. This correction value for the angle beam transducer can be found listed on the DGS/AVG diagram for the selected transducer.

DeltaVt

Transfer correction value used to compensate in amplitude differences as a result of coupling variation (surface condition) from the calibration block to the test piece. EN 583-2:2001 provides methods for calculating transfer correction.

Reg. Level

The height of the main DGS/AVG curve. The curve represents the expected amplitude response across a thickness range from a flat-bottom hole whose diameter is equal to the registration level. This is usually equal to the critical flaw size for the application. This value is limited to the effective diameter of the transducer in use.

Warning Level

This is the position of the secondary DGS/AVG “warning” curve compared to the position of the main DGS/AVG curve. If this value is set to zero, the warning curve is turned off.

AcvSpecimen

This is the attenuation value in dB/m for the test piece (specimen). In some cases, it is necessary to calculate the relative attenuation within the test piece and enter the value here.

AcvCalBlock

This is the attenuation value in dB/m for the calibration block. In some cases, it is necessary to calculate the relative attenuation within the calibration block and enter the value here.

X Value

Used for angle beam inspections only. This is the length of the transducer wedge from the BIP to the front of the wedge, and is used to remove the wedge length from surface distance measurements.

NOTE

You must have been trained to know when it is necessary to apply values to **AcvSpecimen** and **AcvCalBlock**. These values affect the shape of the DGS/AVG curve and, therefore, affect the accuracy of defect sizing. A suggested method for the measurement of relative attenuation is provided in "Relative Attenuation Measurement" on page 267.

When you have correctly completed the selections in the DGS/AVG setup page, press **[ESCAPE]** to return the live A-scan display.

To complete the DGS/AVG curve setup

1. Couple the transducer to the calibration block and obtain a reflection from the selected reference-reflector.
2. Press **[GATE]** to gate the reference indication.
3. Press **[2ND F]**, **[GATE] (AUTO XX%)** to bring the reference-reflector to 80 % FSH.
4. Select **DGS Setup > Ref** to capture the reference-reflector, and then press the **[CHECK]** key to build the DGS/AVG curve.

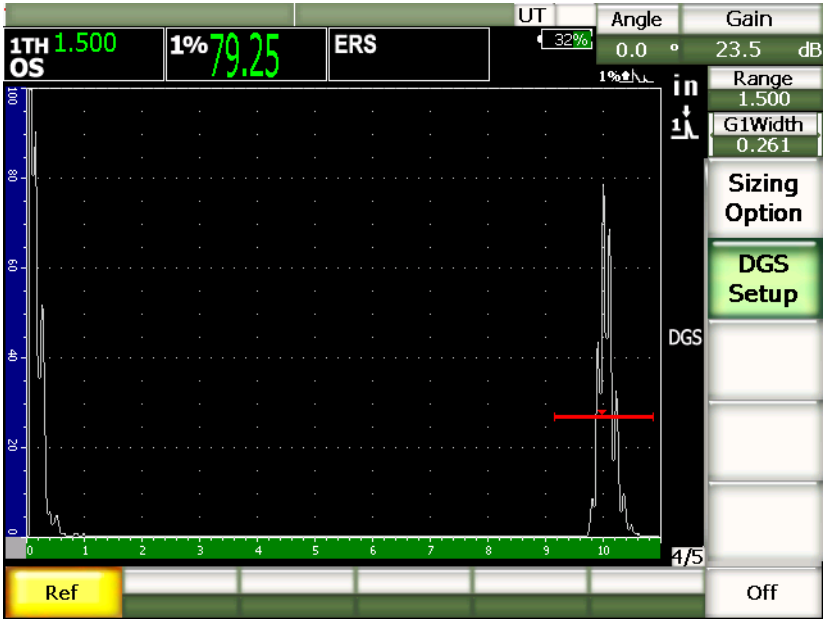

Figure 11-20 Reference-reflector before capture

After capturing the reference-reflector, the EPOCH 1000 Series instrument automatically calculates the DGS/AVG curve(s) and displays the results at the correct registration level amplitude on the screen.

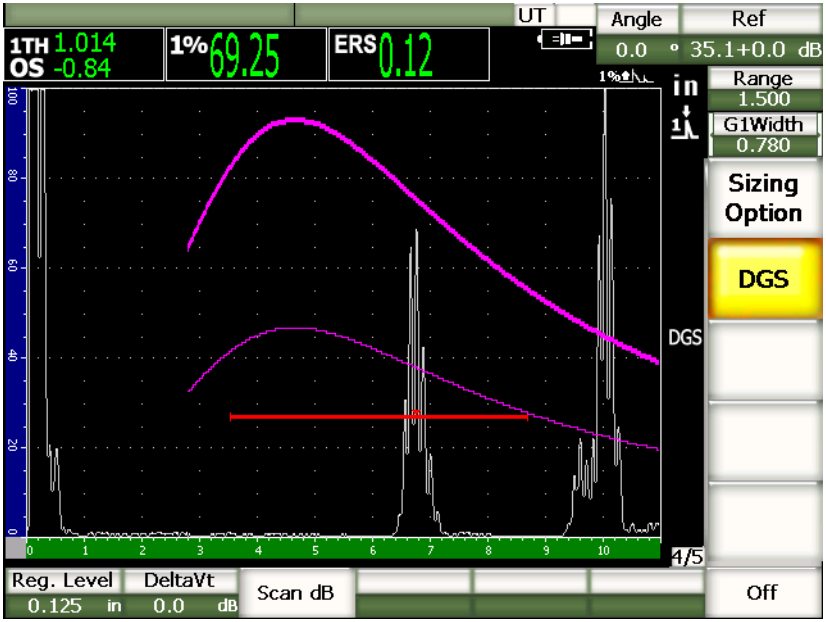

Figure 11-21 DGS/AVG curves on the screen

11.3.2 Measurement Warnings and Limitations

The EPOCH 1000 Series DGS/AVG function incorporates several measurement value warnings and limitations based on the live setup of the inspection. These are designed to eliminate incorrect measurements or warn you that a measurement could be incorrect. These include:

- When the echo amplitude exceeds the full screen height of the display, both the equivalent reflector size (ERS) and overshoot (OS) measurements become blank.
- When the DGS/AVG curve exceeds the full screen height of the display, both the ERS and OS measurements become blank.
- If the echo is measured before the beginning of the DGS/AVG curve, both the ERS and OS measurements display loss of signal (LOS).
- When an echo is measured beyond the 10th division of the screen, both the ERS and OS measurements display loss of signal.
- If the ERS measurement exceeds the effective diameter of the probe in use, the ERS measurement turns red.

- If the echo amplitude is measured below 10 % full screen height, both the ERS and OS measurements are red.

11.3.3 Curve Adjustment Options

After a DGS/AVG curve has been calculated on the EPOCH 1000 Series instrument, it is possible to make adjustments to that curve during an inspection. These adjustments include gain adjustments allowing proper defect scanning and code-compliant defect sizing, as well as reference-reflector adjustments.

11.3.4 Transfer Correction

Transfer correction is an adjustment in the reference gain setting during calibration of the instrument. It is typically added when the surface conditions of a calibration block and the test piece are different. The coupling conditions on the test surface can often cause signal loss after calibrating a DGS/AVG curve, which results in inaccurate comparisons of the test reflectors with the calibrated DGS/AVG curve. You can easily adjust EPOCH 1000 Series instruments for this potential difference by adding transfer correction to the calibrated base gain after completing the DGS/AVG curve setup.

The transfer correction can be added during initial setup of the DGS/AVG curve (**DeltaVt** value), but typically this factor is unknown until after the setup has been completed.

To add transfer correction to a completed DGS/AVG curve

◆ Select **DGS > DeltaVt** to adjust the value of the transfer correction.

NOTE

When adjusting transfer correction, the curve height should remain constant, but the echo height changes.

11.3.5 DGS/AVG Curve Gain

The overall gain level of the entire DGS/AVG curve can be adjusted higher or lower from the reference gain. Most inspection codes do not permit reflectors to be sized below 20 % FSH. Therefore, to inspect beyond a certain depth/sound path time within

a part, it is necessary to raise the gain of both the live A-scan and the DGS/AVG curve to continue the inspection. This is accomplished on the EPOCH 1000 Series instrument by adjusting the DGS/AVG curve gain.

To adjust the DGS/AVG curve gain

1. Press **[GAIN]**.
2. Adjust the curve gain. The curve-gain difference is added/subtracted from the instrument base (reference) gain.

NOTE

The DGS/AVG curve gain adjustment is applied to both the echo height and curve height to maintain the amplitude ratio and therefore the sizing comparisons.

Figure 11-22 on page 266 shows a DGS/AVG setup with curve-gain in use to provide accurate echo-amplitude measurement by placing the echo close to 80 % FSH.

Figure 11-22 Gain curve adjusted DGS

11.3.6 Registration Level Adjustment

The registration level of the DGS/AVG curve defines the height of the main curve. The curve represents the expected amplitude response across a thickness range from a flat-bottom hole whose diameter is equal to the registration level. This is usually equal to the critical flaw size for the application. EPOCH 1000 Series instruments allow you to adjust this registration level during a live inspection.

NOTE

This curve-height adjustment is possible because the DGS/AVG curves are calculated based on a captured reference-reflector and mathematical probe data. This allows the EPOCH 1000 Series instrument to plot the attenuation curve (in steel) for a particular size reflector without having to acquire individual data points, as is required in a DAC/TVG setup. This is one of the key advantages of the DGS/AVG sizing technique over the DAC/TVG sizing technique.

To adjust the registration level

◆ Select **DGS > Reg. Level** to adjust the current registration-level value.

11.3.7 Relative Attenuation Measurement

There are several methods for measuring the ultrasonic attenuation within a material. Often the procedure measures absolute attenuation in a material. This usually requires an immersion test setup and a time-consuming set of measurements. For the purpose of flaw sizing with the DGS/AVG method, under certain conditions, it may be suitable to measure relative attenuation in the test piece or calibration block as needed. This section outlines one method of relative attenuation measurement that is simple and has been found to be generally effective. There might be more suitable methods available. You must decide the most appropriate method to arrive at the values for **AcvSpecimen** and **AcvCalBlock** based on the application and local requirements.

Measurements:

Δ Vg = Gain difference between two successive back wall echoes (d and 2d)

Δ Ve = From DGS/AVG diagram. Gain difference on back wall curve from d to 2d

Calculations:

Δ **Vs** = Δ **Vg** - Δ **Ve** [mm]

Sound attenuation coefficient: α = Δ **Vs** / 2d * 1000 [dB/m]

11.4 AWS D1.1/D1.5 Weld Rating Software

The AWS D1.1 software option for the EPOCH 1000 Series has been created to assist you in performing inspections covered under the American Welding Society D1.1 (or D1.5) Structural Welding code for steel. This code provides inspectors with a method to classify discontinuities found in welds using ultrasonic inspection. This code uses the following formula to develop an indication rating for a reflector found during an inspection:

$$A - B - C = D$$

where:

A = Discontinuity indication level (dB)

B = Reference indication level (dB)

C = Attenuation factor: 2 * (sound path in inches — 1 in. [2.54 mm]) (dB)

D = Indication rating (dB)

The AWS D1.1 inspector must use the Indication Rating (D) that is calculated based on A, B, and C when referencing to an “Ultrasonic Acceptance — Rejection Criteria” table produced by the AWS in order to classify the severity of the discontinuity that has been located. As an inspection is performed, you are required to develop an AWS report that lists the values for all variables listed above as well as transducer information, discontinuity length and location, and the overall evaluation of the discontinuity.

For further details regarding the test equipment, methods, interpretation, and classification requirements for these inspections, please refer to the AWS D1.1 Code Book.

11.4.1 Description

Olympus has developed the AWS D1.1 software option for the EPOCH 1000 Series, with the goal of simplifying inspector tasks and lowering the overall inspection time. This is accomplished by having the EPOCH 1000 Series instrument perform some required calculations automatically and also by permitting the inspector to document discontinuities in the instrument's data logger for reporting purposes.

The EPOCH 1000 Series instrument can also transfer inspection data to the GageView Pro computer interface program to aid in report generation. This program allows the inspector to view the instrument's setup parameters, the waveform generated by a discontinuity, the discontinuity's sound path and location information, and all values for the AWS D1.1 formula variables.

11.4.2 Feature Activation

The first step in operating EPOCH 1000 Series instruments for AWS D1.1 inspections is to calibrate for the transducer and test conditions. For information on the angle beam calibration of the EPOCH 1000 Series, see the calibration section of this manual or the appropriate guidelines from the American Welding Society.

To activate the AWS software feature

◆ Select **Sizing Option > AWS D1.1 = On**.

After activation, you must set a **Ref B** value in order to begin an inspection. This number represents the gain level necessary to bring the echo from a reference-reflector to the desired reference level for the inspection. The reference-reflector is often a side-drilled hole in the calibration block used for the angle beam calibration. Other reference-reflectors can be used, provided that they meet AWS requirements for these inspections. To set the reference level, select **AWS Setup > Ref Level**, and then adjust to the desired value.

To store a Ref B value

1. Use the **[GATE]** key to gate the echo from the reference-reflector.
2. Press **[2ND F]**, **[GATE] (AUTO XX%)** to bring the echo to the reference level.
3. Select **AWS > Ref B** to store the gated reflector as the **Ref B** value.

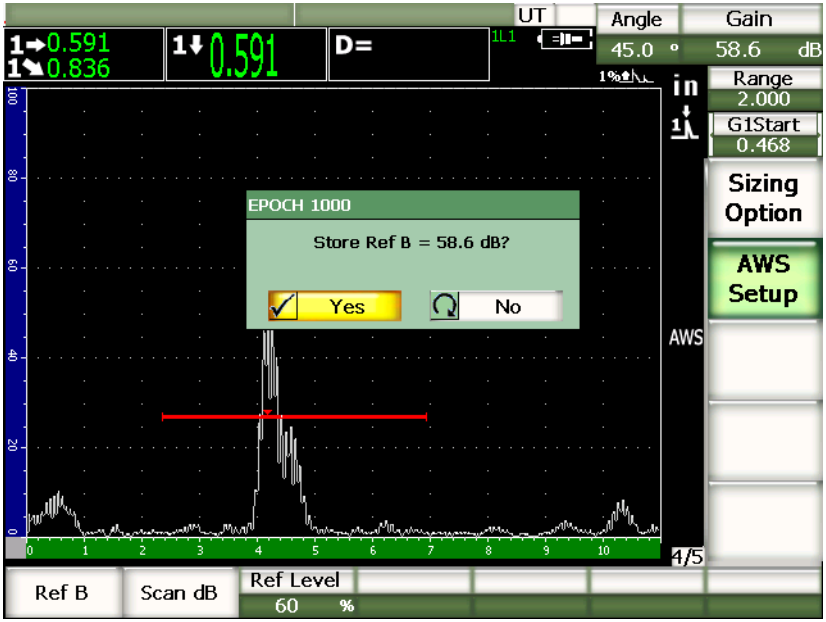

Figure 11-23 Reference B being stored

Once the **Ref B** value is stored, the instrument displays a live D rating of any gated indication. This live D value, which represents the defect indication rating used with the published “AWS Acceptance - Rejection Criteria” tables to classify a potential flaw, can be viewed as a separate measurement reading in one of the six boxes. To activate and view this measurement, see “Reading Setup Page” on page 82.

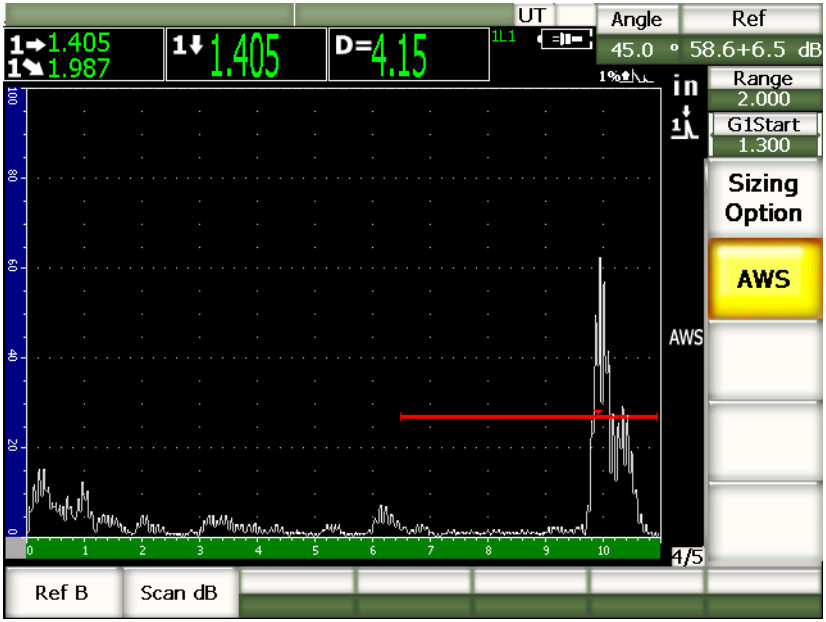

Figure 11-24 Active AWS with D rating

11.4.3 Scanning Gain

AWS codes require that you enter a certain amount of scanning gain to the **Ref B** gain value. This allows you to locate flaws that might be smaller or deeper in the test piece than the reference flaw.

To add scanning gain

1. Use the **[GAIN]** key to adjust the scanning-gain value necessary to perform the inspection as outlined by the AWS Code.
2. Select **AWS > Scan dB** to toggle the scanning gain on and off as necessary.

NOTE

To display a D indication rating value, the gated echo must peak at an amplitude less than 110 % FSH. Often, you simply have to turn off the scanning gain to bring the echo peak onto the screen. In some cases, further gain adjustments may be necessary.

11.4.4 Calculating A and C Values

When a gated echo whose peak is below 100 % FSH is present, the EPOCH 1000 Series instrument automatically calculates the A and C values necessary to provide a D indication rating value. For A, the EPOCH 1000 Series instrument automatically calculates the required dB value to bring the gated echo to 80 % FSH. To calculate C, the instrument uses the data in the sound path calculator to generate an attenuation factor.

NOTE

In order for this calculation to be accurate, you must enter the correct thickness for the test piece.

By pressing **[SAVE]**, you can now save the data for this discontinuity in the EPOCH 1000 Series data logger. For general data logger information, see “Managing the Data Logger” on page 187.

At the bottom of an ID saved with AWS D1.1 active, you can see the values for A, B, C, and D. This data is viewable in the file review window.

NOTE

While using the EPOCH 1000 Series with the AWS D1.1 software option activated, it is your responsibility to take into account any inspection conditions that could cause variations in the displayed indication rating (D value), and also properly interpret the meaning of echo indications and reported D values corresponding to these indications.

11.5 Interface Gate

The EPOCH 1000 Series offers a third gate, the interface gate, as a software option. This interface gate is principally used in immersion applications where the water path distance between the front surface of the test material and the transducer face is continuously changing. The application may involve an “on-line” type approach with the test material moving steadily past a stationary transducer (or vice versa). If the front surface of the test material is not uniform, a slight difference in the water path distance may result. The interface gate option tracks the position of the reflection from the interface of the water path and test piece and compensates for the variance in this reflector’s position. The interface gate is also commonly used with captive water column transducers.

11.5.1 Option Activation

When the interface gate option is activated, the **IF Gate** submenu becomes available. The interface gate status, positioning, and alarm conditions are controlled via the same methods described in chapter “Gates (Conventional UT Mode)” on page 123.

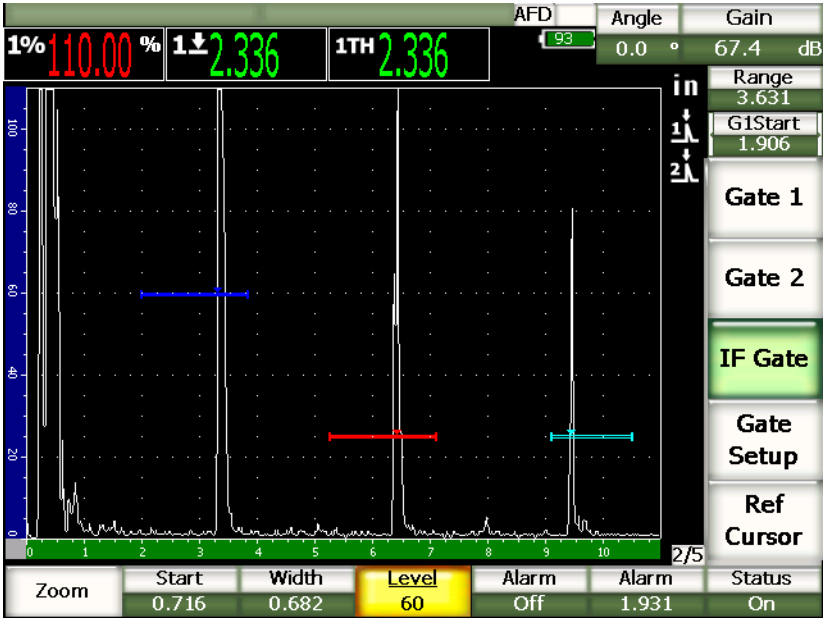

Figure 11-25 The Active IF gate with IF Gate submenu

11.5.2 Setup and Operation

The start, width, and level positions of the interface gate can be adjusted in the **IF Gate** submenu. You can enter a velocity for IF Gate measurements in the **Gate Setup > Setup** submenu under **GateIF Velocity**. Gate tracking settings can be set up using **Gate Setup > G1 Tracks** and **Gate Setup > G2 Tracks**.

The interface gate can be set to Run mode. This mode captures and tracks the indication breaking the IF gate and holds this reflection at the left side of the display. This indication becomes the “acoustic zero” point’ all measurement readings use this indication as the value for zero offset, much like an echo-to-echo measurement.

NOTE

The indication being tracked by the interface gate is determined by the gate measurement mode. For instance, if the interface gate is in edge detection mode, the tracked indication is the first echo to break the interface gate threshold.

To adjust the interface gate operating mode

◆ Select **Gate Setup > IF Run = On** or **Off** (see Figure 11-26 on page 275).

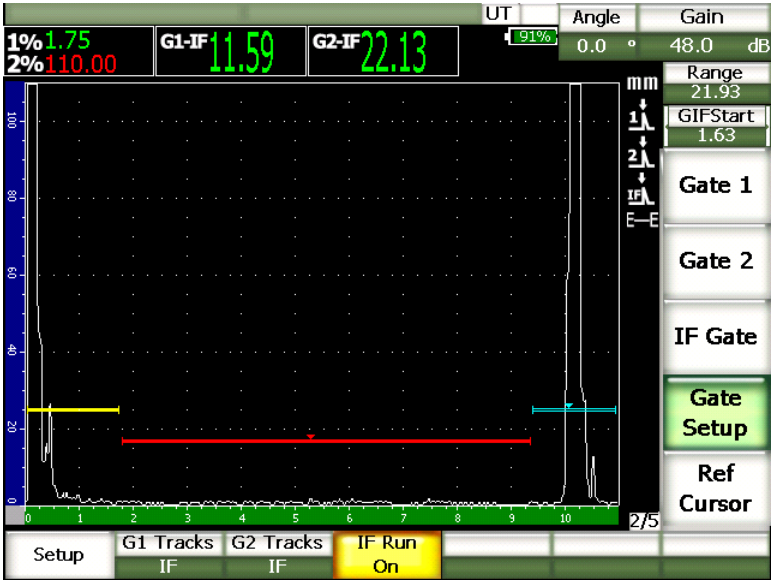

Figure 11-26 IF Gate in Run mode

Interface gate can be used in conjunction with other software features, such as TVG table and DGS/AVG. This allows these features to operate during immersion inspections as well as manual inspections.

When used with TVG table, the interface gate must be activated prior to setting up the TVG table (for additional information on TVG table see “TVG Table” on page 254). The TVG curve will track the interface gate (see Figure 11-27 on page 276).

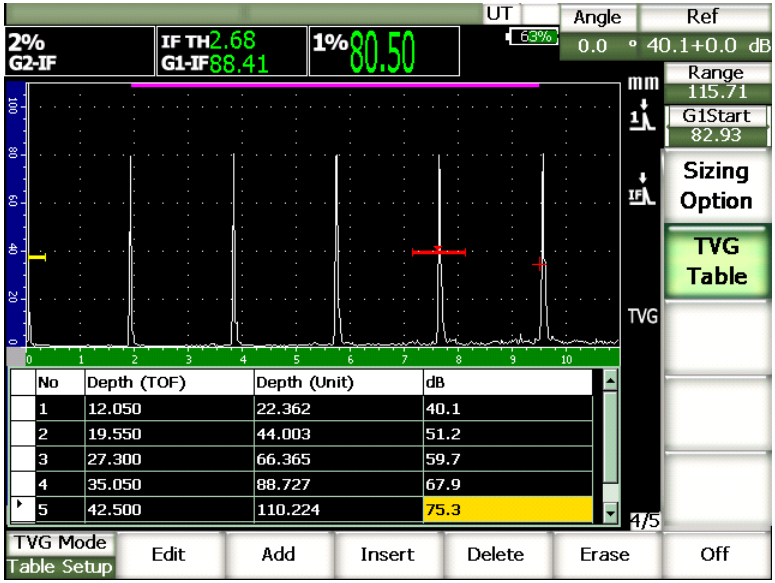

Figure 11-27 TVG table setup with IF gate

11.5.3 Gate Measurements and Alarms

The interface gate does not allow the same standard measurements as gate 1 and gate 2. The interface gate only measures the thickness of a given indication, when applicable.

Individual gate alarms can be set while the interface gate is active. The negative threshold alarm is most common when looking for interface echo drop-out. For more information about setting up gate alarms, see “Gates (Conventional UT Mode)” on page 123.

11.6 Floating Gate

The EPOCH 1000 Series features a floating gate software option. This optional gate function is used to track the peak echo amplitude at a specified gain level below that amplitude (−1 dB to −14 dB in 1 dB increments). The floating gate option provides a more consistent and accurate thickness reading, particularly when using edge-detection mode. In edge-detection mode, the floating gate tracks the highest

amplitude echo breaking the gate, but reports a measurement reading from the first leading edge to break the gate threshold. If the indication height fluctuates, the floating gate tracks this fluctuation to provide more consistent measurements from the same point along the indication's leading edge.

11.6.1 Option Activation

To activate the floating gate option, open the **Gates** setup page by selecting **Gate Setup > Setup** and setting **G<*n*> Float** to **On**. Then select **Gate<*n*> Level** to adjust the level (in dB) at which the gate tracks below the peak amplitude indication.

Figure 11-28 The floating gate setup page

11.6.2 Operating in −6 dB Mode

In −6 dB mode, the desired gate floats at 6 dB below the peak-echo amplitude in the gate. This corresponds to 50 % of the echo's maximum height. Figure 11-29 on page 278 depicts gate 1 with floating gate active in the −6 dB mode. Note that the gate is exactly at 50 % of the echo's peak amplitude. The peak amplitude is at approximately 80 % of the full-screen height.

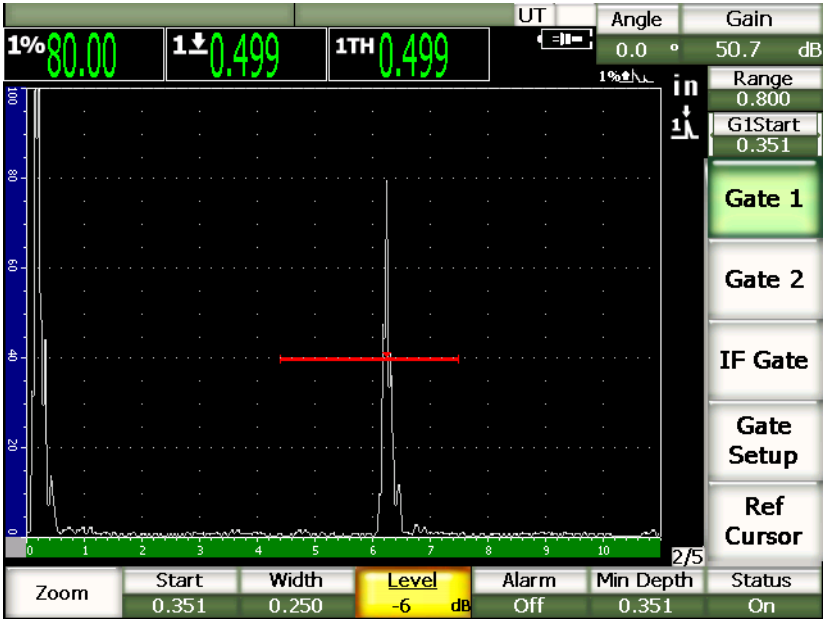

Figure 11-29 Indication using −6 dB floating gate

11.6.3 Operating in −14 dB Mode

In −14 dB mode, the desired gate floats at 14 dB below the peak-echo amplitude in the gate. This corresponds to 20 % of the echo's maximum height. Figure 11-30 on page 279 depicts gate 1 with floating gate active in the −14 dB mode. Note that the gate is exactly at 20 % of the echo's peak amplitude. The peak amplitude is at approximately 80 % of the full-screen height.

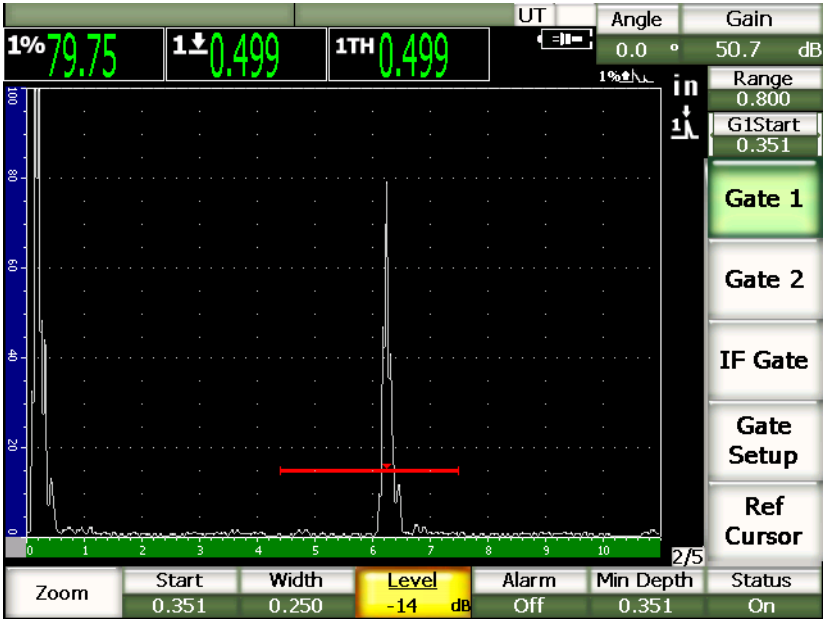

Figure 11-30 Indication using –14 dB floating gate

NOTE

The floating gate option is not valid in **RF** mode. Also, the floating gate cannot be turned on or off while the screen is frozen.

11.6.4 Gate Alarms

Individual gate alarms can be set while the floating gate is active. The minimum depth alarm is most commonly used to monitor thinning areas in the material when floating gate is active and the gates are in edge-detection mode.

11.7 B-Scan

The B-scan software option allows you to generate two types of B-scans: single value and cross-sectional. A single value B-scan represents the side profile of a test material based on thickness or time-of-flight (TOF) measurement. This view, typically used in corrosion scanning applications, is used to verify acquired thickness measurements, and also to provide a visual reference showing areas on the part with critical thickness values. Cross sectional B-scans, used commonly in zero-degree laminar applications, provide an amplitude based image of data over a scanned distance.

A scanner equipped with an internal encoder mechanism can provide transducer-location information (distance traveled) in addition to the thickness reading. This feature increases the functional value of the B-scan as relative location in the material is directly correlated with a thickness measurement at that location. The maximum scan rate is 1200 Hz, or 800 Hz with A-scan storage active. The scan rate is equal to the PRF, when the PRF value is less than or equal to the maximum scan rate.

The B-scan has three separate operating modes:

- Bidirectional Encoded Mode: this mode requires the use of a bidirectional encoder that records location information as data is collected in both forward and backward directions.
- Unidirectional Encoded Mode: this mode requires the use of a bidirectional or unidirectional encoder and records location information as data is collected in either the forward or backward direction as if data is collected in one direction only.
- Timed Mode: this mode does not record location information and does not require the use of an encoder. This mode provides a continuous scan of thickness data with no correlation to its location along the scan. Readings are timed from 1 up to 1 200 readings per second (based on PRF setting) and are not related to transducer movement.

11.7.1 Required Equipment

Olympus offers a handheld portable scanner with an internal encoder (BSCAN-ENC) for use with the B-scan option, which is well suited for a variety of applications. The scanner and general B-scan package (EP1000-BSCAN-KIT-XX) are available with the following optional accessories:

- Magnetic wheels (BSCAN-MW)
- Extension pole bracket (BSCAN-EPB)

- Extended Probe holder wear cap (BSCAN-EWC)
- Transducer and encoder cables of various lengths ([1]XCMD-316-[2]YB, EP1000-ENC-CBL-[3]Z)

You can use other encoders that have a standard TTL quadrature position encoder and a four-conductor connection with a single +5 V power supply. You can also use a remote control scanner to provide a more automated inspection.

To configure the EPOCH 1000 instrument and encoder cart

1. Insert your D790-SM (or similar) transducer, with attached cable, into the encoder cart's probe holder, and then secure the transducer using the two tightening screws.
2. Connect the transducer cable into the BNC or LEMO connector on the EPOCH 1000 Series instrument. This cable provides the ultrasonic information from the transducer to the instrument.
3. Attach the LEMO connector of the encoder cable into the encoder cart. The 26-pin connector plugs into the ALARMS connector on the back of the EPOCH 1000 Series instrument.
4. *Optional*: Connect a couplant feed to the couplant feed port on the scanner, which allows for continuous transducer coupling when used with a water pump or pressurized couplant dispenser.

11.7.2 Option Activation and Setup

When the B-scan option is enabled, the **B-Scan** activation submenu becomes available. Once the B-scan option has been activated, a new set of submenus appear as menu 5/6, which contains additional parameters and controls for use in B-scan inspections. Data logger and reporting functions are now be located in menu 6/6. The functions in the new menu are described below:

- Encoder

  Used to perform an encoder calibration

1.X = Connector type indicating BNC or large LEMO. Replace X in the part number with B to indicate a BNC connector, or L1 to indicate a large LEMO connector.
2.Y = Transducer cable length indicating 3 m (10 ft), 7.5 m (25 ft), 15 m (50 ft), or 30 m (100 ft). Replace Y in the part number with the desired cable length.
3.Z = Encoder cable length indicating 3 m (10 ft), 7.5 m (25 ft), 15 m (50 ft), or 30 m (100 ft). Replace Z in the part number with the desired cable length.

- Cursors
  Position controls for X and Y sizing cursors
- Tools
  Statistics and other post-analysis functions

NOTE

The floating gate option is included with the purchase of the B-scan software and may be used to set the gate height. See “Floating Gate” on page 276 for additional information on floating gate.

11.7.2.1 Initial Setup

Before entering the B-scan mode, it is extremely important that the EPOCH 1000 Series instrument is calibrated and set up properly in the A-scan screen.

To properly set up to perform a B-scan

1. Calibrate the EPOCH 1000 Series instrument for the appropriate transducer and material (for calibration procedures, see “Calibrating the EPOCH 1000 Series (Conventional UT Mode)” on page 147).
2. Position Gate 1 so that the start of the gate is positioned prior to the minimum expected thickness or at zero. Do not capture the initial pulse or interface echo in Gate 1.
3. Position the end of Gate 1 after the maximum expected reading. In edge mode, an echo must break the gate for the instrument to detect it and display a B-scan data point.

When the B-scan mode is turned on, the Gate Start and Gate End positions determine the vertical scale of the single value B-scan. For the best resolution, position the gate as near as possible to the minimum and maximum values expected. Use a slight buffer to include potential unexpected values. The EPOCH 1000 Series instrument automatically zooms the gate and expands the range until the gate represents a full screen. For cross sectional B-scans, be sure to adjust your range to include all points you want to be included on the scan.

11.7.2.2 Scan Rate

When acquiring B-scan data in one of the encoded modes, an alarm is triggered if the scanner is moved too fast for the EPOCH 1000 Series instrument to acquire and display data. The encoder's current scan rate (SR) can be displayed on the top of the screen in the measurement locations when operating in the B-scan mode (see "Reading Setup Page" on page 82).

- The maximum scan rate for B-scan inspections is 1200 measurements/s (1200 Hz).
- With A-scan storage active, the maximum scan rate is limited to 800 measurements/s (800 Hz).
- The scan rate is equal to the PRF for values less than or equal to the maximum scan rate.

If the encoder is moved too fast and exceeds these values, a scan speed alarm condition is noted by an audible beep. Encoded distance traveled (DT) data is kept in sync with the scanner, but no thickness data is drawn on the screen. Bi-directional mode allows the scanner to move in the opposite direction at a slower speed to redraw these thickness values. For fine scan resolution, move the scanner at a slower rate to avoid missing data points. You can adjust the resolution in the **B Scan > Setup** submenu.

11.7.3 Creating an Encoded B-Scan

To create an encoded B-scan, begin with a fully calibrated A-scan setup with properly positioned gates.

To set up your B-scan

1. Select **B Scan > B-scan = On** to turn on the B-scan.

   Once the B-scan is turned on, additional parameters will display in the **B-scan Setup** page (see Figure 11-31 on page 284).

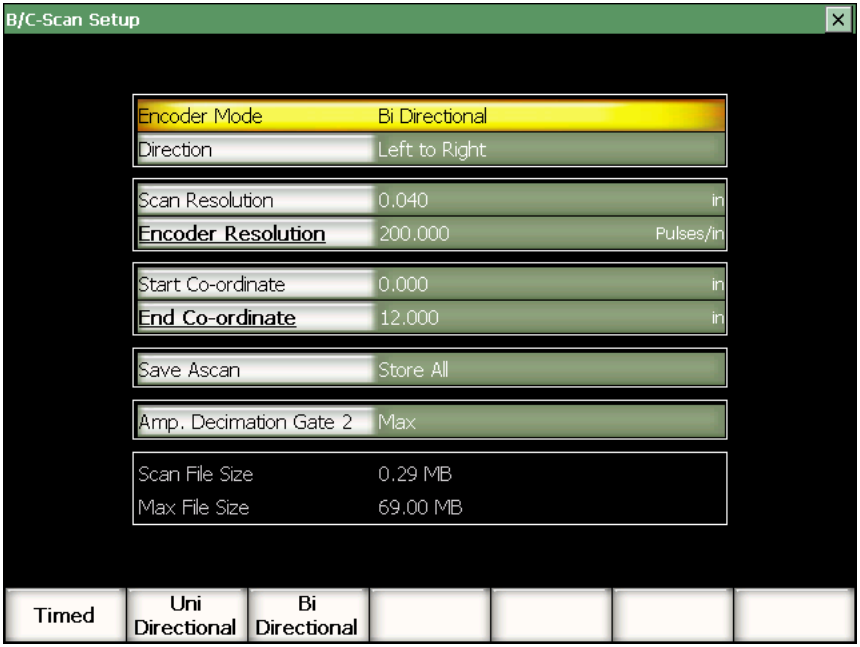

Figure 11-31 The B-scan Setup page

2. Select **B Scan > Setup** to enter the setup screen.
3. In the **Encoder Mode** box, select **Uni-directional** or **Bi-directional**.
4. In the **Direction** box, select a scan direction (this will determine the display view of the A-scan and B-scan image).
5. Set the **Scan Resolution** (spacing between B-scan points).

   This value will determine maximum scanning speed.

NOTE

Scan resolution is limited to increments of the encoder resolution that you are using. For example, if the encoder resolution is 200 pulses/in. (7.87 pulses/mm), then the best resolution possible is 0.005 in. (0.127 mm). Each pulse from the encoder is capable of taking readings in increments of 0.005 in. (0.127 mm). It is possible to take a reading

every other pulse, every third pulse, every fourth pulse, and so on. Therefore, the resolution can be changed in increments as follows:

- 0.005 in. (0.13 mm) — Takes a reading every 1 pulse
- 0.010 in. (0.26 mm) — Takes a reading every 2 pulses
- 0.015 in. (0.38 mm) — Takes a reading every 3 pulses
- 0.020 in. (0.51 mm) — Takes a reading every 4 pulses, and so on.

---

6. Enter the proper **Encoder Resolution** to ensure proper distance values are collected during the scan. The resolution for the BSCAN-ENC B-scan buggy is 200 pulses/in. (7.87 pulses/mm). If this value is unknown, see "Encoder Calibration" on page 298 for a complete encoder calibration procedure.
7. Set the desired **Start Co-ordinates** and **End Co-ordinates** for the scan.

NOTE

If you are beginning the scan at the end of a pipe or plate, you may want to enter a value of zero for the start position. If you are beginning a scan that is a certain distance from the end of the test piece, enter an appropriate start value for that position. You may find it helpful to mark the location on your material to indicate where you have started the inspection for later reference.

---

8. Select whether or not to **Save Ascan** images.

   The B-scan software can automatically save an A-scan image for each point on the B-scan. These A-scan images are necessary for creating a cross-sectional B-scan.
9. If Gate 2 is being used, select the amplitude decimation factor in the **Amp. Decimation Gate 2** box.

NOTE

For encoded B-scans, gate 1 amplitude compression is automatically set to maximum.

   The current **Scan File Size** based on the selected parameters is displayed. This parameter cannot exceed the **Max File Size** of approximately 70 MB.
10. Press the **[ESCAPE]** key to return to the live screen.

To begin acquiring data for your B-scan

1. Select **B Scan > Mode = Start**.

   OR

   Select **B Scan > Mode**, and then press **[CHECK]**.

2. Move your B-scan buggy and transducer along your test piece at the appropriate scan rate so that you do not receive an LOS measurement.

   As the scanner is moved, data is collected and displayed as a cross-sectional image of the test material. The number of data points is based on the movement of the encoder wheel in increments of the resolution entered in the setup screen. Bi-directional mode allows the scanner to move backwards; B-scan data points are updated accordingly (see Figure 11-32 on page 286).

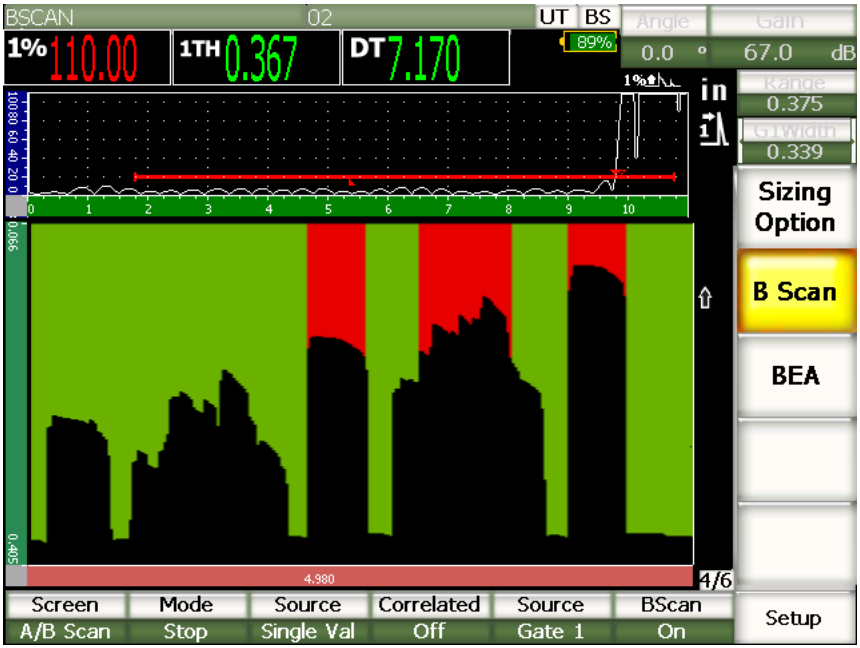

Figure 11-32 An acquired encoded B-scan

11.7.4 Creating a Timed B-Scan

To create a timed B-scan, begin with a fully calibrated A-scan setup with properly positioned gates.

To set up your B-scan

1. Select **B Scan > B-scan = On** to turn on the B-scan.

   Once the B-scan is turned on, additional parameters will display in the **B-scan Setup** submenu.
2. Select **B Scan > Setup** to enter the setup screen (see Figure 11-33 on page 287).

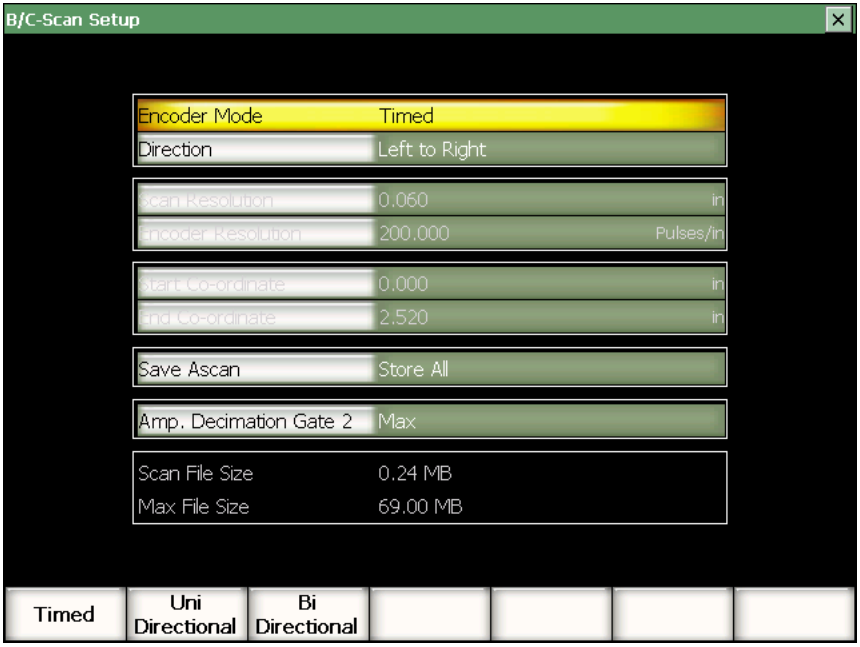

Figure 11-33 The B-Scan Setup page

3. In the **Encoder Mode** box, select **Timed**.
4. In the **Direction** box, select a scan direction (this will determine the display view of the A-scan and B-scan image).

5. Select whether to **Save Ascan** images. These A-scan images are necessary for creating a cross-sectional B-scan.

   The current **Scan File Size** based on the selected parameters is displayed. This parameter cannot exceed the **Max File Size** of approximately 70 MB.
6. Press the **[ESCAPE]** key to return to the live screen.

To begin acquiring data for your B-scan

1. Select **B Scan > Mode = Start**.

   OR

   Select **B Scan > Mode**, and then press **[CHECK]**.
2. Move your B-scan buggy and transducer along your test piece at the appropriate scan rate so that you do not receive an LOS measurement (see Figure 11-34 on page 289).

NOTE

The scan speed for timed B-scans is equal to the PRF. If the scan is moving too quickly, lower your PRF to reduce the scan speed (**Pulser > PRF**).

Figure 11-34 An acquired timed B-scan

11.7.5 Cross-Sectional B-Scan

In addition to the "traditional" single value B-scans on previous EPOCH instruments, the EPOCH 1000 Series also has the capability to create a cross-sectional B-scan. Cross-sectional B-scans draw a B-scan image based on full A-scan amplitude data, regardless of gate position, and are more commonly used in zero-degree laminar inspections. The depth axis on a cross-sectional B-scan uses the entire screen range, rather than just the gated region as on a single value B-scan.

To create a cross-sectional B-scan, A-scans are first digitized and converted to a color scale based on amplitude values. These points are plotted so that the colors are then displayed at the proper depth in the test piece. A-scans from successive transducer positions are "stacked" to form a true cross-sectional image, similar to a phased array zero-degree linear scan.

To switch to cross sectional B-scan view

◆ Select **B Scan > Source = Cross Sect** (see Figure 11-35 on page 290).

NOTE

Before acquiring your B-scan, to be able to create a cross-sectional B-scan on the EPOCH 1000 Series instrument, you must activate the automatic **Save Ascan** images function.

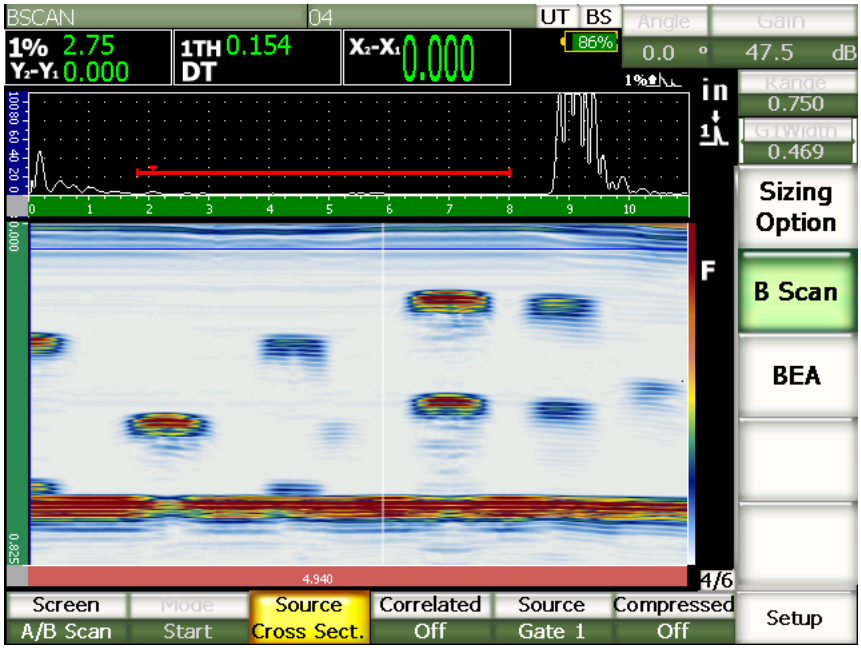

Figure 11-35 Cross-sectional B-scan view

11.7.6 Reviewing Acquired B-Scan Data

Once you have completed a B-scan, you can review the acquired data and source scans in Review Mode. Review Mode also provides image and sizing cursors for basic visual analysis.

11.7.6.1 Entering Review Mode

When you have finished your scan section, or to pause and review your acquired data, freezing your scan will bring you to review mode. When the scan is unfrozen you can continue the scan from the point where the scan was frozen.

To freeze the scan and enter review mode

- Press **[FREEZE]**.

  An "F" icon will display to the left of the scan to indicate that you are reviewing a frozen scan (see Figure 11-36 on page 291).

Figure 11-36 A frozen encoded B-scan

You can also stop the B-scan.

To stop the scan

1. Select **B Scan > Mode = Stop**.

   OR

   Press **[CHECK]** when **B Scan > Mode** is selected.
2. When the B-scan is stopped, save and recall the scan in order to review the data (see chapter "Managing the Data Logger" on page 187 for information about saving and recalling data).

   When the B-scan is restarted, it will create a new scan from the start point rather than resume from the last captured point.

11.7.6.2 Distance Traveled Cursor

The distance traveled (D.T.) cursor selects a specific distance or timed point along the scan axis. For encoded B-scans, the D.T. cursor will select a specific position along the scan axis in inches or millimeters. For timed B-scans, this cursor will correspond to a specific screen pixel along the scan axis.

If selected during the B-scan setup, a compressed A-scan will be stored for each point on the B-scan. The D.T. cursor is used to choose a particular B-scan point to view the A-scan image. The cursor will display as a white line on the B-scan image.

To adjust the D.T. cursor

- Select **Cursors > D.T.** (see Figure 11-37 on page 293).

Figure 11-37 Adjusting the D.T. cursor

11.7.6.3 Sizing Cursors

Sizing cursors are available for basic flaw sizing on the B-scan image. Based on your screen view, the X and Y cursors correspond to part depth (thickness) and scan distance (or time).

To turn on the sizing cursors

- Select **Cursors > Cursors = On** (see Figure 11-38 on page 294).

  The X and Y cursors can then be adjusted to take measurements in both directions along the scan. If you selected Auto measurement mode, the relevant cursor measurements are displayed in the measurement boxes above the scan. The cursors will form a shaded box around the selected area for easier viewing.

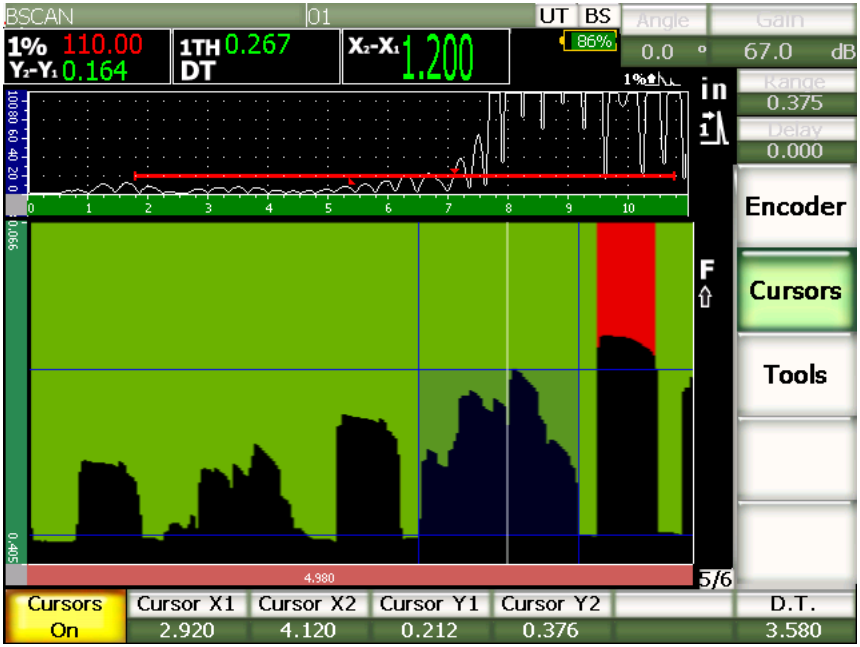

Figure 11-38 Adjusting the sizing cursors

NOTE

Timed B-scans do not provide position information along the scan axis, so cursors in this direction are not used for flaw sizing.

11.7.6.4 Correlated View

The Correlated view aligns the depth axis of the B-scan with the soundpath (part thickness) axis of the A-scan. This view is best used with cross-sectional B-scans, which are plotted over the full range of the A-scan. The A-scan and B-scan will then be aligned along the depth axis.

To turn correlated view on

- Select **B Scan > Correlated = On** (see Figure 11-39 on page 295).

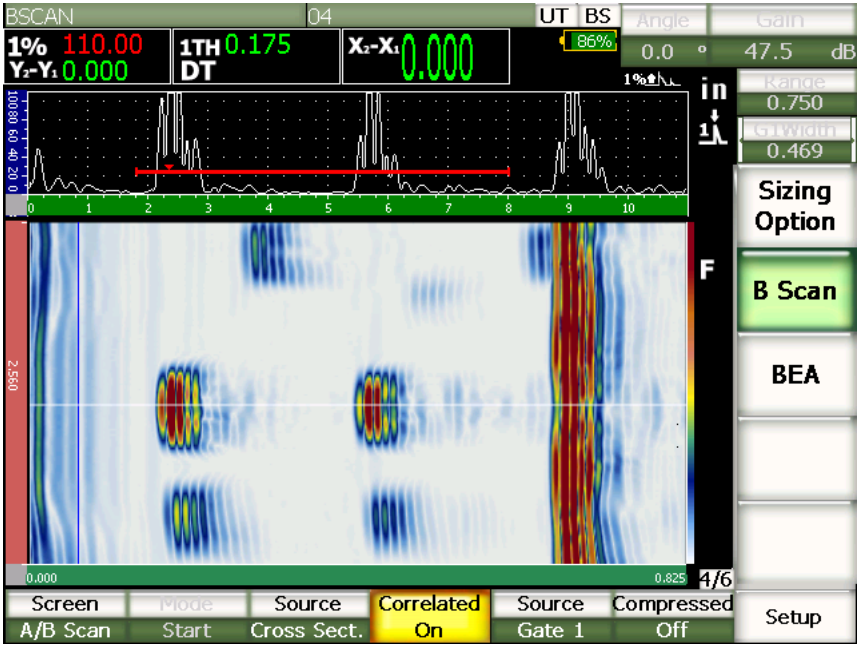

Figure 11-39 Correlated view of a cross-sectional B-scan

11.7.6.5 Changing Gate Source Data

If gates 1 and 2 are active, scan data for both gates is collected when a B-scan is created.

After acquiring a B-scan, you can adjust the **B Scan > Source** parameter to view other relevant B-scan data.

11.7.6.6 Compressed View

Because encoded B-scans allow for data collection for lengths longer than the screen width, the instrument offers you the option to compress the B-scan to view the entire scan on the screen.

To turn compressed view on

- Select **B Scan > Compressed = On** (see Figure 11-40 on page 296).

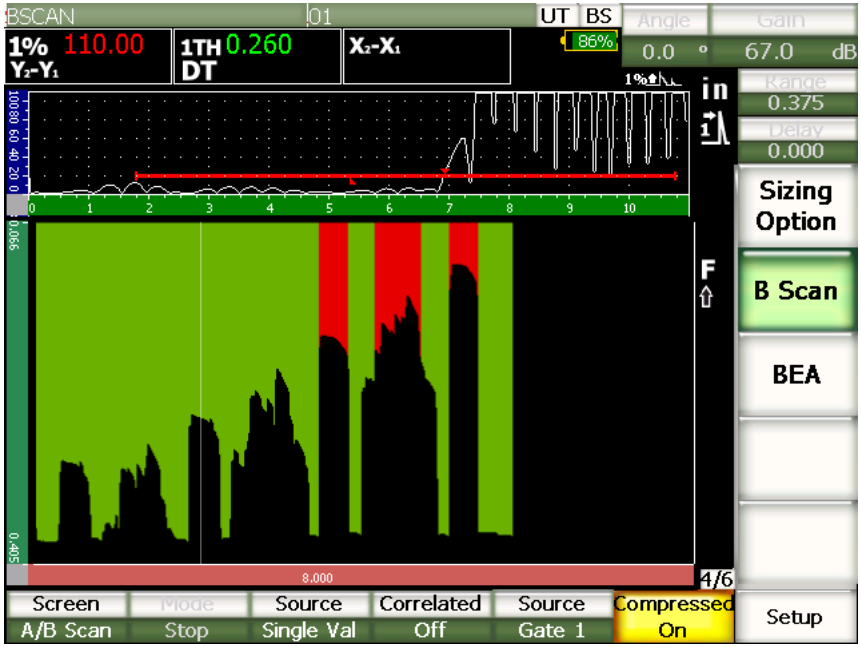

Figure 11-40 Compressed view

11.7.6.7 B-Scan Analysis

After a B-scan has been acquired, you can perform basic analysis onboard the EPOCH 1000 Series instrument. More extensive analysis, including a complete list of all B-scan thickness readings can be accessed through GageView Pro PC interface software.

EPOCH 1000 Series instruments are equipped with a minimum depth alarm, which is triggered whenever the current thickness reading falls below an user-defined level. The minimum depth alarm appears as a cursor on Gate 1 in single-gate mode or on Gate 2 in Echo-to-Echo mode. The alarm is noted by a flashing LED light on the instrument front panel, and a continuous audible tone. (See “Minimum Depth Alarm with a Single Gate” on page 134 and “Minimum Depth Alarm with Gate Tracking” on page 135 for further information.)

When an area of signals triggers the minimum depth alarm, the color of the B-scan changes. This provides you with an additional alert that the current thickness readings are below the minimum depth. In a Single Value B-scan, you can display critical thinning areas in red by adjusting the **Min Depth** alarm position.

To adjust the minimum depth

- Select **Gate 1 > Min Depth** (see Figure 11-41 on page 297).

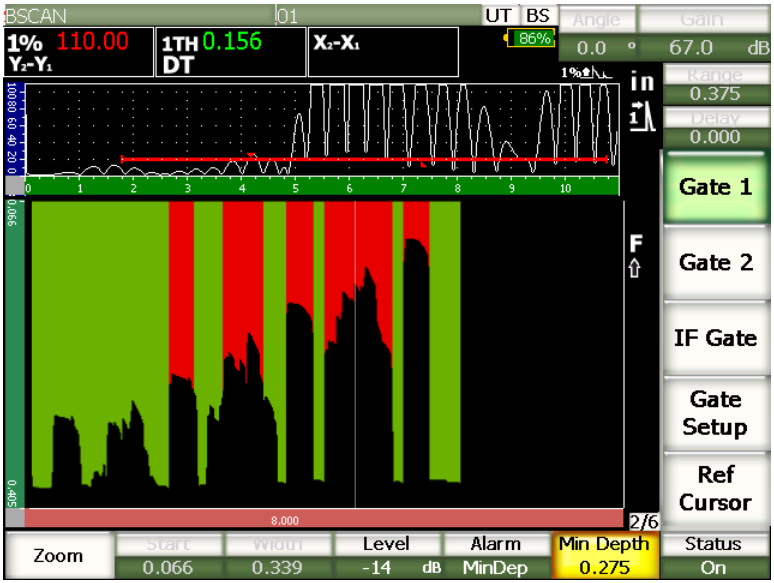

Figure 11-41 Adjusting the minimum depth value

EPOCH 1000 Series instruments also allow you to display statistics for the current acquired B-scan.

To view the information for the current B-scan

- Select **Tools > Statistics** when in review mode (see Figure 11-42 on page 298).

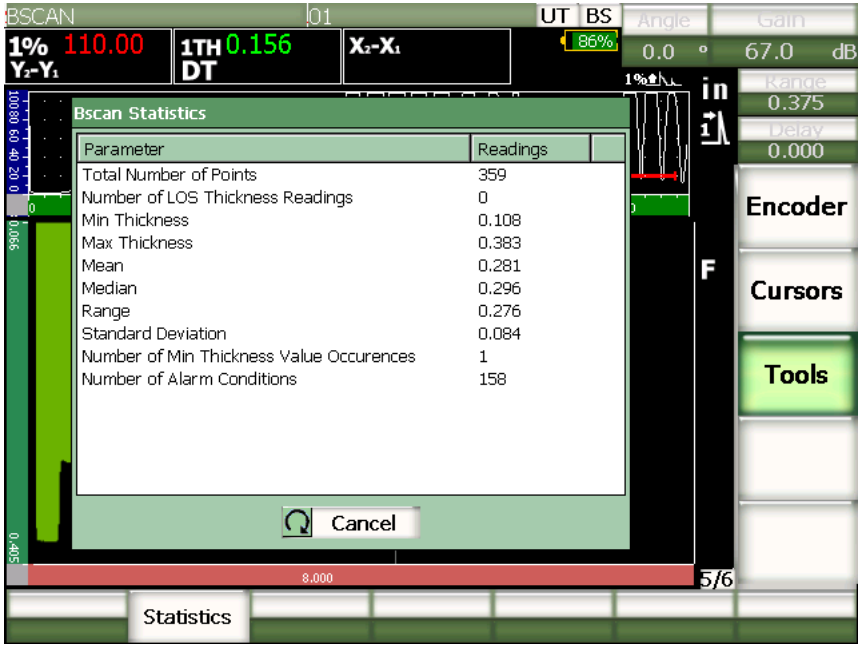

Figure 11-42 Viewing B-scan statistics

11.7.7 Encoder Calibration

Before creating an encoded B-scan, you must determine the correct encoder resolution to ensure accurate distance-traveled data. This is done through an encoder calibration process. The encoder resolution for the BSCAN-ENC encoder buggy is 200 pulses/in. (7.87 pulses/mm). If you are using a different encoder, you will need to perform the encoder calibration to determine this value. In addition to the B-scan encoder, transducer, and appropriate cables, you will need a ruler.

To perform the encoder calibration

1. Attach the encoder to your probe and wedge.
2. Enter the **Encoder > Calibration** submenu.

   The **Encoder Calibration** page appears (see Figure 11-43 on page 299).

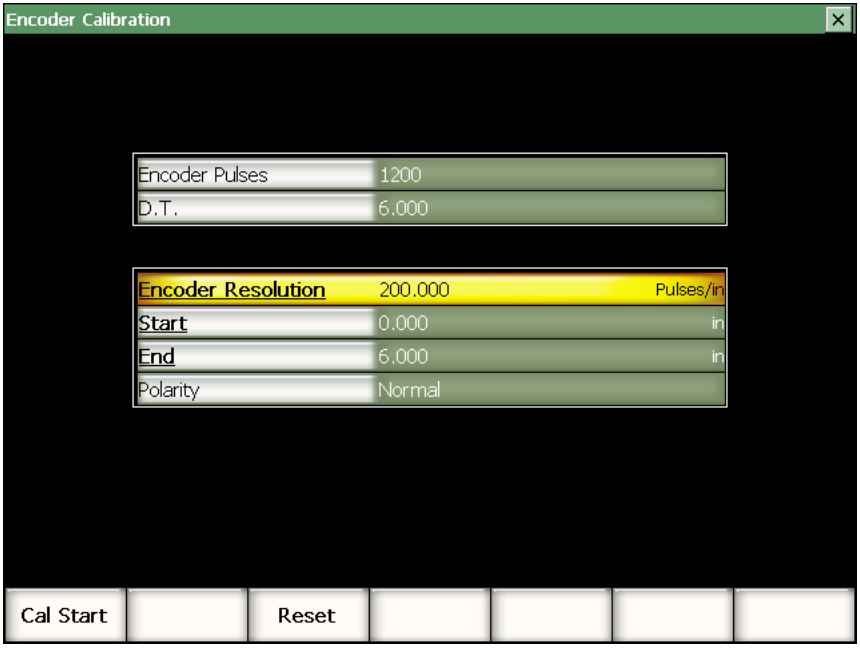

Figure 11-43 The Encoder Calibration page

3. Press **[P3]** (**Reset**) to reset the encoder pulses and D.T. values.
4. Set the **Start** and **End** points to be used for the calibration. Using a greater calibration distance, at least 6 in. (152.4 mm), will increase the encoder resolution accuracy, as error is averaged over a larger distance.
5. Position the front of the encoder buggy at the zero mark (start point) on your ruler.
6. Press **[P1]** (**Cal Start**) to begin the calibration.
7. Move the encoder buggy until the front is at the end point on your ruler.
8. Press **[P1]** (**Cal End**) to complete the calibration.

   After the calibration has been completed, the newly calculated **Encoder Resolution** will display. This value will automatically populate the corresponding **Encoder Resolution** setting in the B-scan setup menu.
9. Press the **[ESCAPE]** key to return to the live screen.

11.8 Back Wall Echo Attenuator (BEA)

The back wall echo attenuation (BEA) option allows you to apply an independent gain level to the A-Scan defined by the Gate 2 start position and width. Using the BEA, you can reduce the amplitude of the back wall echo when high gain levels are being used to find small flaws.

This option is commonly used with two specific forms of inspections, both dealing with very small defects:

The first is an inspection where potential defects may not be oriented parallel to the direction of sound from the transducer. Sound will still reflect from these defects, but the reflection may be directed away from the transducer. In this situation, little or no signal is returned to the instrument for direct measurement. Generally, these defects are instead detected by monitoring for back wall signal loss or attenuation. This back wall amplitude change may be missed entirely if the back wall signal is saturated. The BEA option allows you to monitor the back wall at a lower gain setting for any signal loss, while still scanning the remainder of the test piece at a high gain level for small defects.

In a similar situation, the BEA is very commonly used in porosity inspections. Because porosity tends to scatter sound instead of returning a clear echo, back wall amplitude is sometimes the only way to positively differentiate porosity from material grain structure. The BEA is used to display the entire back wall signal on the screen so that it can be closely monitored.

11.8.1 Option Activation

When the interface gate option is activated, the **BEA** submenu becomes available.

To activate the BEA software feature

- Select **BEA > BEA = On**.

  When the BEA is activated, Gate 2 will be automatically turned on and is positioned at the end of Gate 1.

11.8.2 Operating Back Wall Echo Attenuator

When activated, the back wall echo attenuator (BEA) option displays an independent back wall gain in the **BEA** submenu. This gain is applied within the screen range after **G2Start**. Initially, this base gain level is activated to show the same gain level as the primary gain control. If the primary gain control consists of a reference gain setting and scanning dB, the base gain level of the BEA will be the sum of the reference and scanning gain levels. You can adjust the BEA gain independently to suppress the back wall echo. Measurements and alarms under Gate 2 are based on the attenuated echo.

To adjust back wall gain

1. Select **BEA > Backwall Gain**.
2. Adjust the gain in either coarse or fine adjustments as desired.

   OR

   Press **[2ND F]**, **[GATE] (AUTO XX%)** to position the back wall echo in Gate 2 to the reference level (see Figure 11-44 on page 301).

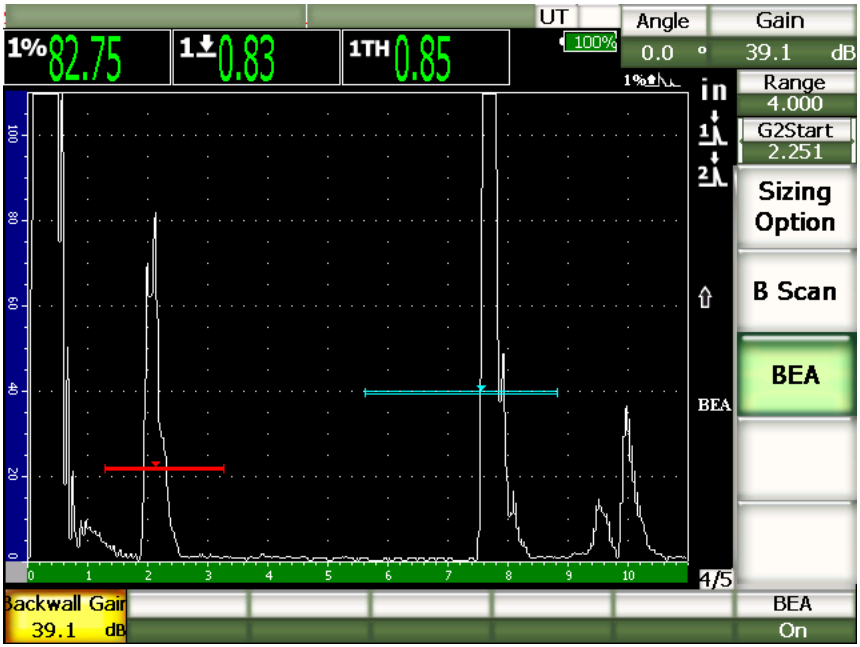

Figure 11-44 Adjusting back wall gain

The position of Gate 2 is controlled through the **[GATES]** key (see “Quickly Adjusting Basic Gate Parameters” on page 125). When using the back wall echo attenuator, or BEA, option, the start position for Gate 2 can only be set to a value after the end position of Gate 1. It is not possible to overlap the two gates. When the width or position of Gate 1 is changed, Gate 2 will be automatically adjusted so that the two gates cannot cover the same screen region (see Figure 11-45 on page 302).

Figure 11-45 Adjusting Gate2 position with BEA active

BEA can be used in conjunction with other software features, such as DAC/TVG, TVG table, and DGS/AVG. These software options must be set up prior to BEA activation. The BEA feature is not compatible with the interface gate option.

12. Probe and Beam Setup (Phased Array Mode)

This chapter describes how to set up a phased array probe on EPOCH 1000 Series instruments.

12.1 Automatic Probe Identification

The EPOCH 1000 Series features automatic probe identification for Olympus phased array probes. When a phased array probe is plugged into the EPOCH 1000 Series instrument, it beeps once and brings you directly to the **Beam** setup page for probe setup.

NOTE

If a phased array probe is plugged into the EPOCH 1000 Series instrument while it is in conventional UT mode, the instrument provides a prompt that enables you to switch to phased array mode or stay in conventional UT mode. If you switch to phased array mode, the instrument switches modes and goes straight the **Beam** setup page described in section “Beam Setup Page” on page 304.

EPOCH 1000 Series instruments acquire probe information directly from Olympus phased array probe specifications stored in the probe itself. If the probe cannot be identified, it is possible to manually enter probe parameters (see “Edit Probe Setup Page” on page 308). It is possible to turn this automatic probe recognition off if desired (see “General Setup Page” on page 88).

12.2 Beam Setup Page

The **Beam** setup page (shown in Figure 12-1 on page 304) allows simplified adjustments of phased array probe and wedge parameters that must be defined prior to calibration and inspection. The **Beam** setup page is automatically displayed when a new phased array probe is attached to the instrument. It can also be accessed by selecting **PA Probe > Beam**.

Figure 12-1 The Beam setup page

The EPOCH 1000 Series phased array mode provides a sector scan (S-scan) image with associated A-scans. This S-scan creates an image using amplitude information from the full sound path range of multiple A-scans. The image is built by acquiring A-scans in regular increments between two fixed angles. For example, a common S-scan image uses A-scans from 40° to 70° in 1° increments to create an image of an inspection piece. If the sound path range is set to 4 in. (101.6 mm), this S-scan would represent all reflections in the test piece from 40° to 70° within a 4 in. (101.6 mm) sound path of the probe.

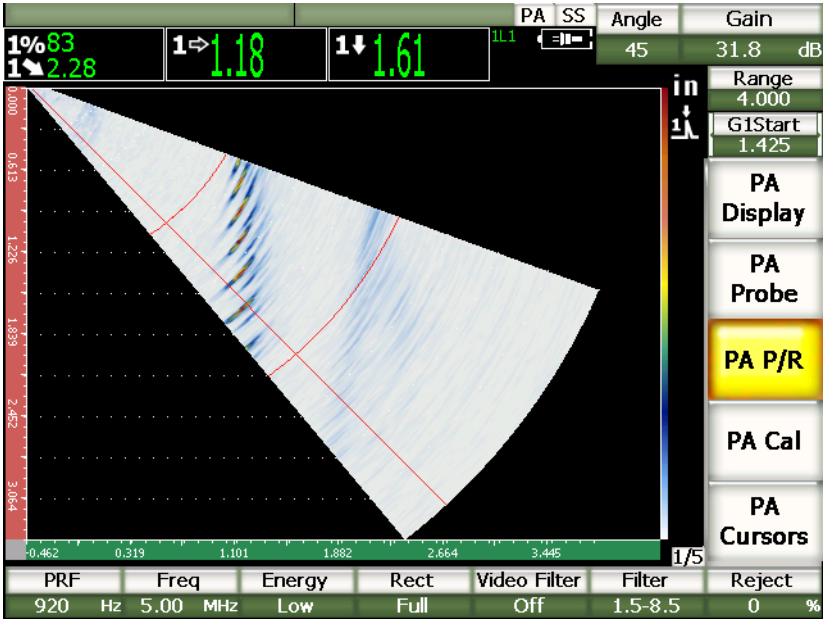

Figure 12-2 S-scan image 40°–70° with 4 in. (101.6 mm) sound path

The **Beam** setup page has three main sections of parameters that must be adjusted to ensure proper phased array setup and calibration. Details about the **Beam** setup page's settings are given in the following sections of the manual.

12.2.1 Probe and Wedge Selection

The first main section of parameters in the **Beam** setup page includes **Probe ID** and **Wedge ID**. These are the two most important parameters to adjust to ensure proper phased array probe setup.

Probe ID

The name of the phased array probe connected to the instrument. This parameter is automatically populated with the correct probe ID name in most cases when using an Olympus phased array probe.

Wedge ID

The name of the wedge attached to the phased array probe. Changing the **Wedge ID** adjusts many of the remaining parameters in the **Beam** setup page to common settings based on the type of wedge selected.

The EPOCH 1000 Series recognizes seven phased array probes as standard probes. These seven probes have been designed to closely match the specifications and frequencies of common conventional probes used in manual inspections. When one of these seven probes is selected, the **Wedge ID** parameter limits possible selections to wedges that are compatible with the selected probe. This allows you to quickly make a wedge selection without browsing through many incompatible wedge types.

If a nonstandard probe is attached to the instrument, the **Wedge ID** list includes all possible wedges. If either the attached probe or the desired wedge is not listed as a possible selection, use the **Edit Probe** setup page to define a custom probe and/or wedge. For more information, see “Edit Probe Setup Page” on page 308.

12.2.2 Inspection Material and Geometry

The second section of parameters in the **Beam** setup page allows adjustment of the material and geometry being inspected. When a standard probe and a wedge are selected using **Probe ID** and **Wedge ID**, the value of these parameters change to default values. You may then make manual adjustments to fit the needs of the current inspection. These parameters include:

Thick

Define the thickness of the part to be inspected. In angle beam inspections, **Thick** allows correct depth-to-reflector measurements as well as correct leg and grid overlays.

Diameter

Specify the outer diameter of a curved inspection piece. This value is used when curved surface correction (CSC) is active for circumferential inspections on the outer diameter of a pipe or other curved surface. The **Thickness** parameter is used to specify the wall thickness of the inspection piece.

CSC

Activation control for curved surface correction (CSC). This software feature corrects measurement readings such as surface distance for circumferential inspections of a pipe or other curved surface. Select **Outer Dia.** for a hollow piece, or **Bar** for a solid piece.

Velocity

Define the standard accepted value of the material velocity for the test piece. The default values for standard probe/wedge combinations are for steel (longitudinal or shear-based on wedge selection).

NOTE

Standard wedges are designed to be used with 1018 carbon steel. When used with other materials, the actual refracted angle might vary. Contact Olympus for more information.

12.2.3 Focal Law Range and Resolution

The third section of parameters in the **Beam** setup page allows you to adjust the focal laws calculated for the given probe/wedge combination. Focal law definition defines the angular coverage (sweep) and resolution of the phased array probe for the inspection. When a standard probe and wedge are selected using **Probe ID** and **Wedge ID**, these parameters default to the most common settings used with the selected probe/wedge combination. These parameters include:

Start Angle

Used to define the starting inspection angle of the phased array probe, one end of the S-scan angular coverage (sweep). Common start angles are 40° (angle inspection) and −30° (straight beam inspection).

End Angle

Used to define the ending inspection angle of the phased array probe, the other end of the S-scan angular coverage (sweep). Common end angles are 70° (angle inspection) and +30° (straight beam inspection).

Angle Step

Used to define the resolution of the S-scan image, the angle increment between contiguous focal laws in the S-scan. Available increments are 0.5°, 1°, and 2°.

Aperture

Used to define the number of elements used at one time to generate the focal laws. Aperture settings include 1, 4–16 (or maximum number of probe elements if less than 16).

First Element

Used to define the element number on the probe from which the defined S-scan aperture will begin to be generated. This feature is most useful when generating S-scans from a probe with a large number of elements, such as 32 or 64.

Focus Depth

Used to define focus depth of inspection. For general applications, **Max** focus or **Unfocused** are recommended. Focusing optimizes the probe response for indications at a particular depth.

The EPOCH 1000 Series is limited to 61 focal laws for a given probe setup. To avoid focal law setup errors, use the following formula:

$$\frac{EndAngle - StartAngle}{AngleStep} \leq 61$$

After all parameters in the Beam setup page have been reviewed, use the **[ESCAPE]** key to apply these settings and return to the live display.

NOTE

When you have finished reviewing the **Beam** setup page, the instrument must recalculate all focal laws based on any changes to the parameter definitions. This recalculation typically takes less than 15 seconds.

12.3 Edit Probe Setup Page

EPOCH 1000 Series instruments allow you to connect any phased array probe/wedge combination for use during inspection. If the phased array probe and/or wedge are not available in the standard library from the **Beam** setup page, you must define a custom probe and/or wedge before calibration and inspection.

NOTE

If a custom probe/wedge has been used in a saved ID, you cannot delete or modify it. This protection is to prevent accidental deletion of an probe/wedge that is required by a file in memory or loss when transferring a file from one unit to another. If you try to delete or modify a saved custom probe/wedge, you will receive an error message.

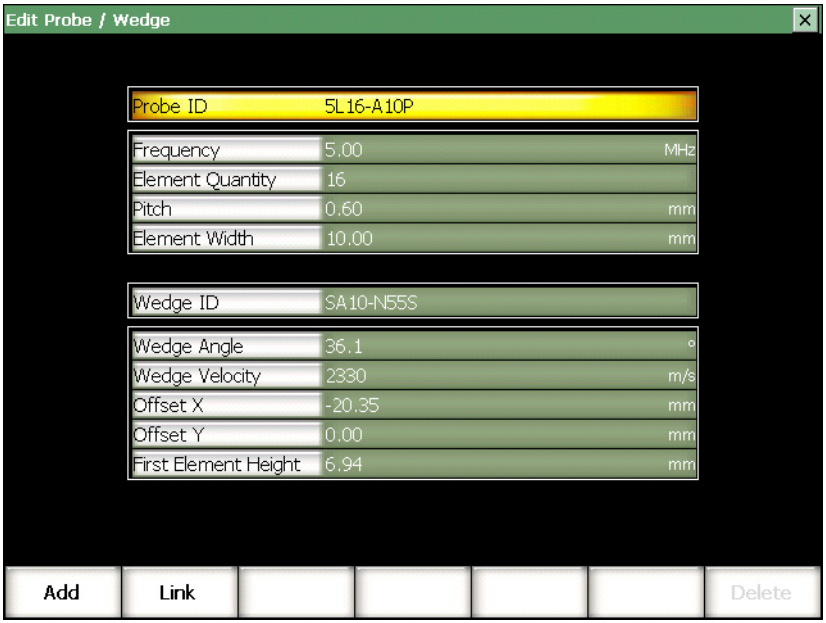

Figure 12-3 The Edit Probe/Wedge setup page

12.3.1 Adding a Custom Probe

The EPOCH 1000*i* features automatic probe parameter recognition for all OmniScan compatible probes made by Olympus by reading this probe data from the information stored in the probe connector. In most cases, you will not need to define a custom probe.

To add a custom probe

1. Select **PA Probe > Edit** to enter the **Edit Probe/Wedge** setup page (see Figure 12-3 on page 309).
2. Select **Probe ID**, and then select **Add**.
3. Enter the desired probe ID name using the virtual keypad (see Figure 12-4 on page 310), and then press **[CHECK]** to complete.

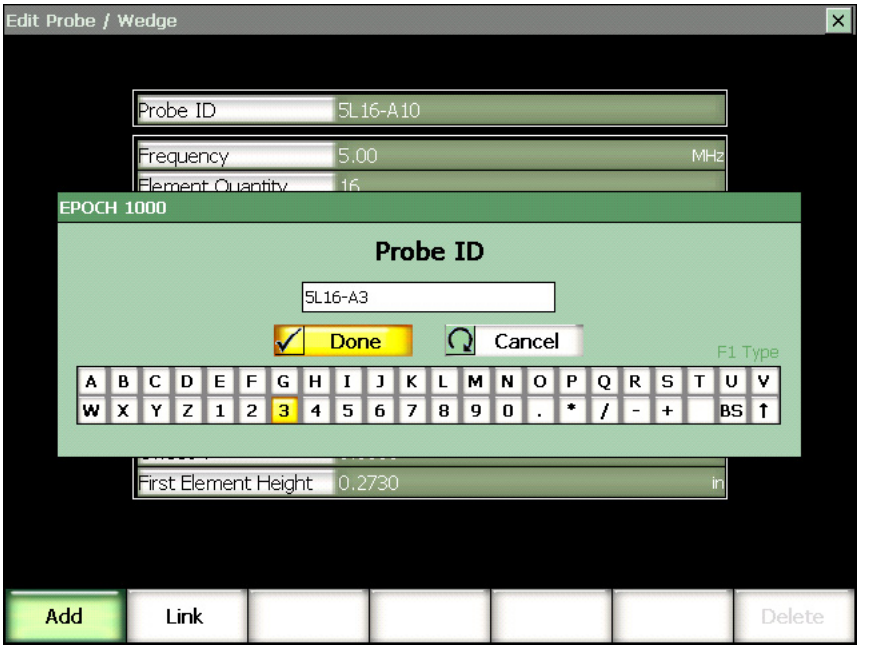

Figure 12-4 Adding a custom probe

4. Enter the specific probe information in the **Frequency**, **Element Quantity**, **Pitch**, and **Element Width** boxes. This information is included with the phased array probe.

   The probe is now stored in the EPOCH 1000*i* instrument's probe-wedge database.

12.3.2 Adding a Custom Wedge

EPOCH 1000 Series instruments come loaded with preset phased array probe and wedge definitions for the most common probes and wedges used with these instruments. These include the A10P, AWS1, and DGS1 series probes and associated wedges.

Only wedges for the most common probes are stored in the EPOCH 1000 Series database.

To add a custom wedge

1. Select **PA Probe > Edit** to enter the **Edit Probe/Wedge** setup page.
2. Select **Wedge ID**, and then select **Add**.
3. Enter the desired probe ID name using the virtual keypad (see Figure 12-5 on page 311), and then press **[CHECK]** to complete.

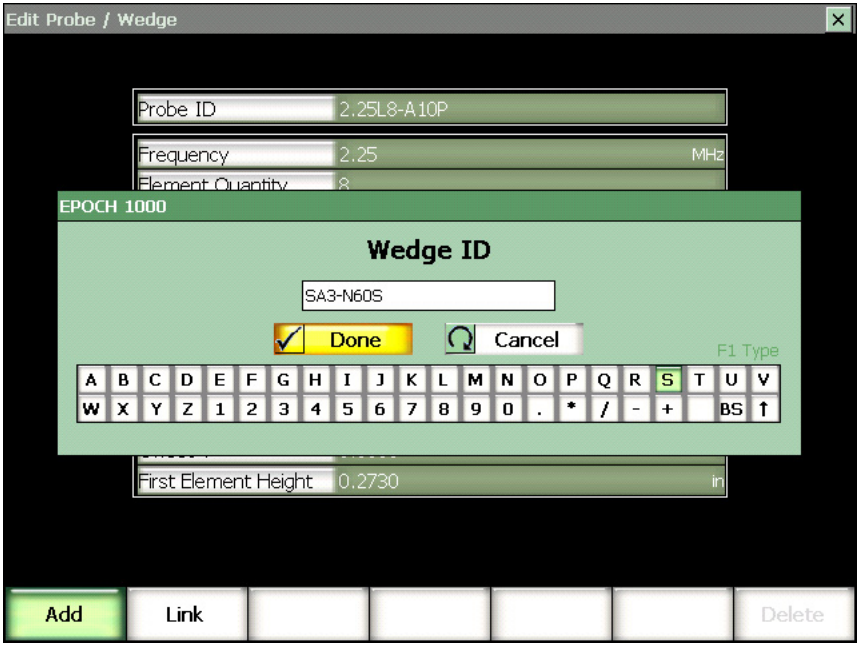

Figure 12-5 Adding a custom wedge

4. Enter the specific wedge information in the **Wedge Angle**, **Wedge Velocity**, **Offset X**, **Offset Y**, and **First Element Height** boxes. This information is included with the phased array probe.

NOTE

The **Offset X** and **Offset Y** parameters correspond to the primary and secondary offset values respectively.

The wedge is now stored in the EPOCH 1000 Series instrument's probe-wedge database.

12.3.3 Custom Probe and Wedge Linking

After you have entered a custom probe and/or wedge into the database, you can select the probe and wedge from the **PA Probe > Beam** submenu, continue normal beam setup and calibration procedures.

You can also link the custom probe and wedge together to reduce initial setup time. Linking allows you to select a specific wedge (or wedges) to be displayed with the selected probe. Only these selected wedges will show up in the wedge list in the **PA Probe > Beam** submenu for that specific probe.

To link a probe and wedges

1. Select **PA Probe > Edit** to enter the **Edit Probe/Wedge** setup page (see Figure 12-6 on page 313).

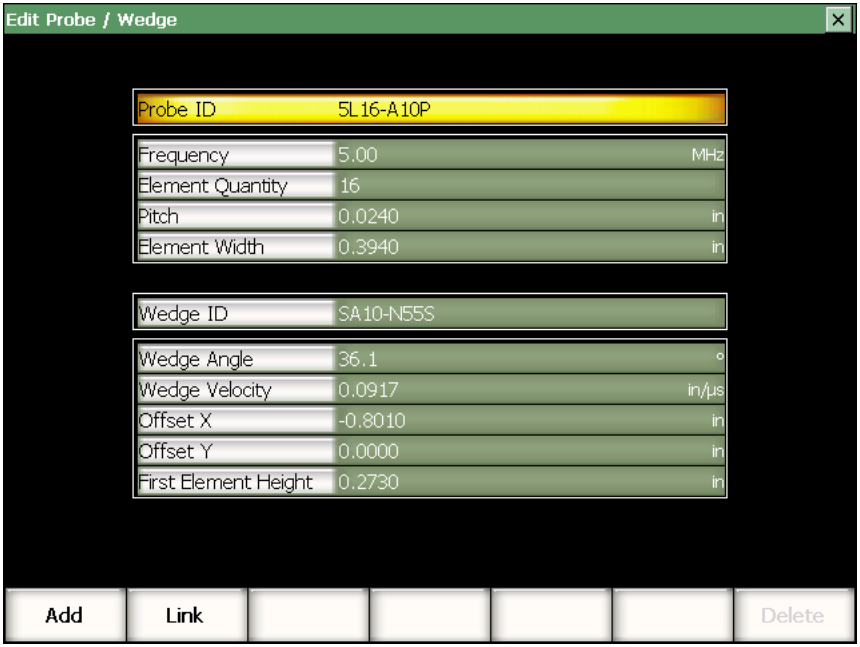

Figure 12-6 The Edit Probe/Wedge Setup page

2. Press **Link** to open the **Probe Wedge Association** dialog box (see Figure 12-7 on page 314).
3. From the **Probe ID** list, highlight the desired probe.
4. Press the **[RIGHT]** arrow key to enter the **Wedge ID** list.
5. Select the wedges you want to link with the probe, and then press **[CHECK]** to associate that wedge with the highlighted probe.
6. Press **[ESCAPE]** to complete.

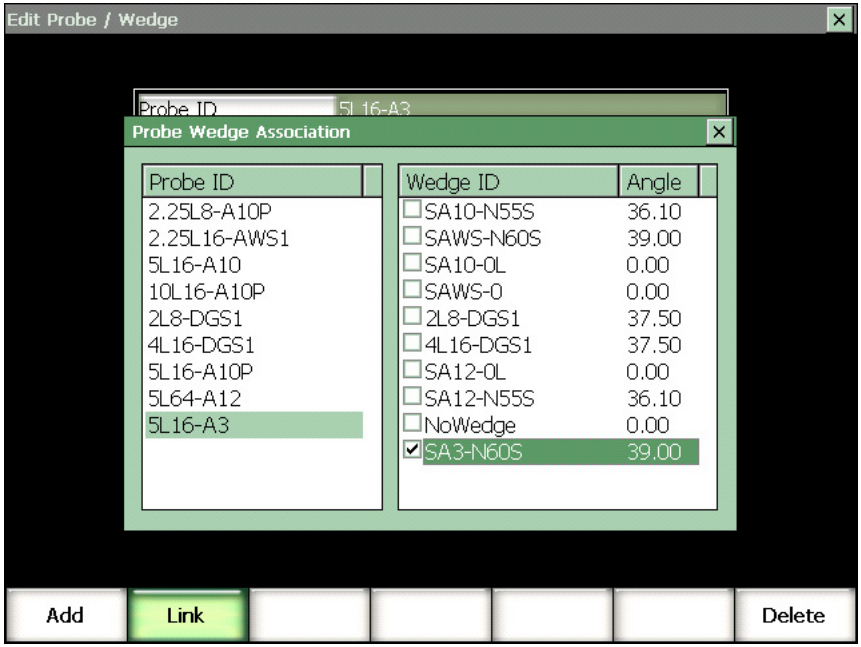

Figure 12-7 The Probe Wedge Association dialog box

12.4 Advanced Beam Setup Page

Advanced phased array beam settings are available in the **Advanced Beam Setup** page. The features in this page are intended for very specific applications or uses, and may not be applicable for general inspections with the EPOCH 1000 Series.

These advanced settings, accessed through the **PA Probe > Advanced** submenu, include:

- Global Delay Offset
- Element Deactivation tool

12.4.1 Global Delay Offset

The Global Delay Offset feature allows you to dynamically control a single zero offset value that is applied to all focal laws. When this feature is turned on, the standard zero calibration (which calibrates a discrete zero offset for each individual focal law) is replaced by the global delay offset control. When the global zero value is adjusted, the same zero offset (wedge delay in microseconds) value is applied to every focal law.

This approach simplifies the process of calibration to a single focal law for distance measurements, and offers several advantages:

- Allows fast calibration of the zero-degree focal law when using a −30 to 30 degree S-scan for zero degree inspection
- Allows you to calibrate for distance, even if reference reflections are not available across the entire scan range
- Commonly used in angled inspection of stainless steel, where material properties cause attenuation variations, and calibration across all focal laws is rarely possible

To adjust the global zero

1. Select **PA Probe > Advanced** to enter the **Advanced Beam Setup** page (see Figure 12-8 on page 316).

Figure 12-8 The Advanced Beam Setup page

2. Set the **Global Delay Offset** to **On**.
3. Press **[ESCAPE]** to return to the live screen.
4. Select **PA Cal > Calibration = CAL Zero**, and then adjust the **Global Zero** parameter as desired (see Figure 12-9 on page 317).

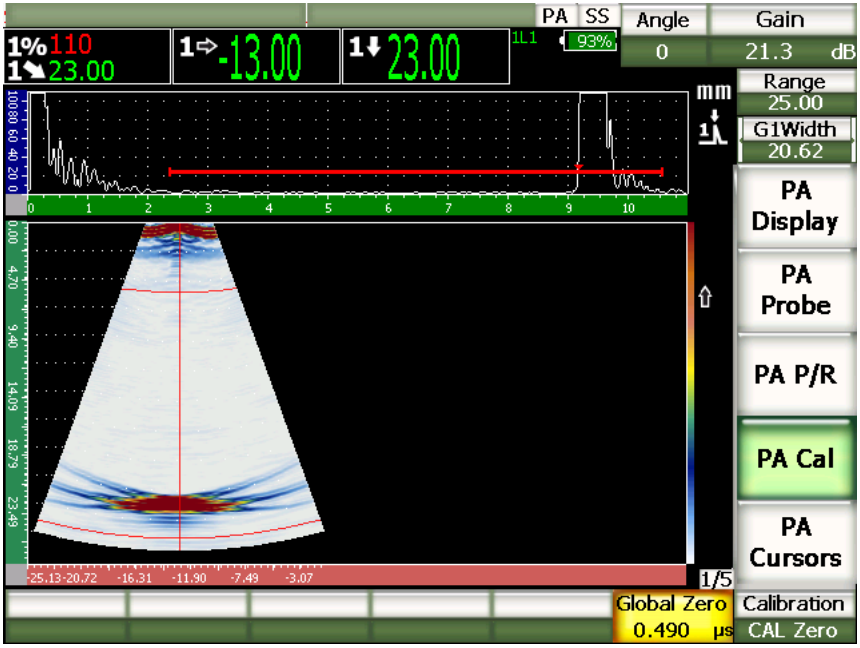

Figure 12-9 Adjusting the global zero offset

12.4.2 Element Deactivation

The Element Deactivation tool is a simple tool that allows you to selectively deactivate individual elements on a PA probe to simulate operation with dead elements. This selective deactivation of elements is most commonly used during performance demonstration qualifications of the instrument for certain inspection procedures. You can use this tool, along with Element Check, to show detection and sizing thresholds when certain elements on the PA probe are low in sensitivity or completely dead.

IMPORTANT

This tool is not commonly used and not recommended for most EPOCH 1000 Series operators.

To use the Element Deactivation tool

1. Select **PA Probe > Advanced** to enter the **Advanced Beam Setup** page (see Figure 12-10 on page 318).

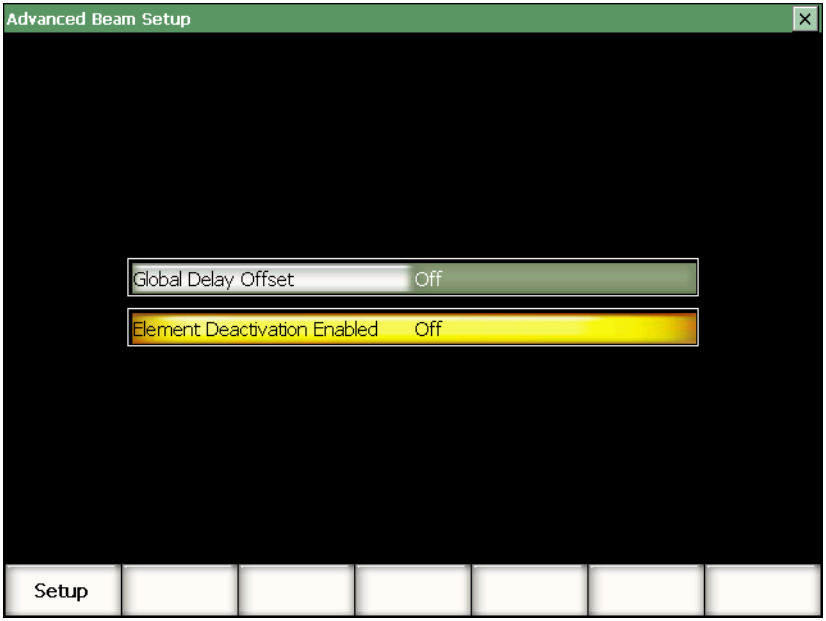

Figure 12-10 The Advanced Beam Setup page

2. Highlight **Element Deactivation**, and then press **Setup** to view a list of all probe elements (see Figure 12-11 on page 319).

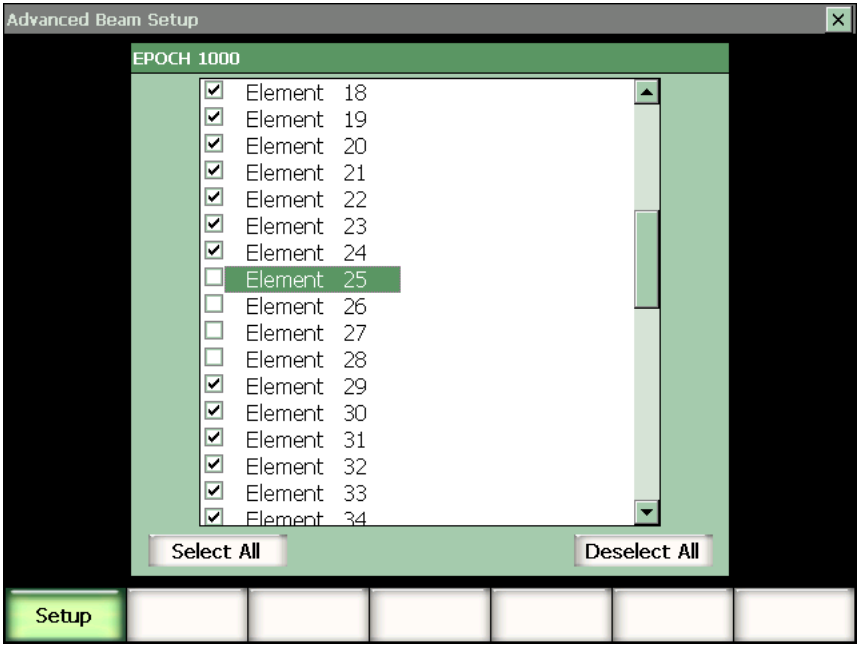

Figure 12-11 Selecting elements to deactivate

3. Use the knob to highlight each element that should be deactivated.
4. Press the **[CHECK]** key to deactivate or activate the highlighted element.
5. When finished, press the **[ESCAPE]** key to return to the live screen (see Figure 12-12 on page 320).

NOTE

Element deactivation settings are NOT saved with files. Any reset of the instrument or change to the focal laws will reset the element deactivation. This is to prevent unintentional deactivation of elements during inspections.

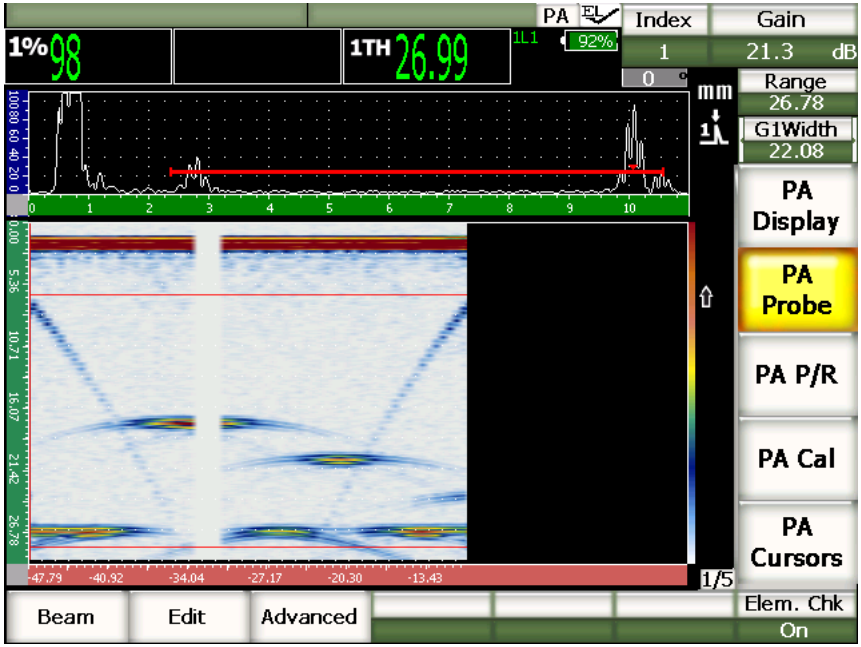

Figure 12-12 Deactivated elements viewed in element check view

12.5 Element Check

Beginning with software version 1.3.0.*x*, the element check capability is included on all EPOCH 1000*i* instruments.

If you are running an older version of firmware you will need to upgrade your instrument to make this feature available. (For information on firmware upgrades please visit our website at www.olympus-ims.com or contact your local sales representative.)

Element check allows you to verify the phased array probe element performance by looking at each element's ability to transmit and receive ultrasonic energy.

When turned on, the element check will automatically set up a phased array scan where only one element in the phased array probe is pulsed at a time (a zero-degree linear scan with an element aperture of 1). You can then scroll through each of the elements in the probe to check the signal response for that isolated element.

NOTE

Exact details for how to perform an element check can be detailed in your inspection procedure. The following is a simple example of one way to perform an element check.

To perform an element check

1. Remove the wedge from the PA probe.
2. Select **PA Probe > Elem. Chk = On**.

   Turning on element check will erase any currently active calibrations.
3. Press **[CHECK]** to confirm.
4. Adjust the settings so you can see a back wall reflection from an appropriate calibration block at all focal laws.
5. Press **[ANGLE]** and scroll through each of the elements to find the element with the highest amplitude signal.
6. Set the highest element signal to 80 % FSH.
7. Scan through all the elements and note the amplitude responses.

   The amplitude received from each element should be approximately the same.

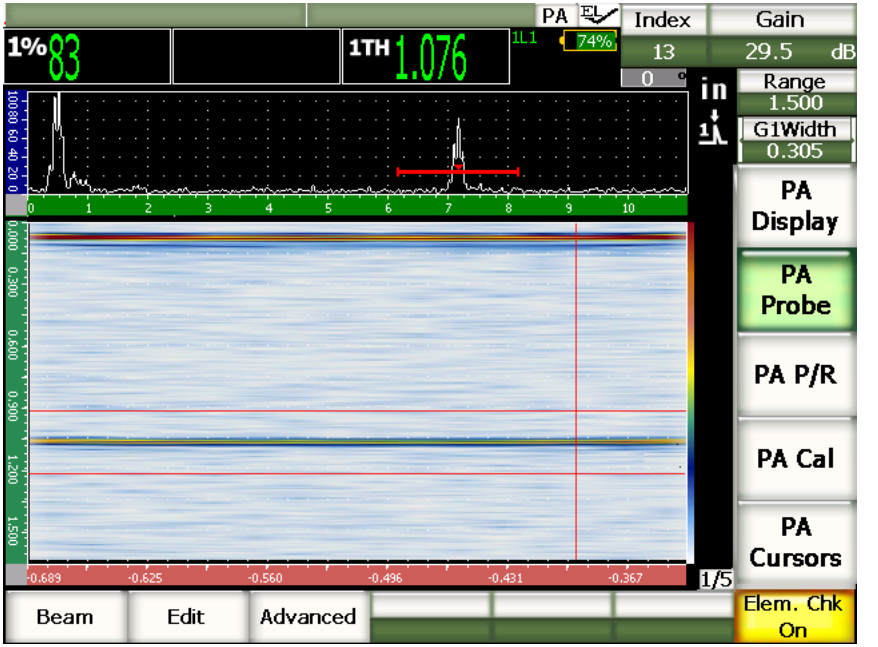

Figure 12-13 Performing an element check with a 5L16-A10P probe

Below are some general guidelines for phased array probe element performance:

- Any element that does not produce a signal is considered dead.
- Any element that produces a signal more than 6 dB less than the maximum element response can be considered defective. No more than 25 % of the elements should be defective according to many common procedures.
- When a new phased array probe is received, it is strongly recommended that an element verification test be performed and documented for each element to establish a baseline.

13. Adjusting the Pulser Receiver (Phased Array Mode)

This chapter describes how to adjust the EPOCH 1000 Series pulser/receiver in phased array mode.

13.1 Setup from Automatic Probe ID

The EPOCH 1000 Series employs an automatic probe identification for Olympus phased array probes. When a standard Olympus phased array probe is connected and set up using the **Beam** setup page, the instrument automatically adjusts the pulser and receiver settings to the most common values used for inspections with the specified probe. The values can be reviewed using in the **PA P/R** submenu.

For phased array probes that are not automatically recognized, or to allow optimization of the pulser and receiver settings, EPOCH 1000 Series instruments allow you to manually adjust pulser and receiver parameters.

13.2 Manual Pulser Adjustment

The EPOCH 1000 Series phased array mode pulser settings are available from the **PA P/R** submenu. The pulser setup parameters are:

- Pulse Repetition Frequency (PRF)
- Pulser Frequency Selection (Pulse Width)
- Pulse Energy (Voltage)

13.2.1 Pulse Repetition Frequency (PRF)

Pulse repetition frequency (PRF) is a measurement of how often the probe is being pulsed by the electronic circuitry in the EPOCH 1000 Series instrument. PRF is typically adjusted based on the test method or test-piece geometry. For parts with long sound paths, it is necessary to lower the PRF to avoid wrap-around interference that results in spurious signals on the display. For applications with rapid scanning, it is often necessary to use a high PRF rate in order to assure that small defects are detected as the probe moves past the part.

The EPOCH 1000 Series phased array mode automatically defines the PRF value based on phased array probe specifications. The PRF value can be adjusted in the **PA P/R > PRF** parameter.

NOTE

The EPOCH 1000 Series phased array mode is limited to 1 520 Hz.

13.2.2 Pulser Frequency Selection (Pulse Width)

Pulser frequency selection sets the pulse width applied to the phased array probe. This frequency selection allows you to tune the shape and duration of each pulse to obtain the best performance from the probe being used. In general, the best performance is achieved by tuning the pulser frequency as close to the center frequency of the probe as possible.

The EPOCH 1000 Series automatically sets the pulser frequency to match the defined frequency of the phased array probe selected using the **Beam** setup page.

To manually adjust the pulser frequency

1. Select **PA P/R > Freq**.
2. Vary the **Freq** value in either coarse or fine adjustment.

13.2.3 Pulse Energy (Voltage)

The EPOCH 1000 Series phased array mode allows two pulser voltage values:

- **Low**: 40 V
- **High**: 80 V

To adjust the pulser energy, use the **Energy** parameter.

NOTE

To maximize instrument battery life and probe life, it is recommended that you use the **Low** energy setting when the application permits it.

13.3 Manual Receiver Adjustments

The EPOCH 1000 Series phased array receiver settings are found in the **PA P/R** submenu. The receiver setup parameters are:

- Waveform Rectification
- Video Filtering
- Digital Receiver Filters

13.3.1 Waveform Rectification

The EPOCH 1000 Series phased array mode can operate in one of four different rectification modes:

- **Full** (full-wave)
- **Half +** (half-wave positive)
- **Half –** (half-wave negative)
- **RF** (unrectified)

The **RF** mode is not active while operating in special software feature modes, such as DAC mode or peak memory.

To adjust the Rectification

1. Select **Rect**.
2. Vary the **Rect** setting.

NOTE

In **RF** rectification, the S-scan palette changes to allow for positive and negative amplitude values.

13.3.2 Video Filtering

EPOCH 1000 Series instruments allow video filtering in phased array mode. Video filtering is a digital algorithm that mathematically smooths the shape of each A-scan. By smoothing the shape of each acquired A-scan, the instrument produces a smoothed S-scan image that is easier to interpret.

NOTE

Video filtering is common in phased array applications to provide a clean S-scan image. However, this smoothing can obscure small indications from the A-scan. It is recommended to avoid video filtering in applications where you rely on fine A-scan interpretation to characterize potential defects.

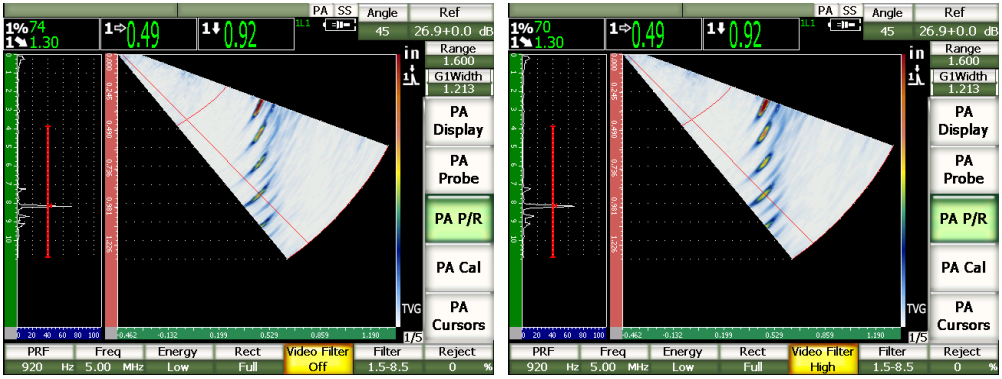

Figure 13-1 A/S Vert view with Video Filter set to Off (left) and to High (right)

EPOCH 1000 Series instruments provide three settings of video filtering:

Off

No filtering applied to A-scan or S-scan.

Low

Minimal filtering applied to both A-scan and S-scan.

High

Maximum filtering applied to both A-scan and S-scan.

To adjust video filtering

1. Select **PA P/R > Video Filter**.
2. Switch filtering settings.

IMPORTANT

Video filtering can affect measurement readings. Always apply the desired **Video Filter** setting prior to instrument calibration.

13.3.3 Digital Receiver Filters

The EPOCH 1000 Series has a total instrument bandwidth of 26.5 MHz at −3 dB. The instrument has several broadband and narrow band digital filter settings. These are designed to improve the instrument's signal-to-noise ratio by filtering out unwanted high and/or low frequency noise outside of the test frequency spectrum.

The EPOCH 1000 Series phased array mode automatically adjusts the filter setting of the instrument based on the defined frequency of the phased array probe selected using the **Beam** setup page.

To manually adjust the filter settings

1. Select **PA P/R > Filter**.
2. Vary the **Filter** setting.

The phased array mode of the EPOCH 1000 Series instrument can access all 37 available digital filter settings. For a full description of these available filter sets, see "Adjusting the Pulser/Receiver (Conventional UT Mode)" on page 99. Based on the selected phased array probe, the instrument only allows access to a subset of all available filters during manual adjustment. This subset includes all digital filters that include the center frequency of the selected probe within the filter limits.

14. Managing Phased Array Image Display

This chapter describes how to manage EPOCH 1000 Series display settings in the phased array mode.

14.1 Display View Mode

In phased array mode, the EPOCH 1000 Series offers four live inspection views accessible by selecting **PA Display > Screen**:

A/S Vert

Selected A-scan and S-scan are both viewable. A-scan is oriented vertically and located on the left side of display.

Sscan

Only the S-scan is viewable.

Ascan

Only the selected A-scan is viewable (standard conventional UT display).

A/S Horz

Selected A-scan and S-scan are both viewable. The A-scan is oriented horizontally and located above the S-scan on the display.

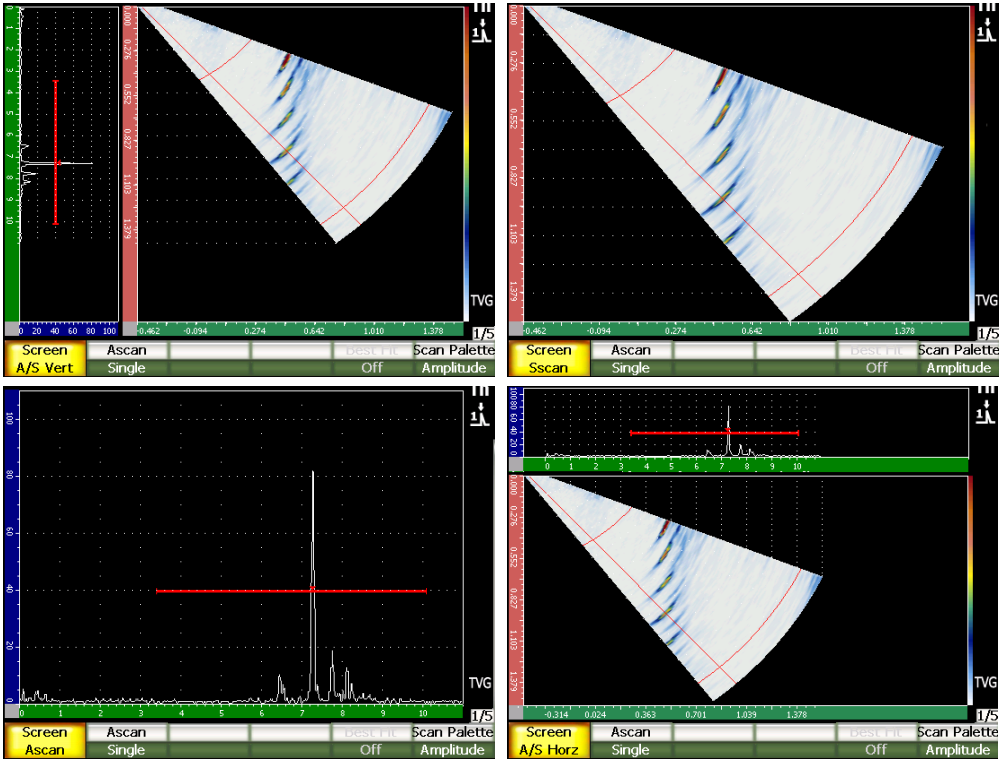

Figure 14-1 The four display view modes

NOTE

The EPOCH 1000 Series displays all A-scans in sound path mode only. The S-scan view is displayed in true-depth mode. This means that in **A/S Vert** mode, indications viewed in the selected A-scan do not line up horizontally with their corresponding point in the S-scan. For further information, see “Display Grid Modes and Overlays” on page 345.

14.2 Focal Law (Angle) Selection Cursor

The EPOCH 1000 Series features a dedicated focal law (angle) cursor on the S-scan image that identifies the currently selected A-scan. The currently selected A-scan is the viewable A-scan in **A/S Vert**, **A/S Horz**, and **Ascan** view modes, and is also the source of measurement readings while in phased array mode.

Adjusting the selected A-scan is a common task performed in phased array mode. To increase inspection efficiency and ease of use, the EPOCH 1000 Series gives direct access to this adjustment.

To adjust the focal law (angle) selection cursor

1. Press **[ANGLE]**.
2. Change the value of the selected focal law (angle).

Alternatively, you may adjust the focal law (angle) selection cursors by selecting **PA Display > Angle**.

When the focal law (angle) selection cursor is adjusted, a red line appears on the S-scan image. This line corresponds to the single A-scan that is currently being displayed and/or used for measurement reading acquisition. The value of this angle is displayed at the top of the instrument display in the **Angle** parameter box.

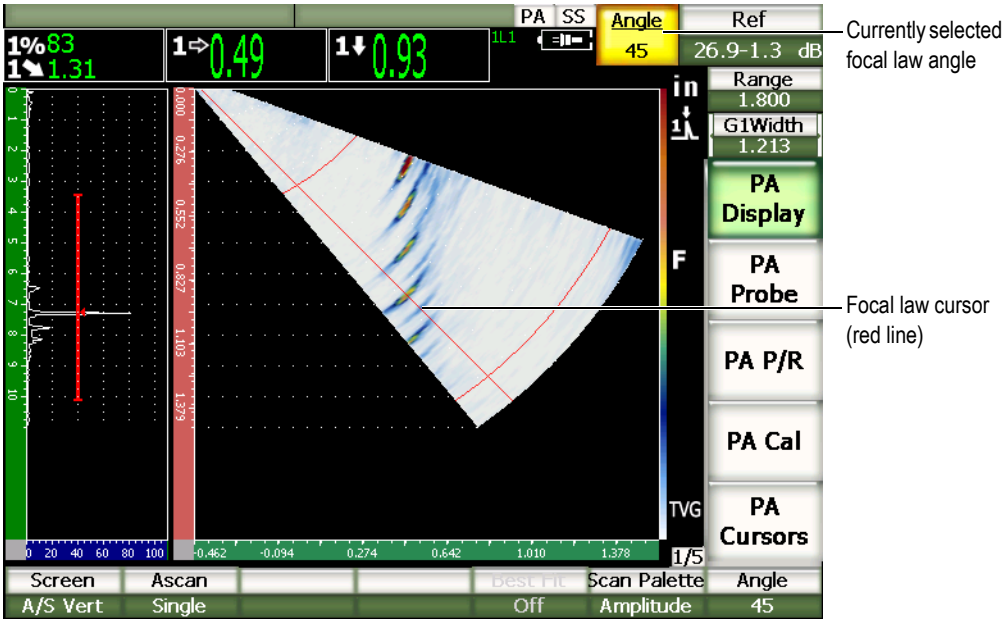

Figure 14-2 A-scan and S-scan with the focal law cursor and the Angle parameter box

14.3 Color Palettes

The EPOCH 1000 Series offers multiple color palettes for phased array sector, linear, and C-scans for use with various applications. These different palettes apply different color gradients that visually display variation in amplitude from 0 % to 110 % FSH. An example of a color-amplitude relationship is shown below:

- Red = 110 % FSH
- Yellow = 50 % FSH
- White = 0 % FSH

Palettes can also be used in depth view scans where the color gradient is distributed over the part or gate thickness rather than amplitude.

14.3.1 Choosing a Color Palette

To choose a color palette

1. Select **Display Setup > Color Setup** to enter the **Color** page.
2. Select **Scan Palette**, and then choose the desired palette for amplitude-based scan images (sector, linear, and amplitude C-scans).
3. Select **Depth Palette**, and then choose the desired palette for depth-based scan images (depth C-scans).

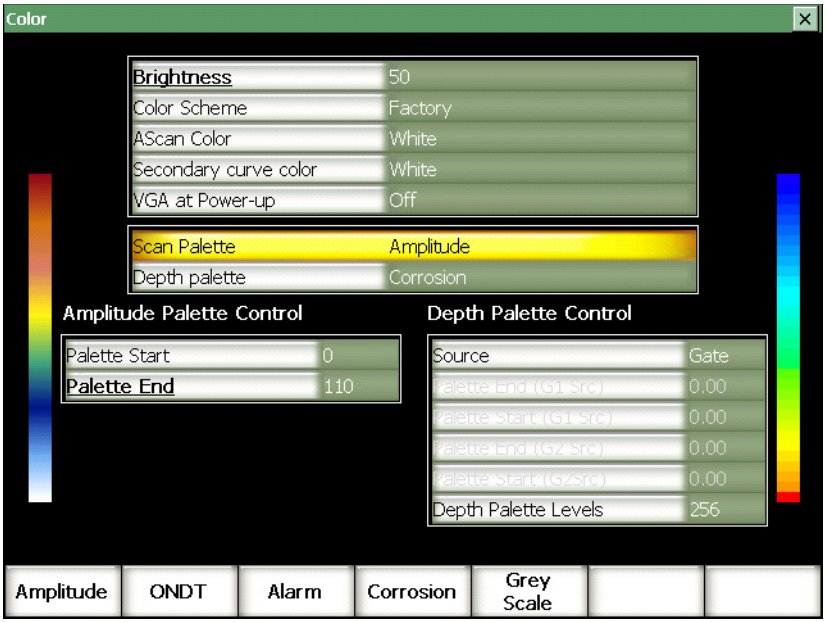

Figure 14-3 Selecting a scan palette

NOTE

You can also adjust the color palette by selecting **PA Probe > Scan Palette**.

The available scan palettes are as follows:

Amplitude (see Figure 14-4 on page 335)

Default setting, full-color palette from white (LOS) to red (high/saturated signal).

ONDT (see Figure 14-5 on page 335)

Colored palette from black (LOS) to red (high/saturated signal).

Alarm (see Figure 14-5 on page 335)

Dual color palette, often used with positive gate alarm, green for lower signals and red for higher signals (customizable color transition level).

Corrosion (see Figure 14-6 on page 336)

More commonly used with depth scans, reverse color palette from red (LOS) to blue (high/saturated signal).

Grey Scale (see Figure 14-6 on page 336)

Grey scale palette from black (LOS) to white (high/saturated signal).

Grey RF (see Figure 14-7 on page 336)

Grey scale palette for RF mode with same white-to-black color gradient from 0 % to 110 % and 0 % to −110 % (white mapped to 0 %, black mapped to 110 % or −110 %).

Amp RF (see Figure 14-7 on page 336)

Colored palette for RF mode with same white-to-red color gradient from 0 % to 110 % and 0 % to −110 % (white mapped to 0 %, red mapped to 110 % or −110 %).

Polarity (see Figure 14-8 on page 337)

Colored palette for RF mode with different color gradient from 0 % to 110 % and 0 % to −110 %. White to red palette is mapped to positive amplitudes, while white to blue palette is mapped to negative amplitudes.

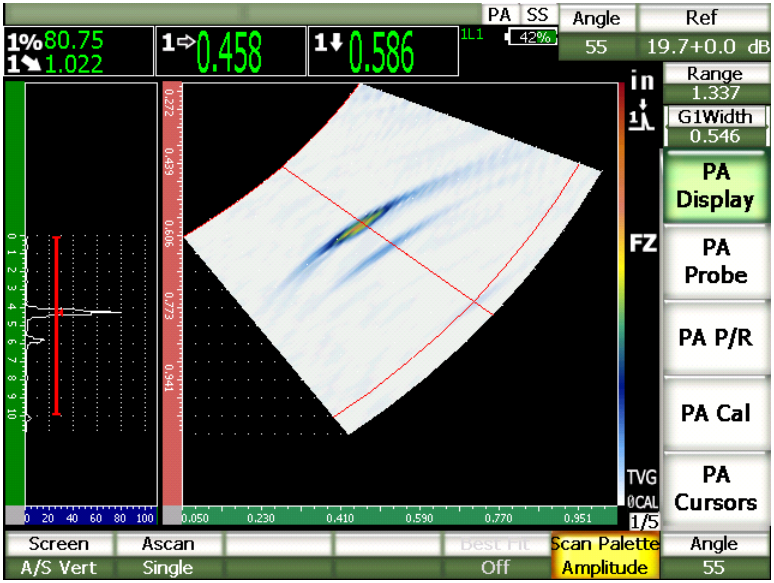

Figure 14-4 The Amplitude palette

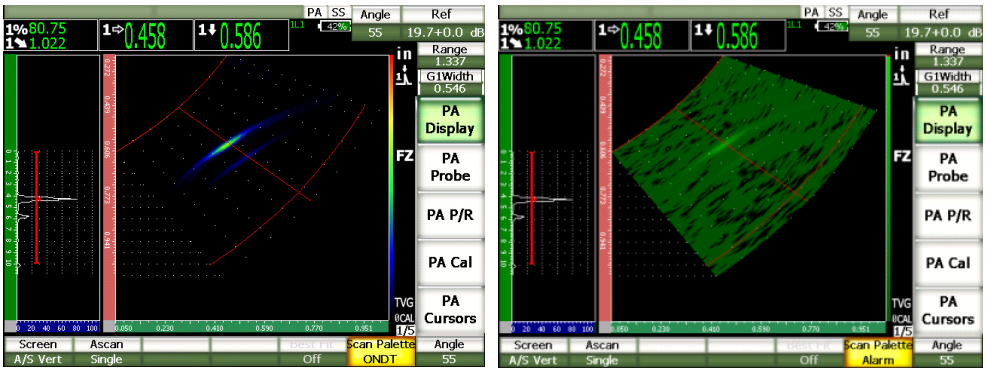

Figure 14-5 The ONDT *(left)* and Alarm *(right)* palettes

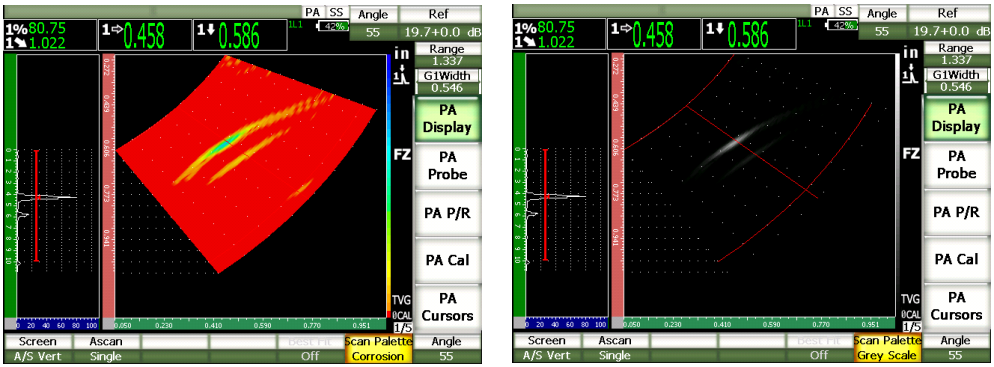

Figure 14-6 The Corrosion *(left)* and Grey Scale *(right)* palettes

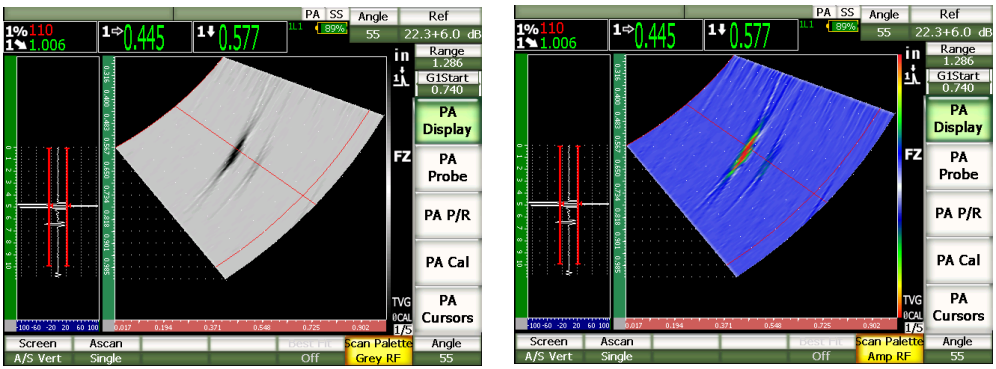

Figure 14-7 The Grey RF *(left)* and Amp RF *(right)* palettes

Figure 14-8 The Polarity palette

14.3.2 Color Palette Adjustment

You can also manually modify the color scale of any of the color palettes to meet your specific application needs. Color palette adjustment will not affect any of the raw data displayed on the A-scan and will only change the color scale on the PA scan image.

Both the Amplitude and Depth palettes can be adjusted in the **Display Setup > Color Setup** under **Amplitude Palette Control** and **Depth Palette Control**.

14.3.2.1 Amplitude Palette Adjustment

Each of the color palettes has a preset color scale that is applied over the full range of signal amplitudes from 0–110 % FSH. You can adjust the maximum and minimum amplitude color values using the parameters under **Amplitude Palette Control** in the **Display Setup > Color Setup** submenu (see Figure 14-9 on page 338).

- **Palette Start** sets the upper color threshold for signals above the set amplitude. The lowest gradient color will extend up to this value.
- **Palette End** sets the lower color threshold for signals below the set amplitude. The highest gradient color will extend down to this value.

- The standard color gradient for the selected palette will continue in between the start and end values.

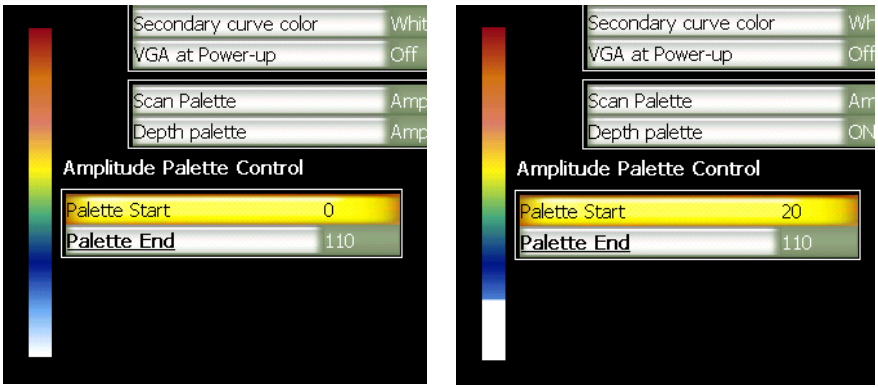

Figure 14-9 Adjusting Amplitude palette values

The new adjusted color scale will be displayed to the left of the settings in the **Color Setup** submenu (see Figure 14-10 on page 338). The active phased array scan image will also update to the custom palette settings.

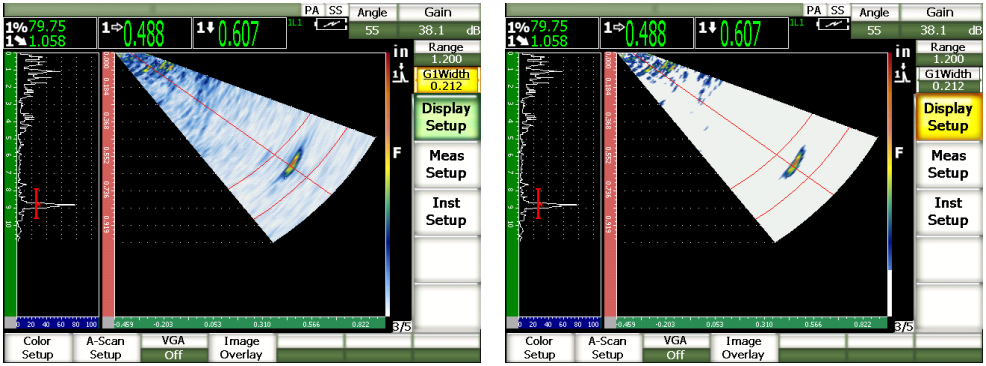

Figure 14-10 S-scan images with default (left) and modified (right) color palettes

14.3.2.2 Depth Palette Adjustment

For Depth C-scans, the color palette scale can be set based on the gate range, or manually set to custom points using the **Source** parameter. The colors are then distributed evenly between the start and end points. You can also select how many color levels to span across the range using the **Depth Palette Levels** parameter (see Figure 14-11 on page 339).

When set to **Gate**, the color scale is set with the gate start and end points as the minimum and maximum values of the scale with the colors distributed evenly over the gate width.

In **Custom** mode, you manually set the start and end points of the color scale. This allows you to adjust the start and end points for each gate to capture only the area of the part containing flaws. Colors can also be adjusted to include the entire part thickness without interference from any gated initial pulse or back wall echo.

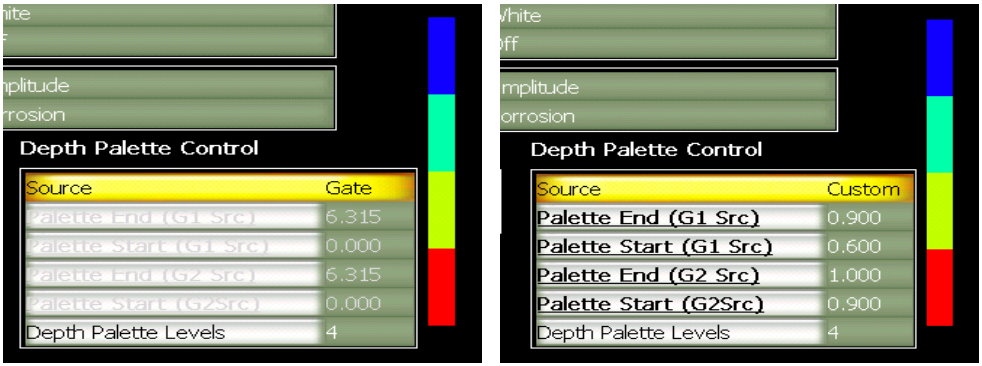

Figure 14-11 Adjusting the Depth palette values

The new adjusted color scale will be displayed to the left of the settings in the **Color Setup** submenu. The active phased array scan image will also update to the custom palette settings.

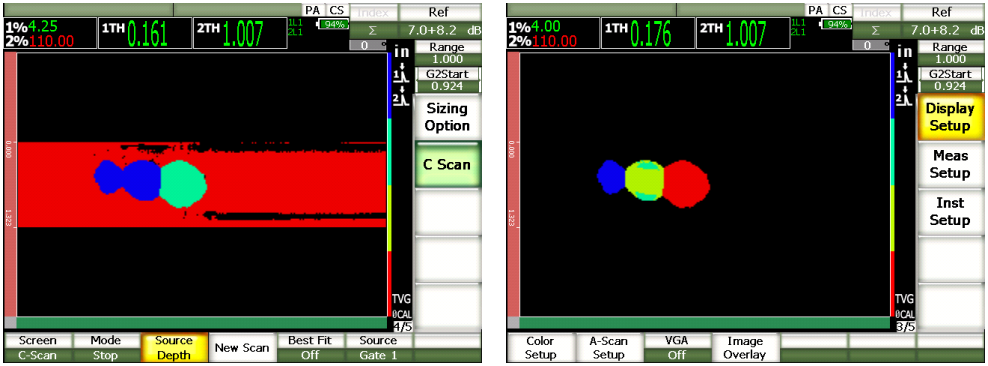

Figure 14-12 C-scan images with default (left) and modified (right) color palettes

14.4 Best Fit Mode

The S-scan image created during a phased array inspection displays the full sound path (as defined by **[RANGE]**) for each angle within the focal law range (sweep). This S-scan image is drawn on the display as a to-scale representation of the angular coverage within the test piece.

For example, a 70° focal law is drawn within the S-scan display window at 70° from vertical. This allows you to visualize reflections from the S-scan as if viewing a cross-section of the test piece.

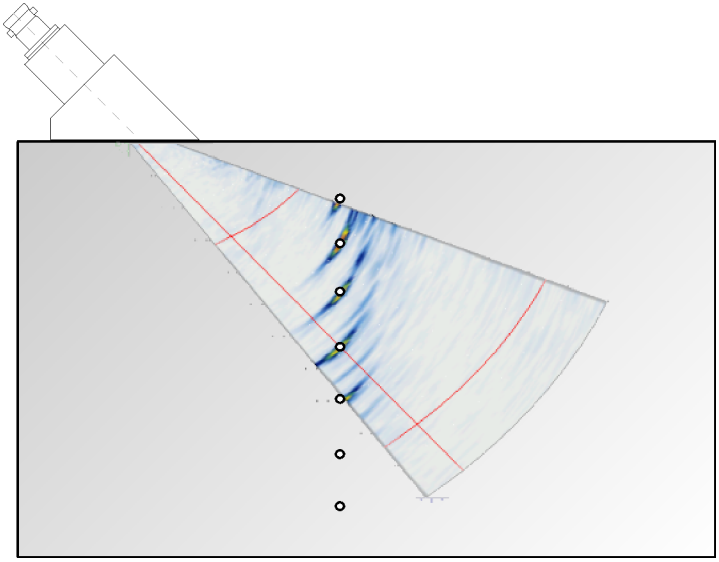

Figure 14-13 S-scan showing the location of visible defects

When inspecting using higher angles, such as 70°, this to-scale representation of the image limits the amount of the display area used to draw the S-scan. In a standard 40° to 70° S-scan image, almost 30 % of the vertical display window used to draw the S-scan is left blank.

The EPOCH 1000 Series phased array mode uses the best fit feature to rotate the S-scan image so that it uses the maximum amount of screen area possible to draw the S-scan.

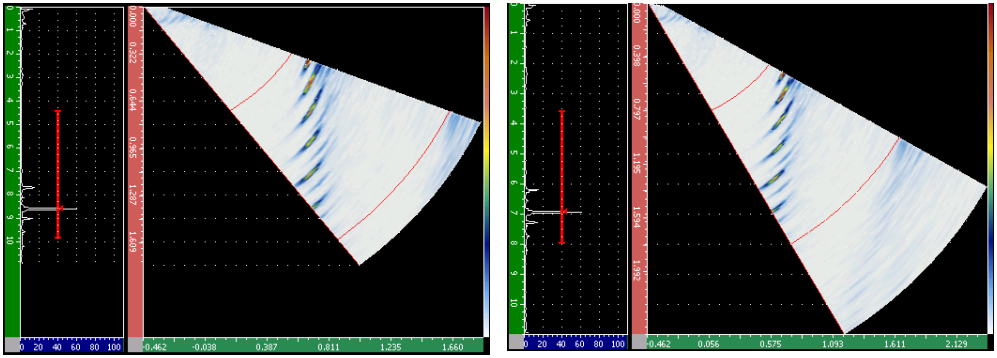

Figure 14-14 Best fit off and on

IMPORTANT

The best fit feature does not distort the S-scan image. Instead, it rotates the image, without distortion, to fit in the display window. This rotation means that the horizontal and vertical S-scan rulers are not correct when best fit is active.

NOTE

Best fit mode is automatically deactivated when freeze is activated.

14.5 Image and A-Scan Grid and Rulers

The EPOCH 1000 Series phased array mode provides separate rulers for the A-scan display and S-scan display.

14.5.1 A-scan Grid Mode

The rulers available for display on the A-scan representation are the same as in conventional ultrasound mode. They are available from the **A-Scan** setup page, which is accessed by selecting **Display Setup > A-Scan Setup**. They include:

Y-Axis Grid Mode

Amplitude height in 100 % or 110 %.

X-Axis Grid Mode

Standard 10 Divisions, Sound Path, Leg, or Off

14.5.2 Image Rulers

Two rulers are active for the S-scan image.

Vertical

The vertical ruler displays depth measurements per grid division in the currently selected measurement unit (in., mm, or μs).

Horizontal

The horizontal ruler displays surface distance measurements per grid division in the currently selected measurement unit (in., mm, or μs).

NOTE

In angle beam applications, the horizontal-ruler scale is based on the front of wedge and not the beam index point. This allows the ruler to maintain consistent values regardless of focal law selection.

14.5.3 Reject

The **PA P/R > Reject** parameter eliminates unwanted, low-level signals from the display. It is linear and adjustable from 0 % to 80 % FSH. Increasing the **Reject** value does not affect the amplitude of the signals above the reject level.

NOTE

The reject function can be used in RF display mode.

IMPORTANT

The reject level is displayed as a horizontal line (or two lines in the case of the RF display mode) on the A-scan display only. In the S-scan view mode, it is not possible to identify that the reject function is active.

14.6 Peak Memory

The peak memory feature in the EPOCH 1000 Series phased array mode applies only to the selected A-scan display (current focal law).

For a full description of the peak memory function, see “Peak Memory” on page 112.

14.7 Peak Hold

The peak hold feature in the EPOCH 1000 Series phased array mode applies only to the selected A-scan display (current focal law).

For a full description of the peak hold function, see “Peak Hold” on page 114.

14.8 Freeze

The freeze function of the EPOCH 1000 Series in phased array mode is similar to the freeze function in conventional ultrasound mode. For a full description of the freeze function, see “Freeze” on page 114.

In phased array mode, when the display is frozen, you can use the focal law (angle) selection cursor to select any A-scan from the S-scan image. The raw data from each A-scan is available in frozen mode. This allows you to apply a variety of instrument functions to any A-scan from the S-scan image after the **[FREEZE]** key is activated. These include:

- Display view mode
  Change between all four display views using the **PA Display > Screen** parameter.
- Gate movement
- Gain
- Range and delay
- Data logger
- Printing

When Freeze is active, the following parameters cannot be changed/accessed:

- Zero offset
- Range (cannot be increased)
- Pulser/receiver settings other than gain

To disable the freeze function and return to normal operation, press **[FREEZE]** again.

14.9 Display Grid Modes and Overlays

The phased array mode of the EPOCH 1000 Series offers additional display overlays to augment the standard grid modes described in section “Grid Modes” on page 115. These display overlays facilitate interpretation of the S-scan image and its relationship to the selected A-scan. The special display overlay parameters are available in the **Display** setup page accessible by selecting **Display Setup > Image Overlay**.

Figure 14-15 The Display setup page

14.9.1 Leg Indicators

When a part thickness is defined in the **Beam** setup page (see “Probe and Beam Setup (Phased Array Mode)” on page 303), the instrument draws one or multiple horizontal lines, depending on the overall inspection range, to visually indicate the part thickness on the S-scan image. These lines correspond to the part thickness on the vertical (depth) axis of the S-scan image.

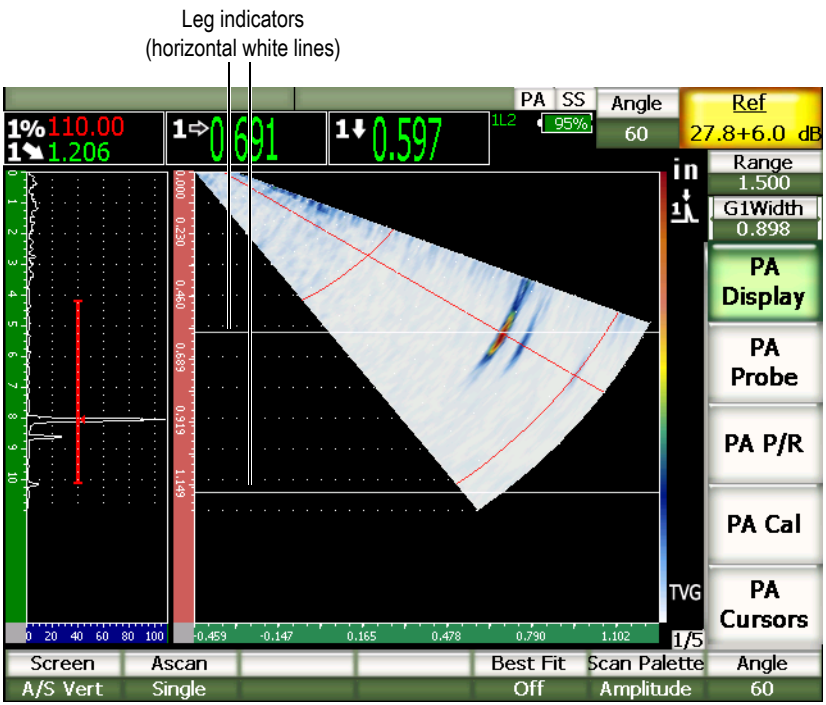

Figure 14-16 S-scan with the leg indicators active

14.9.2 Grid Modes

The **Display** setup page allows you to independently turn on or off A-scan and S-scan grid views.

To turn a grid mode on or off

1. To open the **Display** setup page, select **Display Setup > Image Overlay**.
2. Select **Sector Grid = On** or **Ascan Grid = On**.

These grid modes correspond to the x-axis grid modes described in chapter "Managing Special Waveform Functions (Conventional UT Mode)" on page 111. Available grid modes include: **Off**, **Standard**, **Sound Path**, **Leg**, **100%**, and **110%**. These modes can be activated or deactivated from the **A-scan Setup** page, which is accessed by selecting **Display Setup > A-Scan Setup**.

In **A/S Vert** and **A/S Horz**, the x-axis grid modes of the A-scan and S-scan are directly correspondent to each other.

For example, in **A/S Vert** screen mode with the **Standard** x-axis grid pattern active, the horizontally oriented A-scan grids from 0 to 10 connect with the grids on the S-scan. These horizontal lines allow you to visually correlate an A-scan indication at division 3 with its corresponding S-scan image, also at division 3.

Figure 14-17 A-scan and S-scan in Grey Scale mode with indication

NOTE

The A-scan display is a sound path A-scan. Therefore, indications on the A-scan do not line up horizontally with their corresponding indications on the S-scan. This requires that the grids applied to the S-scan are curved to follow a sound path contour (see Figure 14-17 on page 348).

14.9.3 Probe Front Cursor

The probe front cursor uses the probe and wedge specifications defined in the initial phased array setup (see “Probe and Beam Setup (Phased Array Mode)” on page 303) to determine the horizontal position of the front of the probe wedge. When active, this feature draws a vertical white line on the S-scan image, indicating the position of the wedge front for visual reference.

To activate the probe front cursor

1. Select **Display Setup > Image Overlay** to open the **Display** setup page.
2. Select **Probe Front Cursor = On**.

   The probe front cursor appears on the S-scan (see Figure 14-18 on page 349).

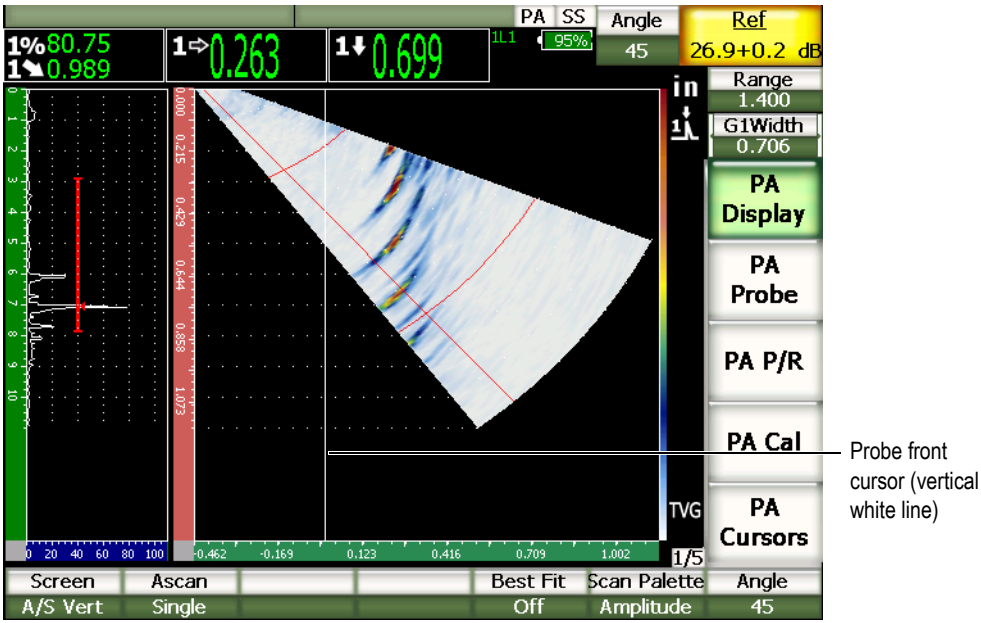

Figure 14-18 S-scan with the probe front cursor active

15. Gates (Phased Array Mode)

This chapter describes the operation of EPOCH 1000 Series measurement gates while in phased array mode.

15.1 General Gate Operation

The functional operation, including measurement capabilities, of gate 1 and gate 2 in phased array mode is identical to operation in conventional ultrasound mode. Refer to chapter “Gates (Conventional UT Mode)” on page 123 for a complete overview of gate functions.

15.2 Gate S-Scan View

EPOCH 1000 Series instruments display gates in both the A-scan and S-scan views. The placement of the gate(s) in A-scan view is identical to placement of the gate(s) in conventional ultrasound mode.

In the S-scan view, gates are displayed as two colored lines overlaid on the S-scan image. You can choose to display the gates on the S-scan in either sound path or depth mode, depending on your application.

NOTE

Gate type is a global setting that is applied to all active gates.

15.2.1 Sound Path Gate Mode

The Sound path gate display is the default display mode on EPOCH 1000 Series instruments. When in Sound path gate mode, the start and end position values of the gates are represented in inches, millimeters, or microseconds relative to the sound path of the display range.

In the Sound path gate mode, the gates are displayed as curved lines on the S-scan image. The gate start position is represented with a single curved line across all focal laws, and the gate end position is represented with a second curved line across all focal laws (see Figure 15-1 on page 352). This gate end position is defined using the **Gate Width** parameter.

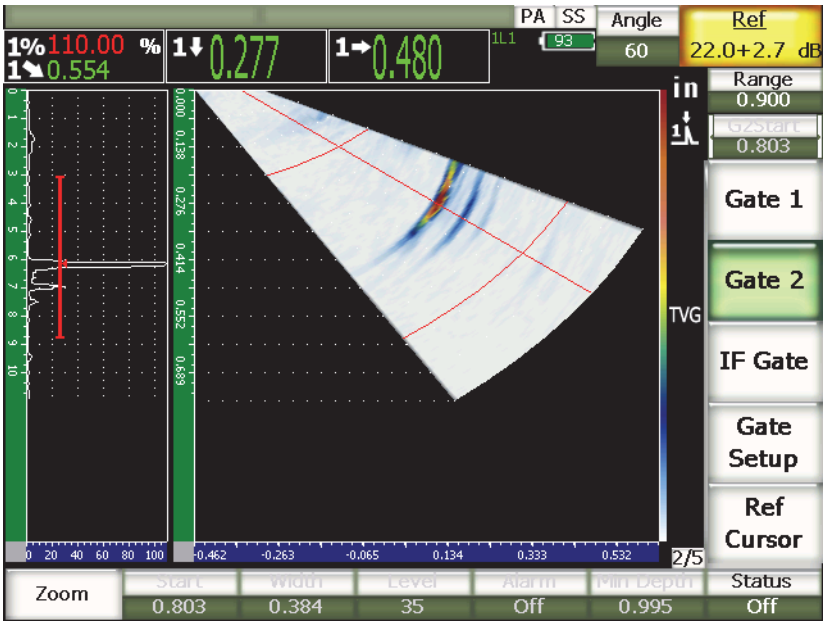

Figure 15-1 A-scan and S-scan with sound path gates

To select Sound path gate mode

1. Select **Gate Setup > Setup** to enter the **Gates** setup page (see Figure 15-2 on page 353).
2. Set the **Gates Type** parameter to **Sound path**.

3. Press **[ESCAPE]** to exit the page and return to the live screen.

Figure 15-2 Selecting the Sound path gate mode

15.2.2 Depth Gate Mode

Gates can also be displayed in Depth (or true depth) mode on the S-scan, which allows you to collect measurements from a constant depth area in the part, across all focal laws. The Depth gate mode is especially helpful when you need to capture data from a specified depth range within a test piece, such as a single leg skip distance when creating a C-scan image.

NOTE

When the Depth mode is selected, the A-scan gates remain in sound path mode.

True depth gates appear as straight horizontal lines on the S-scan image (see Figure 15-3 on page 354). These gate start and gate end positions correspond to depths within the test piece, not sound paths. True depth and sound path gates are only equivalent at the 0° focal law.

Figure 15-3 A-scan and S-scan with depth gates

To select depth gates

1. Select **Gate Setup > Setup** to enter the **Gates** setup page (see Figure 15-4 on page 355).
2. Set the **Gates Type** parameter to **Depth**.
3. Press **[ESCAPE]** to exit the page and return to the live screen.

Figure 15-4 Selecting the Depth gate mode

16. Image and Sizing Cursors (Phased Array Mode)

This chapter describes the EPOCH 1000 Series sizing cursor features.

16.1 Sizing Cursors

The EPOCH 1000 Series provides two sets of sizing cursors in phased array mode. These two cursor sets are applied to the phased array scan image for a visual reference and for sizing of image components. The X cursor set (X2, X1) allows measurements in the horizontal plane, and the Y cursor set (Y2, Y1) allows measurements in the vertical plane. Because the scan images provide scaled representations of defects, these cursor sets can accurately size flaws such as cracks and delamination.

NOTE

Cursors are not available when Best Fit mode is turned on.

16.2 Cursors Status

To activate the image-sizing cursors

- Select **PA Cursors > Cursor = On**.

16.2.1 Cursor Positioning

Each cursor set has two measurement cursors. This allows cursor-to-cursor measurements in the horizontal (X) and vertical (Y) directions.

To position image-sizing cursors on the display

1. Select **PA Cursors > Cursor = On**.
2. Select **PA Cursors > Cursor X1**, **Cursor X2**, **Cursor Y1**, and **Cursor Y2** parameters to adjust cursor-position values.

Figure 16-1 Cursors and S-scan during adjustment

The image-sizing cursors cannot be positioned beyond the visible screen range. Also, **Cursor X2** and **Cursor Y2** cannot be positioned before **Cursor X1** or **Cursor Y1**, respectively.

16.2.2 Cursor Measurements

The EPOCH 1000 Series image-sizing cursors allow four main types of measurements, which you can select from the **Reading Setup** page accessed by selecting **Meas Setup > Reading Setup**. You can select the following cursor measurements:

X2 - X1

The horizontal distance between X cursors.

Y2 - Y1

The vertical distance between Y cursors.

CursorX1, CursorY1 Intersect Amplitude

The signal amplitude at the intersection point of X1 and Y1.

CursorsX1, CursorY1 Intersect Depth

The thickness/TOF measurement of the signal at the intersect point of X1 and Y1.

NOTE

Cursor measurements will display automatically when **[FREEZE]** is active.

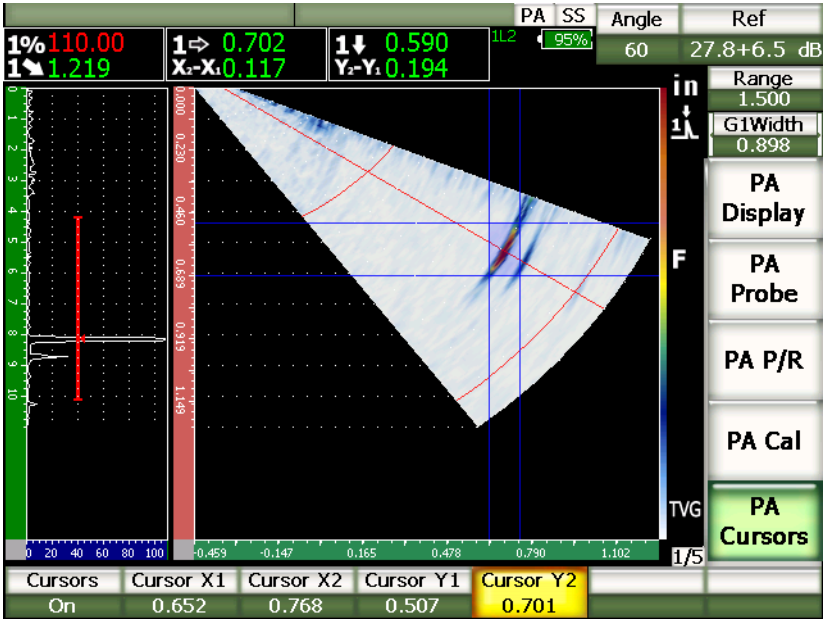

Figure 16-2 Cursors on S-scan with measurement

16.2.3 Cursor Shading

To more clearly view the area being sized on a phased array scan image, you can choose to shade the area surrounded by the X and Y sizing cursors.

To shade the sizing area, select **Display Setup > Contrast**. As the contrast is increased, the sizing area will become darker shaded in blue.

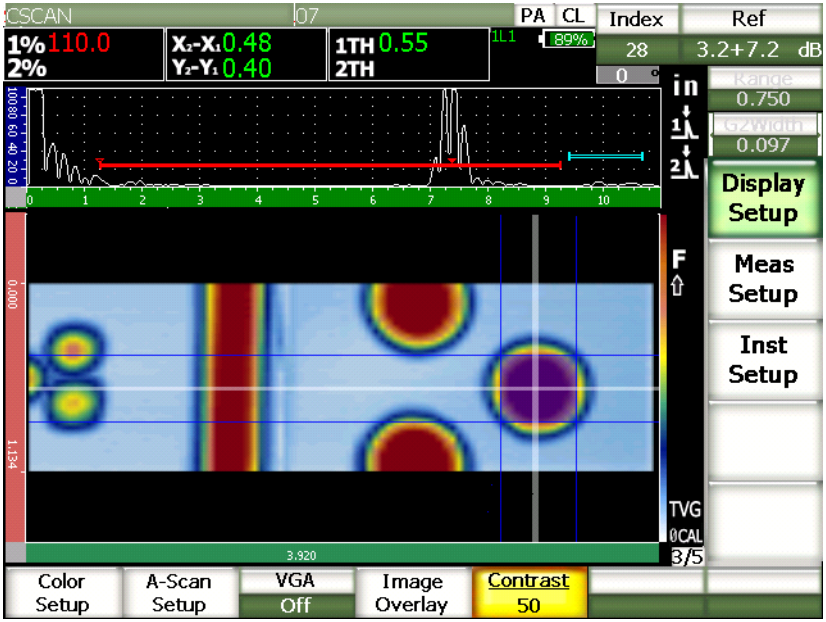

Figure 16-3 Adjusting the shading contrast

NOTE

This contrast feature also controls the contrast of the weld overlay if it is being used.

16.3 Image Cursors

EPOCH 1000 Series instruments have image cursors available for use on both the A-scan and phased array images. The following sections describe these cursors and their functions.

16.3.1 Focal Law/Index Cursor

This cursor is used to select the desired focal law or index on a phased array scan image.

In sectorial scans, or C-scans created from S-scans, this cursor selects the specific focal law. In linear scans, or C-scans created from linear scans, this cursor is used to select the specific index (aperture) along the probe width.

To adjust the focal law/index cursor, press **[ANGLE]**. For additional information, see "Focal Law (Angle) Selection Cursor" on page 331.

16.3.2 Distance Traveled Cursor

The distance traveled (D.T.) cursor selects a specific point along the scan axis in C-scan images. For encoded C-scans, the D.T. cursor selects a specific encoder position along the scan axis in inches or millimeters. For timed D-scans, this cursor corresponds to a specific screen pixel along the scan axis.

To adjust the D.T. cursor, select **PA Cursors > D.T.** For additional information, see "Linear Scan and Encoded C-scan Option" on page 454.

16.3.3 Centerline Cursor

The centerline (CL) cursor allows for positioning of the weld overlay on the phased array image to accurately reflect the relationship between the probe and the weld. The CL distance is measured from the front of the selected phased array probe.

To adjust the focal law/index cursor, select **PA Cursors > CL Cursor**. For additional information, see "Weld Overlay" on page 471.

17. Calibrating the EPOCH 1000 Series (Phased Array Mode)

This chapter describes how to calibrate the phased array mode of the EPOCH 1000 Series. Phased array calibration is the process of adjusting the instrument so that it measures accurately on a particular material, using a particular probe at a particular temperature, across all active focal laws. You must adjust the material velocity, wedge delay, and sensitivity (gain) parameters of the EPOCH 1000 Series instrument during calibration. The EPOCH 1000 Series has an advanced auto-calibration feature, which provides a fast and easy calibration process. The following section details the procedure for calibrating the EPOCH 1000 Series instrument for each of the parameters listed above in angle or straight beam (zero degree) mode.

17.1 Getting Started

Until you are completely comfortable operating your EPOCH 1000 Series instrument, we recommend that a basic review and setup procedure be used prior to starting the actual calibration.

The majority of initial instrument setups in phased array mode are accomplished using the **Beam** setup page accessible by selecting **PA Probe > Beam**. Automatic probe identification or manual probe definition allows you to easily set appropriate parameters for the selected phased array probe, wedge, and inspection type. For more information on using the **Beam** setup page, see “Beam Setup Page” on page 304.

To set up the EPOCH 1000 Series phased array mode before calibrating

1. Use the **Beam** setup page to define the probe, wedge, geometry, focal laws and other general inspection parameters.
2. Press **[GAIN]** to select an initial gain value that is appropriate for the calibration. If the appropriate gain level is unknown, set the initial gain to 12 dB and adjust it as necessary during calibration.
3. Use the **Range** parameter to set the range based on the sound path range within the selected calibration block.

TIP

Always use the steepest angle to select the maximum range for calibration. This ensures full coverage across all focal laws during calibration.

17.2 Calibration Types

The EPOCH 1000 Series phased array mode requires up to three types of calibration to be performed to attain accurate distance and amplitude measurements across all focal laws within the angular coverage area (sweep). These three calibration types are described in the following sections.

17.2.1 Velocity

The **Velocity** calibration type allows you to properly calibrate for the velocity of sound within the test material. This calibration type can only be performed using a single reflector of known sound path (typically the arc or back wall of a test block).

17.2.2 Wedge Delay

The **Wedge Delay** calibration type allows you to properly correct for the delay between the electronic firing of the probe and the point in time when the sound beam enters the test piece. This parameter is known as **CAL Zero** in the conventional UT mode.

In phased array mode, this is a more complex parameter to evaluate than in the conventional UT mode. In most phased array inspections, each focal law has a specific wedge delay. This is because each focal law typically has a specific angle of inspection with a different beam index point (BIP) on the wedge, and therefore, a different length of wedge material to travel through before reaching the surface of the inspected material. In phased array mode, the instrument calculates a wedge delay for each focal law. When the currently selected focal law changes, the instrument dynamically applies the corresponding wedge delay to the measurement readings.

EPOCH 1000 Series instruments allow you to use a single calibration step to calculate the wedge delay for all focal laws. This allows accurate measurement readings of sound path, depth, and/or surface distances for all angles of inspection through a single calibration.

17.2.3 Sensitivity (Gain)

The **Sensitivity (Gain)** calibration type allows you to properly correct variations in system sensitivity to a particular reflector across all focal laws. This calibration is related to the fourth step of a conventional angle beam calibration, where the system sensitivity is calibrated to a known reflector and the reference gain is established. The sensitivity (gain) calibration essentially establishes a reference gain for every focal law in the angular coverage area (sweep).

The instrument's sensitivity to a particular reflector varies based on sound path and wedge delay. Compared to low angle sound beams, high angle sound beams must travel a longer material path to reach a given reflector. This increase in material path means an increase in beam spread and beam attenuation, resulting in the reflector producing a lower-amplitude indication on the screen.

EPOCH 1000 Series instruments allow you to use a single calibration step to track the amplitude response of a single reflector across all focal laws within the angular coverage area, and then apply individual gain adjustments for each focal law to normalize the amplitude response of the given reflector.

17.2.3.1 Single Sensitivity (Gain) Calibration

EPOCH 1000 Series instruments allow you to perform a sensitivity (gain) calibration using only one reflector. This normalizes the amplitude response of flaws located at or near the sound path/depth of the calibration reflector.

17.2.3.2 Multi-Point Sensitivity (Gain) Calibration

EPOCH 1000 Series instruments allow you to perform a sensitivity (gain) calibration at multiple points (depths) within a material. By using multiple points, the instrument can normalize the response of a given reflector across an entire sound path/depth inspection range, instead of at a single focus.

The multi point sensitivity calibration feature creates a time-varied gain (TVG) setup for all focal laws within the calibrated region. This allows easy scanning and clear imaging of potential defects across an entire inspection range.

17.3 S-Scan Calibration with a Zero-Degree Probe

Use Olympus probe part number 5L16-A10P, with a frequency of 5.0 MHz and an element count of 16 to perform the sample zero-degree calibration. This calibration requires the use of the zero-degree wedge, part number SA10P-0L. The calibration also requires a test block with two known thicknesses made from the material to be measured. Ideally, the two thicknesses should represent thicknesses that are both below and above the expected thickness of the material being inspected.

For the example of the following procedure, an Olympus standard 5-step block (part number 2214E) is used (see Figure 9-31 on page 186 for details).

NOTE

If the EPOCH 1000 Series instrument is set to work in metric units, the calibration process is exactly the same, except that the entries are in millimeters rather than inches.

To calibrate using a zero-degree probe

1. Follow the initial setup procedure described in section “Getting Started” on page 363.
2. For the example outlined in the following sections, select the SA10P-0L wedge in the **Beam** setup page accessible by selecting **PA Probe > Beam**.
3. Verify that the **Start Angle** is −30° and the **End Angle** is +30°.

17.3.1 Calibrating the Velocity with a Zero-Degree Probe

To calibrate the velocity with a zero-degree probe

1. Press **[RANGE]**, and then enter an appropriate range for the calibration.
   For this example, use 1.00 in. (25.4 mm).
2. Select **PA CAL > Calibration = CAL Velocity**.
3. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 0°.
4. Couple the probe to the 0.200 in. (5.08 mm) step of the calibration block.
5. Use the **[GATE]** key to position gate 1 so that it surrounds the back wall echo from the 0.200 in. (5.08 mm) step of the block.
6. Adjust the gain so that the echo amplitude is at approximately 80 %.

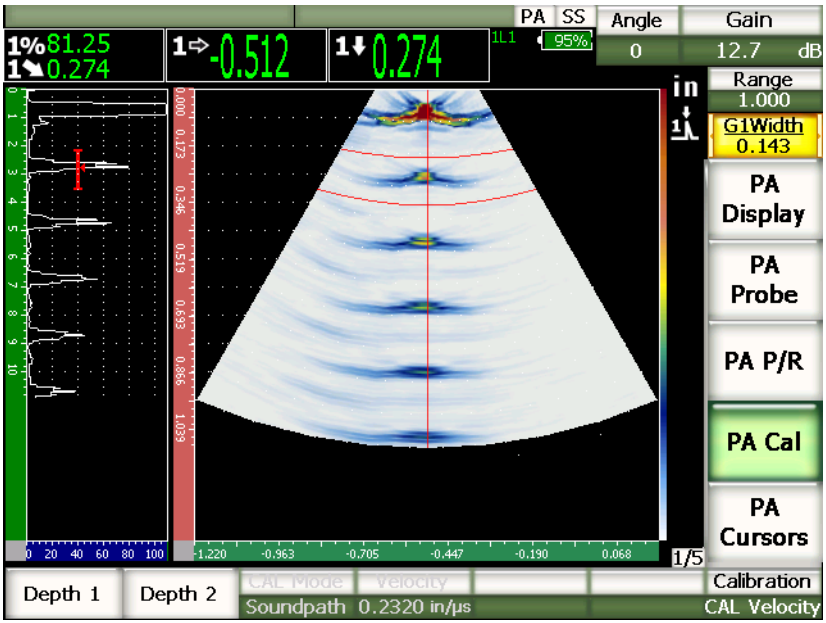

Figure 17-1 Example of gated calibration signal

7. When a steady reading is achieved, select **PA CAL > Depth 1**.
   The screen freezes and the **Enter Value for Thin Standard** dialog box appears.

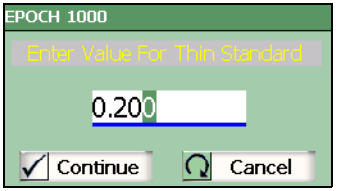

Figure 17-2 The Enter Value for Thin Standard dialog box

8. Adjust the value to match the known thickness of the gated indication (for this example, 0.200 in. [5.08 mm]), and then press **[CHECK]** to continue to the second calibration step.

NOTE

If for any reason you need to exit without acquiring calibration data, press **[ESCAPE]**.

---

9. Couple the probe to the 0.500 in. step of the calibration block.
10. Use the **[GATE]** key to position gate 1 to surround only the back wall echo from the test block.
11. Adjust the gain so that the echo amplitude is at approximately 80 %.

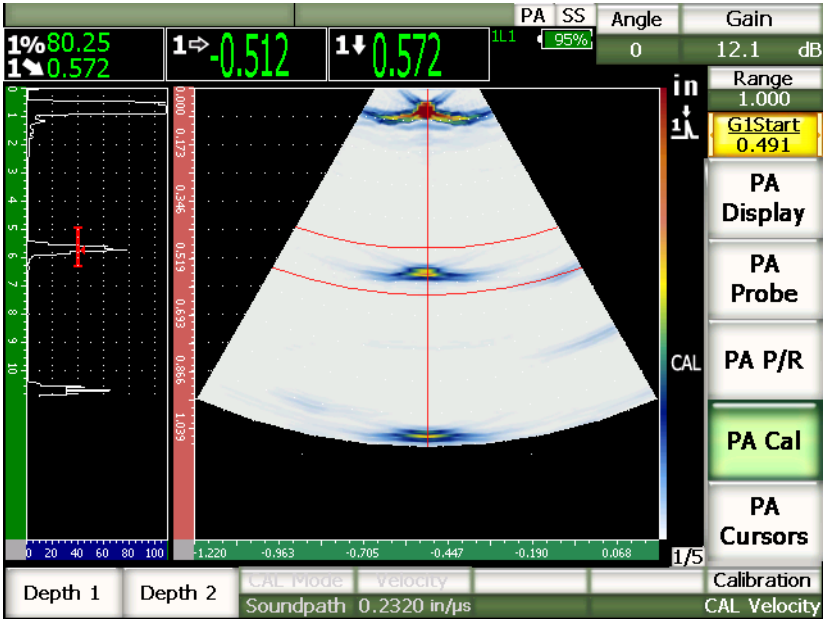

Figure 17-3 Example of the second gated calibration signal

12. When a steady reading is achieved, select **PA CAL > Depth 2**.
    The screen freezes and the **Enter Value for Thick Standard** dialog box appears.

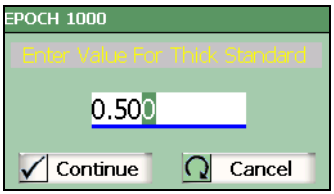

Figure 17-4 The Enter Value for Thick Standard dialog box

13. Adjust the value to match the known thickness of the gated indication (for this example, 0.500 in. [12.7 mm]), and then press **[CHECK]** to complete the calibration process.

17.3.2 Calibrating the Wedge Delay with a Zero-Degree Probe

The wedge delay can be calibrated using a discrete reflector, such as a side-drilled hole or a back wall reflection. In the following example the small side-drilled hole of the IIW block is used to calculate the wedge delay.

To calibrate the wedge delay with a zero-degree probe

1. Press **[RANGE]** to enter an appropriate range for the calibration.
   For this example, 1.00 in. (25.4 mm).
2. Select **PA CAL > Calibration = CAL Zero**.
3. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 0°.
4. Couple the probe to the side of the block.
5. Use the **[GATE]** key to position gate 1 to surround only the reflection from the side-drilled hole.
6. Adjust the gain so that the echo amplitude is at approximately 80 %.

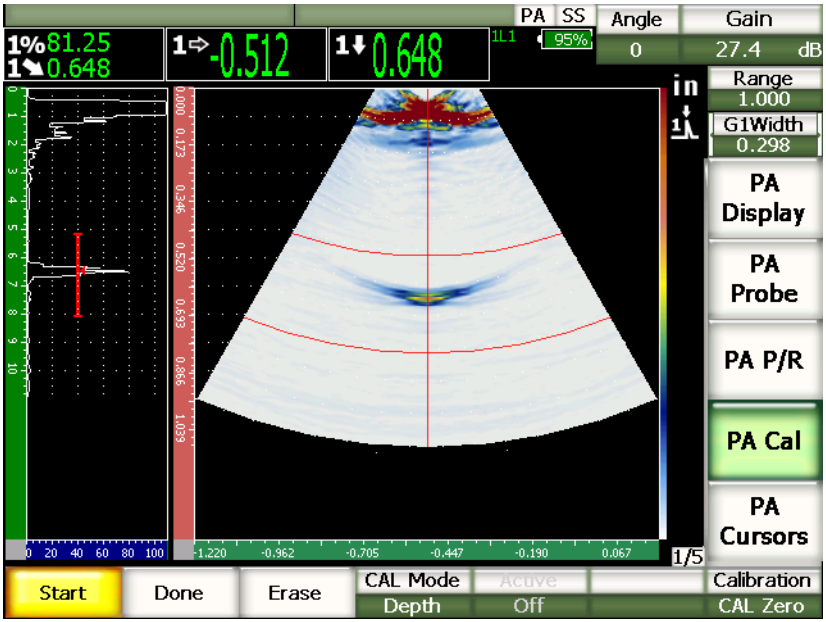

Figure 17-5 Example of gated calibration signal

IMPORTANT

The gated region must capture the wedge delay indication for all focal laws. If the wedge delay indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate wedge delay for that/those focal law(s).

7. Select **PA CAL > Start** to begin the calibration process.

   The screen freezes and the **Enter Value for Zero Cal** dialog box appears.

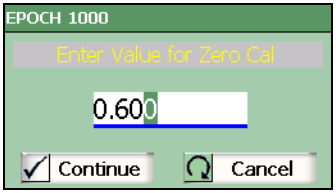

Figure 17-6 The Enter Value for Zero Cal dialog box

8. Adjust the value to match the known thickness of the gated indication (for this example, 0.600 in. [15.24 mm]), and then press **[CHECK]** to continue to the second calibration step.

   The A-scan at the top of the screen is replaced by a new view representing the thickness measurement reading (yellow line) for the gated indication across all focal laws (see Figure 17-7 on page 372). Ideally, the thickness measurement reading line should be a straight line, which indicates that the instrument is making the same thickness measurement from the same reflector for each focal law. A dotted-line through the center of this small window represents the user-defined known value of the actual thickness measurement. For this example, the calibrated line should look like the one shown in Figure 17-7 on page 372.

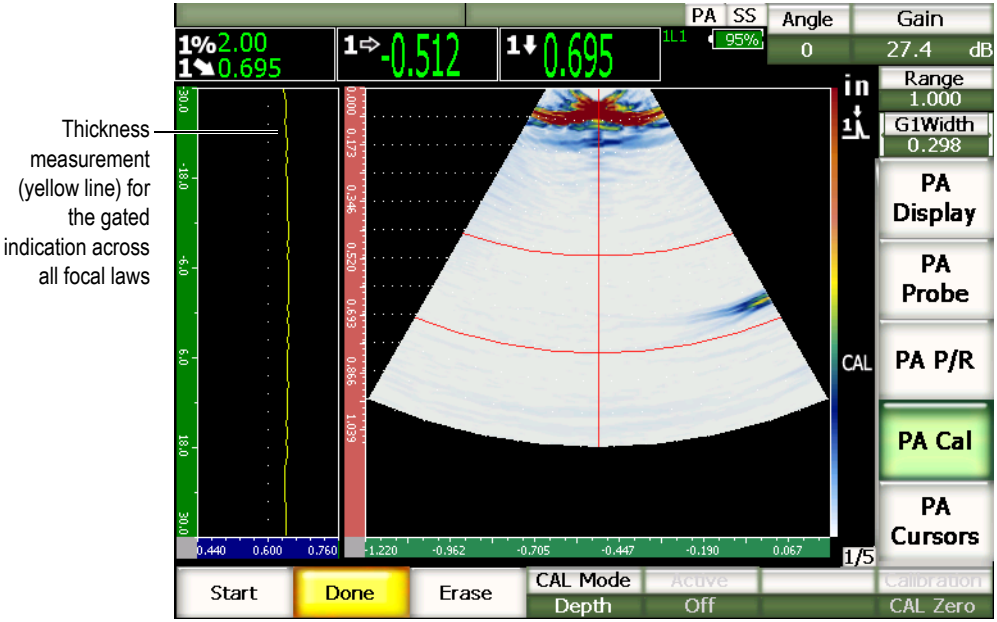

Figure 17-7 The wedge delay acquisition screen

9. If necessary, move the probe back and forth to acquire uncalibrated thickness-measurement data across all focal laws.

NOTE

When using a side-drilled hole to calibrate wedge delay, it is necessary to move the probe across the side-drilled hole to acquire a thickness measurement for all focal laws.

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew. Make multiple passes over the reflector.

---

10. Select **PA Cal > Erase** to clear the current wedge delay curve and redraw a new curve.

NOTE

If the yellow wedge delay curve saturates the screen, adjust the gain to a lower value and redraw the curve.

11. Select **PA Cal > Done** to accept the drawn line and to calculate the wedge delay.

    A **0CAL** flag will display on the bottom right corner of the screen to indicate that the wedge delay calibration has been completed (see Figure 17-8 on page 373).

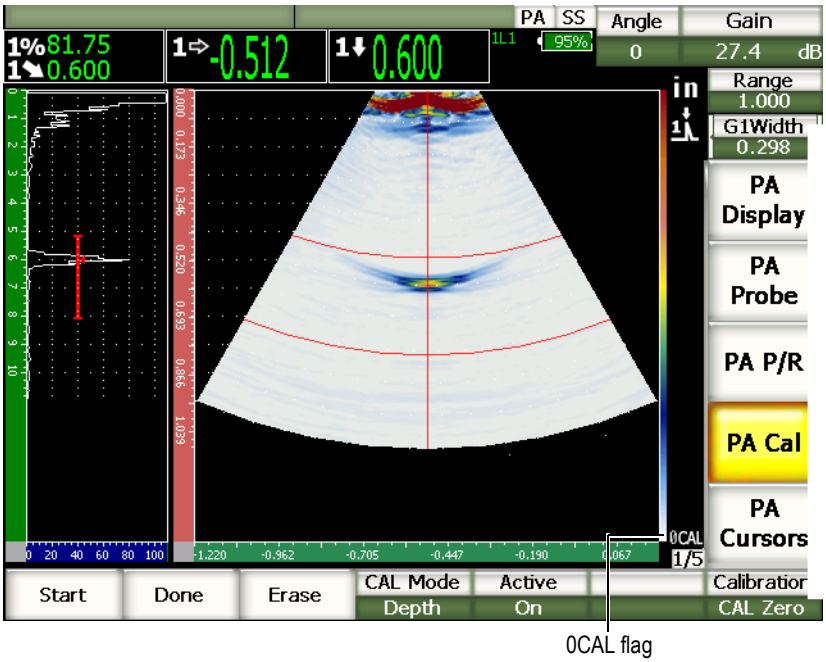

Figure 17-8 A completed wedge delay calibration

17.3.3 Calibrating the Sensitivity (Gain) with a Zero-Degree Probe

Sensitivity (gain) can be calibrated using a discrete reflector, such as a side-drilled hole or a back wall reflection. In the following example, the small side-drilled hole of the IIW block is used to calculate sensitivity (gain).

To calibrate the sensitivity with a zero-degree probe

1. Press **[RANGE]**, and then enter an appropriate range for the calibration.
   For this example, 1.00 in. (25.4 mm).
2. Select **PA CAL > Calibration = CAL Gain**.
3. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 0°.
4. Couple the probe to the IIW block over the side-drilled hole.
5. Use the **[GATE]** key to position gate 1 to surround only the reflection from the side-drilled hole.
6. Adjust the gain so that the echo amplitude is at approximately 80 %.

IMPORTANT

The gated region must capture the side-drilled hole indication for all focal laws. If the side-drilled hole indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate sensitivity (gain) for that/those focal laws.

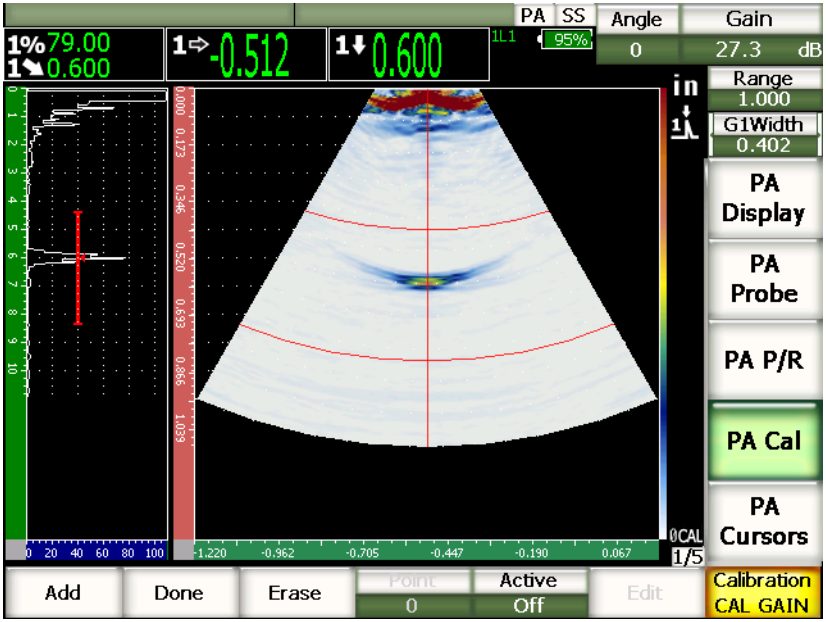

Figure 17-9 Example of the captured echo

7. Select **PA CAL > Add** to begin the calibration process.

   The A-scan at the top of the screen is replaced by a new view representing the amplitude reading (yellow line) for the gated indication across all focal laws (see Figure 17-7 on page 372). Ideally, the thickness reading line should be a straight line, which indicates that the instrument is making the same thickness measurement from the same reflector for each focal law (when that reflector is peaked up). In this example, the calibrated line should look like the one shown in Figure 17-10 on page 376.

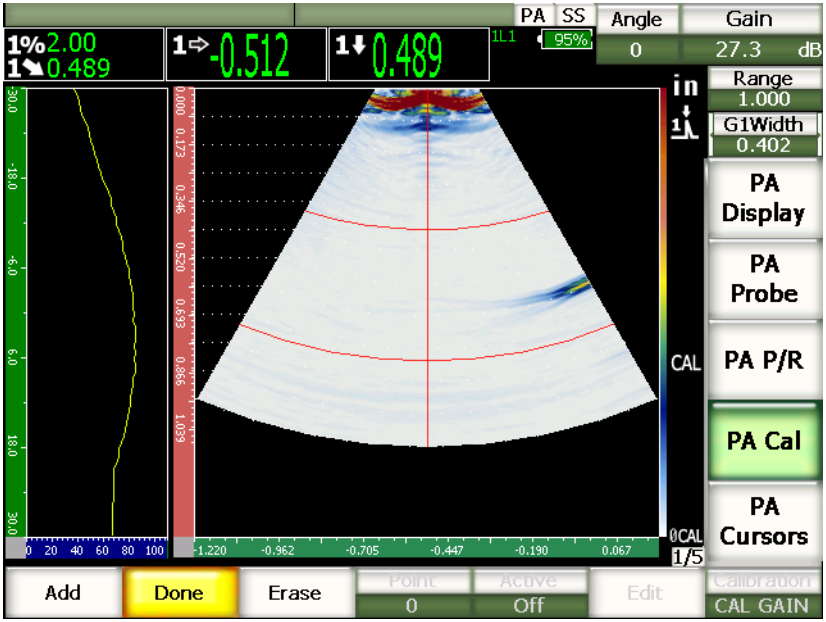

Figure 17-10 The CAL Gain acquisition screen

8. Move the probe back and forth over the side-drilled hole to acquire uncalibrated peak amplitude measurement data across all focal laws.

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew, and make multiple passes over the reflector.

---

9. Select **PA CAL > Erase** to clear the current gain curve and to redraw a new curve.

NOTE

If the yellow gain curve saturates the screen, adjust the gain to a lower value and redraw the curve.

---

10. Select **PA CAL > Done** to accept the drawn line and calculate sensitivity.

A **TVG** flag displays on the bottom-right corner of the screen to indicate that the sensitivity calibration has been completed (see Figure 17-11 on page 377).

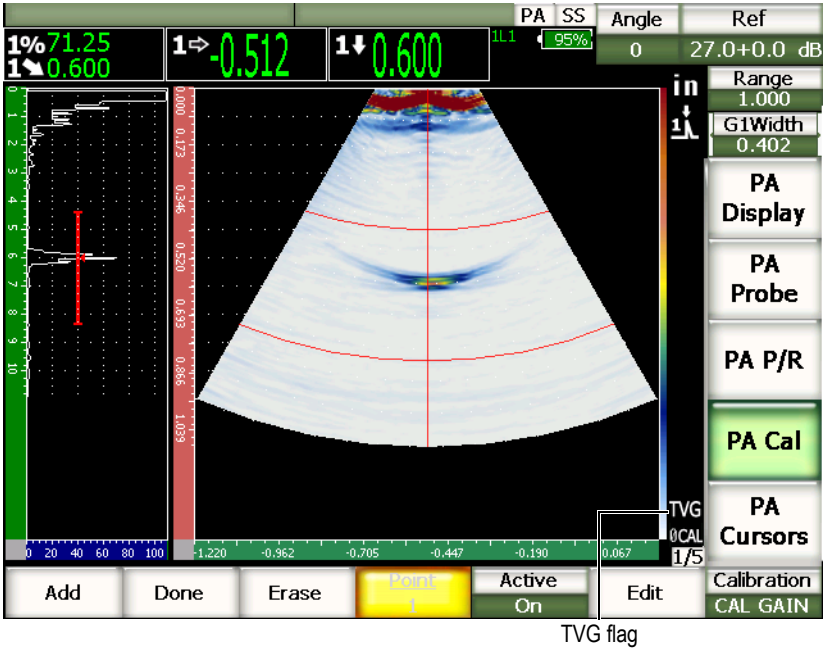

Figure 17-11 The completed gain calibration

NOTE

Sensitivity (gain) calibration can be performed before wedge delay calibration, if desired. In some cases, normalizing the amplitude response of a given reflector allows a more precise thickness measurement during wedge delay calibration. However, velocity calibration must always be the first calibration step.

17.4 S-Scan Calibration with an Angle Beam Probe

The procedures of the following sections use an Olympus IIW Type I carbon-steel calibration block, part number TB7541-1.

To calibrate using an angle beam probe

1. Follow the initial setup procedure described in section “Getting Started” on page 363.
2. For this example, open the **Beam** setup page by selecting **PA Probe > Beam**.
3. Highlight **Wedge ID**, and then select the **SA10P-N55S** wedge.
4. Verify that the **Start Angle** is 40° and the **End Angle** is 70°.

17.4.1 Calibrating the Velocity with an Angle Beam Probe

To calibrate the velocity with an angle beam probe

Press **[RANGE]**, and then enter an appropriate range for the calibration. For this example, 10 in. (254 mm).

1. Select **PA Cal > Calibration = CAL Velocity**.
2. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 45°.
3. Couple the probe to the test block at the 0 mark.

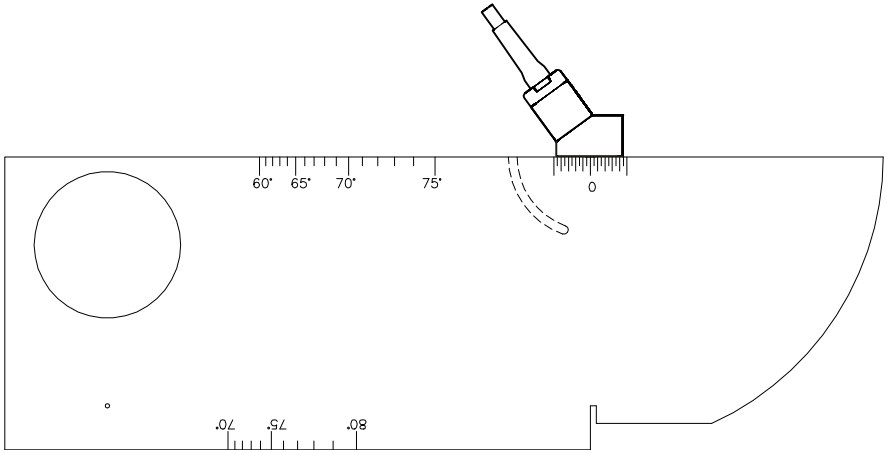

Figure 17-12 The IIW block with the probe

4. Move the probe forward and backward to bring the echo to its maximum amplitude (peak). Ensure that the echoes do not exceed 100 %. Reduce the gain setting if necessary.
5. Use the **[GATE]** key to position gate 1 around the first back wall echo.

TIP

If it is unclear from the S-scan, use the A-scan to position the gate start and width positions so that only the first back wall reflection is in the gated region.

---

6. Use the **[GATE]** key to position gate 1 so that it surrounds the first reflection from the arc of the block.

   This reflection should be close to 4 in. (101.6 mm).
7. Adjust the gain so that the echo amplitude is at approximately 80 %.

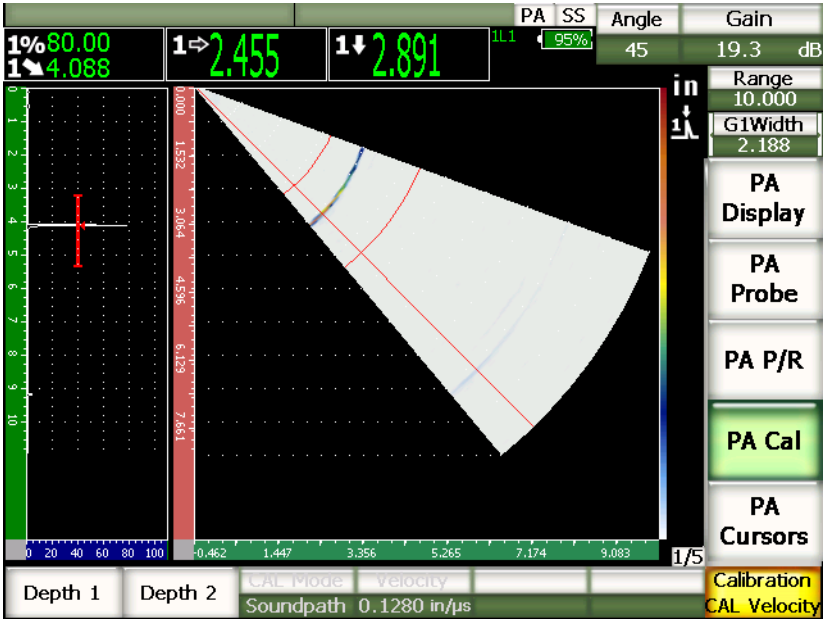

Figure 17-13 The gated calibration signal

8. When a steady reading is achieved, select **PA Cal > Depth 1**.
   The screen freezes and the **Enter Value For Thin Standard** dialog box appears.

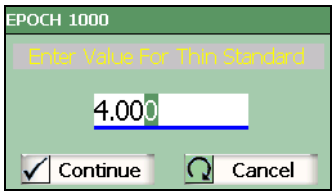

Figure 17-14 The Enter Value For Thin Standard dialog box

9. Adjust the value to match the known thickness of the gated indication (for this example, 4.000 in. [101.6 mm]), and then press **[CHECK]** to continue to the second calibration step.

NOTE

If for any reason you need to exit without acquiring calibration data, press **[ESCAPE]** to cancel.

Figure 17-15 The second gated calibration signal

10. Continue coupling the probe to the calibration block at the 0 mark.
11. Use the **[GATE]** key to position gate 1 so that the second echo reflection from the arc of the block is within the gated region.

    This reflection should be close to 9 in. (228.6 mm).
12. Adjust the gain so that the echo amplitude is at approximately 80 %.
13. When a steady reading is achieved, select **PA Cal > Depth 2**.

    The screen freezes and the **Enter Value For Thick Standard** dialog box appears.

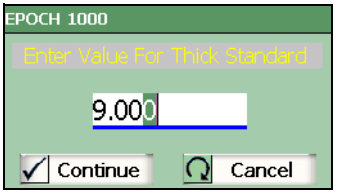

Figure 17-16 The Enter Value For Thick Standard dialog box

14. Adjust the value to match the known thickness of the gated indication (for this example, 9.000 in. [228.6 mm]), and then press **[CHECK]** to calculate and complete the calibration process.

17.4.2 Calibrating the Wedge Delay with an Angle Beam Probe

The wedge delay can be calibrated using a discrete reflector, such as a side-drilled hole or a back wall reflection. In the following procedure the first back wall of the arc of the IIW block is used to calculate the wedge delay.

To calibrate the wedge delay with an angle beam probe

1. Press **[RANGE]**, and then enter an appropriate range for the calibration.
   For this example, 6 in. (152 mm).
2. Select **PA Cal > Calibration = CAL Zero**.
3. Select **PA Cal > CAL Mode = Soundpath**.

NOTE

The wedge delay calibration can be performed using a reflector of known depth, such as a side-drilled hole. To use such a reflector, select **PA Cal > CAL Mode = Depth** and follow the instructions below, using the known depth as the **Wedge Delay** value.

---

4. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 45°.
5. Couple the probe to the test block at the 0 mark.

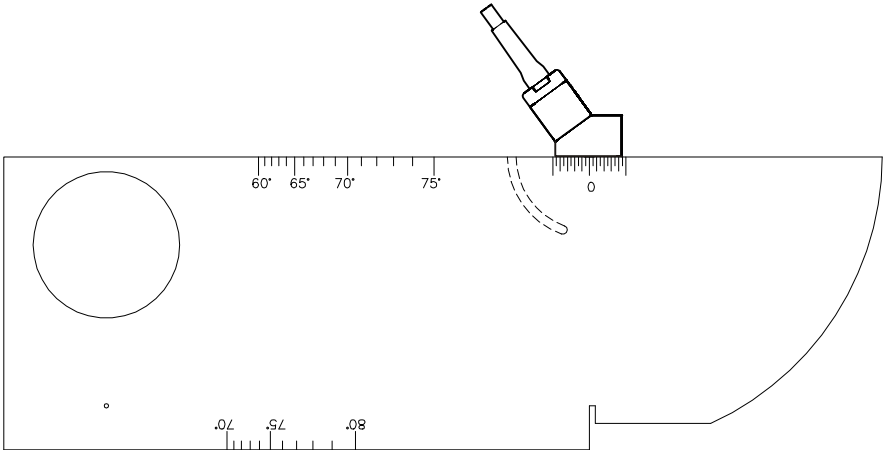

Figure 17-17 The probe coupled to the 0-mark of the IIW block

6. Use the **[GATE]** key to position gate 1 so that it surrounds the first reflection from the arc of the block. This reflection should be close to 4 in. (101.6 mm).
7. Adjust the gain so that the echo amplitude is at approximately 80 %.

Figure 17-18 The first echo

IMPORTANT

The gated region must capture the wedge delay indication for all focal laws. If the wedge delay indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate wedge delay for that/those focal law(s).

8. Select **PA Cal > Start** to begin the calibration process.

   The screen freezes and the **Enter Value for Zero Cal** dialog box appears.

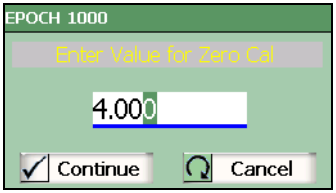

Figure 17-19 The Enter Value for Zero Cal dialog box

9. Adjust the value to match the known thickness of the gated indication (for this example, 4.000 in. [101.6 mm]), and then press **[CHECK]** to continue to the second calibration step.

   The A-scan on the left side of the screen is replaced by a new view representing the thickness reading (yellow line) for the gated indication across all focal laws. Ideally, this thickness reading line should be a straight line, which indicates that the instrument is making the same thickness measurement from the same reflector at each focal law. A dotted-line through the center of this small window represents the user-defined known value of the actual thickness measurement. In this example, the calibrated line should look like the one shown in Figure 17-20 on page 386.

Figure 17-20 The wedge delay acquisition screen

10. Move the probe forward and backward to acquire uncalibrated thickness measurement data across all focal laws.

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew. Make multiple passes over the reflector.

11. Select **PA Cal > Erase** to clear the current wedge delay curve and to redraw a new curve.

NOTE

If the yellow wedge delay curve saturates the screen, adjust the gain to a lower value and redraw the curve.

12. Select **PA Cal > Done** to accept the drawn line and calculate wedge delay.

A **0CAL** flag will display on the bottom right corner of the screen to indicate that the wedge delay calibration has been completed (see Figure 17-21 on page 387).

Figure 17-21 The completed wedge delay calibration

NOTE

When using a side-drilled hole to calibrate wedge delay, it is necessary to move the probe across the side-drilled hole to acquire a thickness measurement for all focal laws.

17.4.3 Calibrating the Sensitivity (Gain) with an Angle Beam Probe

Sensitivity (gain) can be calibrated using a discrete reflector, such as a side-drilled hole or a back wall reflection. In the example below, the small side-drilled hole of the IIW block is used to calculate sensitivity (gain).

To calibrate the sensitivity with an angle beam probe

Press **[RANGE]**, and then enter an appropriate range for the calibration. For this example, 2 in. (50.8 mm).

1. Select **PA Cal > Calibration = CAL Gain**.
2. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 45°.
3. Couple the probe to the IIW block over the side-drilled hole.
4. Use the **[GATE]** key to position gate 1 to surround only the first reflection from the side-drilled hole.
5. Adjust the gain so that the echo amplitude is at approximately 80 %.

IMPORTANT

The gated region must capture the side-drilled hole indication for all focal laws. If the side-drilled hole indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate sensitivity (gain) for that/those focal laws.

Figure 17-22 The captured echo

6. Select **PA Cal > Add** to begin the calibration process.

   The A-scan on the left side of the screen is replaced by a new view representing the amplitude reading (yellow line) for the gated indication across all focal laws. Ideally, this amplitude reading line should be a straight line, which indicates that the instrument is making the same amplitude measurement from the same reflector at each focal law (when that reflector is peaked up). In this example, the calibrated line should look like the one shown in Figure 17-23 on page 390.

Figure 17-23 The Gain acquisition screen

7. Move the probe forward and backward over the side-drilled hole to acquire uncalibrated peak amplitude measurement data across all focal laws.

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew. Make multiple passes over the reflector.

8. Select **PA Cal > Erase** to clear the current gain curve and redraw a new curve.

NOTE

When the yellow gain curve saturates the screen, adjust the gain to a lower value and redraw the curve.

9. Select **PA Cal > Done** to accept the drawn line and calculate sensitivity.

A **TVG** flag displays on the bottom-right corner of the screen to indicate that the sensitivity calibration has been completed (see Figure 17-24 on page 391).

Figure 17-24 The completed gain calibration

TIP

Sensitivity (gain) calibration can be performed before wedge delay calibration, if desired. In some cases, normalizing the amplitude response of a given reflector allows a more precise thickness measurement during wedge delay calibration. However, velocity calibration must always be the first calibration step.

17.5 Gate Adjustment During Calibration

The wedge delay and sensitivity (gain) calibration procedures described in the previous sections often require you to acquire either an amplitude or thickness measurement from a single reflector across all focal laws. It is critical that while acquiring this reflection during the calibration process, no other reflector of higher amplitude enters the gated region. If there are other reflectors within the gated region during either wedge delay or sensitivity (gain) acquisition, those other reflections can interfere with the data being tracked by the instrument and can corrupt the calibration process.

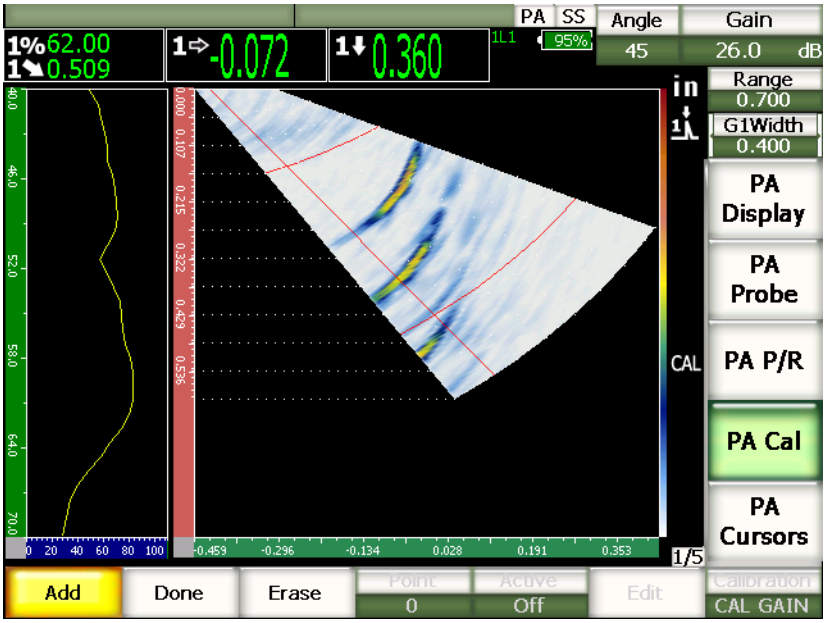

Figure 17-25 Wide gate with two echoes interfering

EPOCH 1000 Series instruments allow you to adjust the start position and/or width of gate 1 while acquiring data during a calibration procedure. This allows you to use a narrow gate width to measure the amplitude/thickness of the desired calibration reflection for one subset of focal laws. Then you reposition the gate to acquire the remaining amplitude/thickness measurements from the same reflection at another subset of focal laws.

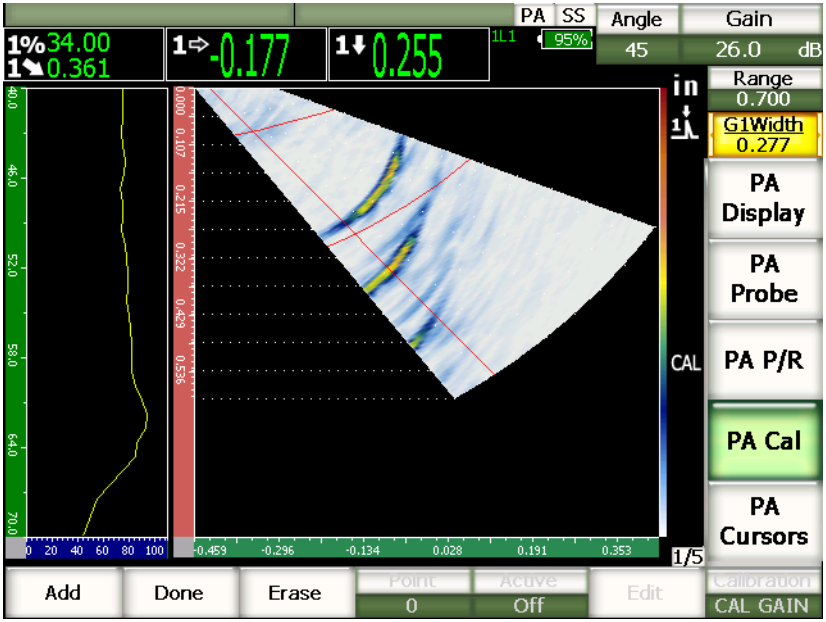

Figure 17-26 Narrow gate to capture only one echo

Using this gate adjustment during calibration, you can eliminate interfering indications from other reflectors within a test block and acquire correct and valid calibration data.

17.6 Calibration On and Off

EPOCH 1000 Series instruments allow you to toggle both the wedge delay and sensitivity (gain) calibration on and off. Both calibrations have an impact on the image displayed in the S-scan.

Wedge delay, while correcting for measurement readings, can make the S-scan image appear slightly distorted from the natural image view. This is not a problem, as it correctly represents the delay inherent across all focal laws, but you may find that there are advantages to viewing the same S-scan in a calibrated and uncalibrated mode.

Sensitivity (gain), especially when calibrated using multiple depths, builds a two-dimensional (2-D) TVG curve on the S-scan image (across depths and focal laws). This gain correction is helpful in most defect interpretation and sizing situations, but this varying gain adjustment does not represent the "natural" response of the defect.

To toggle on or off calibration

- Select **PA Cal > Active**.

17.7 Curved Surface Correction

EPOCH 1000 Series instruments allow surface distance correction when inspecting pipes, cylinders, and other curved surfaces using an angle beam probe. This applies only to inspections where the surface of the test piece is curved in the direction of the sound path of the probe. This feature corrects the horizontal distance and depth-to-reflector measurements based on part thickness and part diameter.

EPOCH 1000 Series instruments allow you to correct for curved surface inspections where the probe is placed on the outer diameter of the part, as well as inspections from the inner diameter. For more information regarding the activation of curved surface correction, see "Probe and Beam Setup (Phased Array Mode)" on page 303.

17.8 Linear Scan Probe Calibration for Zero-Degree Inspection

Use Olympus probe part number 5L64-A12, with a frequency of 5.0 MHz and an element count of 64 to perform the sample zero degree calibration. This calibration requires the use of the zero-degree wedge, part number SA12-0L. The calibration also requires a test block with two known thicknesses made from the material to be measured. Ideally, the two thicknesses should represent thicknesses that are both below and above the expected thickness of the material being inspected.

For the example outlined in the following procedure, an Olympus IIW Type 1 carbon-steel calibration block (part number TB7541-1) is used (see Figure 9-25 on page 181 for details).

NOTE

If the EPOCH 1000 Series instrument is set to work in metric units, the calibration process is exactly the same, except that the entries are in millimeters rather than inches.

To calibrate using a zero-degree probe

1. Follow the initial setup procedure described in section “Getting Started” on page 363.
2. For the example of the following sections, select **PA Probe > Beam**. In the **Beam** setup page, highlight **Scan Type**, and then select **Linear Scan**.
3. Select the SA12-0L wedge in the **Beam** setup page.
4. Verify that the **Angle** is 0°.

17.8.1 Calibrating the Velocity with a Zero-Degree Probe

To calibrate the velocity with a zero-degree probe

1. Press **[RANGE]**, and then enter an appropriate range for the calibration.

   For this example, 2.00 in. (50.8 mm).
2. Select **PA CAL > Calibration = CAL Velocity**.
3. Press **[ANGLE]**, and then adjust the selected focal law (index) to 25°.
4. Couple the probe to the side of the calibration block so that the first reflection from the block represents 1.000 in (25.4 mm].
5. Use the **[GATE]** key to position gate 1 so that it surrounds the back wall echo from the 1.000 in (25.4 mm] step of the block.
6. Adjust the gain so that the echo amplitude is at approximately 80 %.

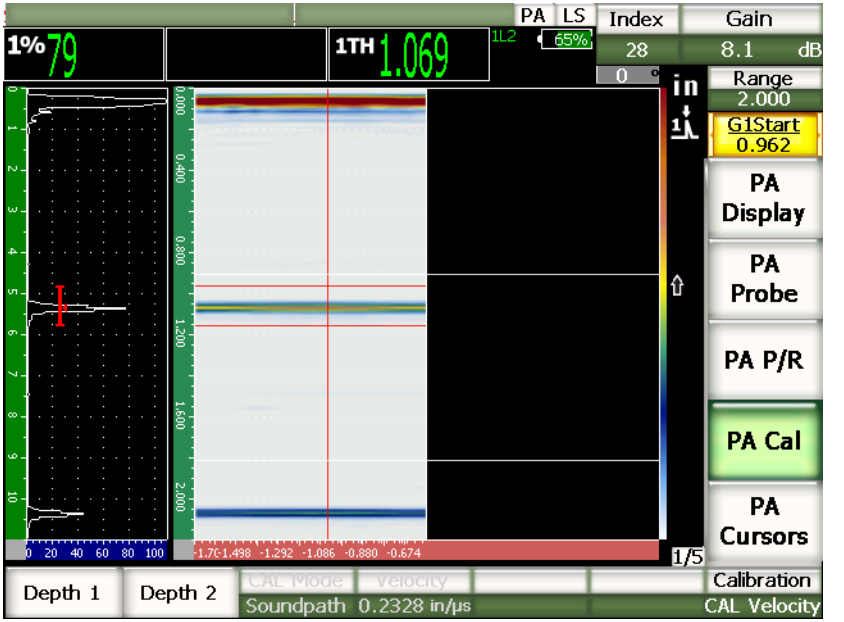

Figure 17-27 Example of gated calibration signal

7. When a steady reading is achieved, select **PA CAL > Depth 1**.
   The screen freezes and the **Enter Value for Thin Standard** dialog box appears.

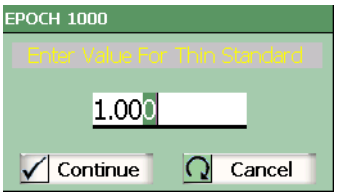

Figure 17-28 The Enter Value for Thin Standard dialog box

8. Adjust the value to match the known thickness of the gated indication (1.000 in. [25.4 mm] in this example), and then press **[CHECK]** to continue to the second calibration step.

NOTE

If for any reason you need to exit without acquiring calibration data, press **[ESCAPE]**.

9. Use the **[GATE]** key to position gate 1 to surround the second back wall echo from the test block.
10. Adjust the gain so that the echo amplitude is at approximately 80 %.

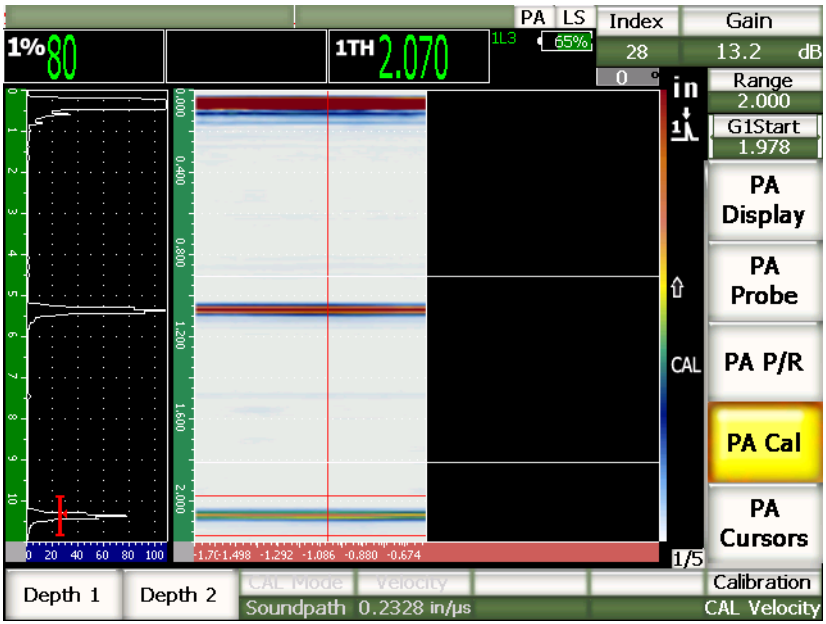

Figure 17-29 Example of the second gated calibration signal

11. When a steady reading is achieved, select **PA CAL > Depth 2**.
    The screen freezes and the **Enter Value for Thick Standard** dialog box appears.

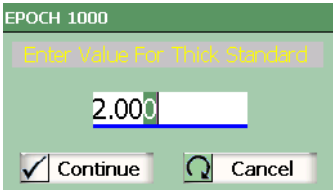

Figure 17-30 The Enter Value for Thick Standard dialog box

12. Adjust the value to match the known thickness of the gated indication (for this example, 2.000 in. [50.8 mm]), and then press **[CHECK]** to complete the calibration process.

17.8.2 Calibrating the Wedge Delay with a Zero-Degree Probe

Wedge delay can be calibrated using a discrete reflector, such as a side-drilled hole or a back wall reflection. In the following example the small side-drilled hole of the IIW block is used to calculate the wedge delay.

To calibrate the wedge delay with a zero-degree probe

1. Press **[RANGE]** to enter an appropriate range for the calibration.

   For this example, 1.00 in. (25.4 mm).
2. Select **PA CAL > Calibration = CAL Zero**.
3. Press **[ANGLE]**, and then adjust the selected focal law (index) to 25°.
4. Couple the probe to the IIW block over the side drilled hole.
5. Use the **[GATE]** key to position gate 1 to surround only the reflection from the side-drilled hole.
6. Adjust the gain so that the echo amplitude is at approximately 80 %.

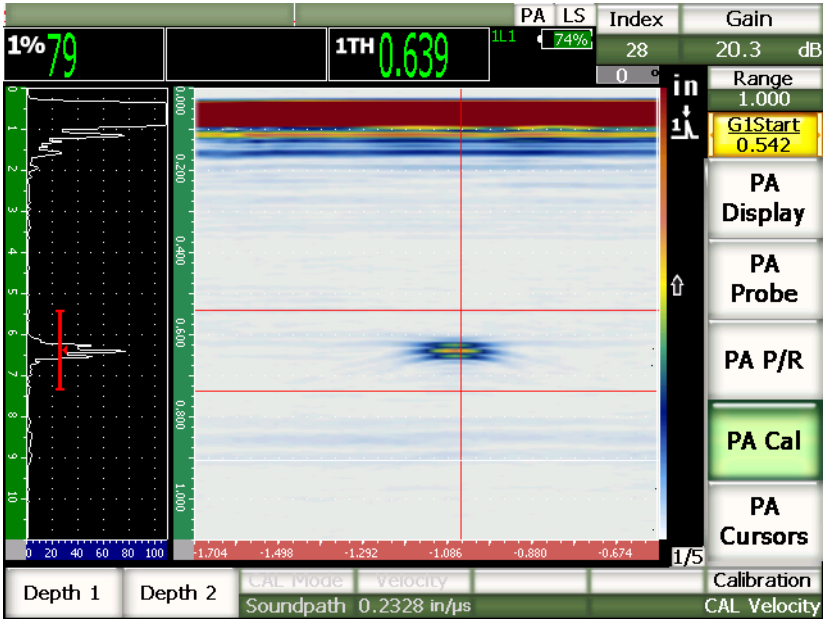

Figure 17-31 Example of gated calibration signal

IMPORTANT

The gated region must capture the wedge delay indication for all focal laws. If the wedge delay indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate wedge delay for that/those focal law(s).

7. Select the **PA CAL > Start** to begin the calibration process.

   The screen freezes and the **Enter Value for Zero Cal** dialog box appears.

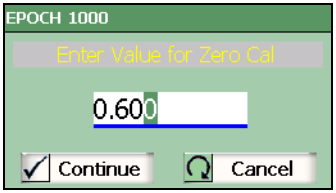

Figure 17-32 The Enter Value for Zero Cal dialog box

8. Adjust the value to match the known thickness of the gated indication (for this example, 0.600 in. [101.6 mm]), and then press **[CHECK]** to continue to the second calibration step.

   The A-scan at the top of the screen is replaced by a new view representing the thickness measurement reading (yellow line) for the gated indication across all focal laws (see Figure 17-33 on page 401). Ideally, the thickness measurement reading line should be a straight line, which indicates that the instrument is making the same thickness measurement from the same reflector for each focal law. A dotted-line through the center of this small window represents the user-defined known value of the actual thickness measurement. In this example, the calibrated line should look like the one shown in Figure 17-33 on page 401.

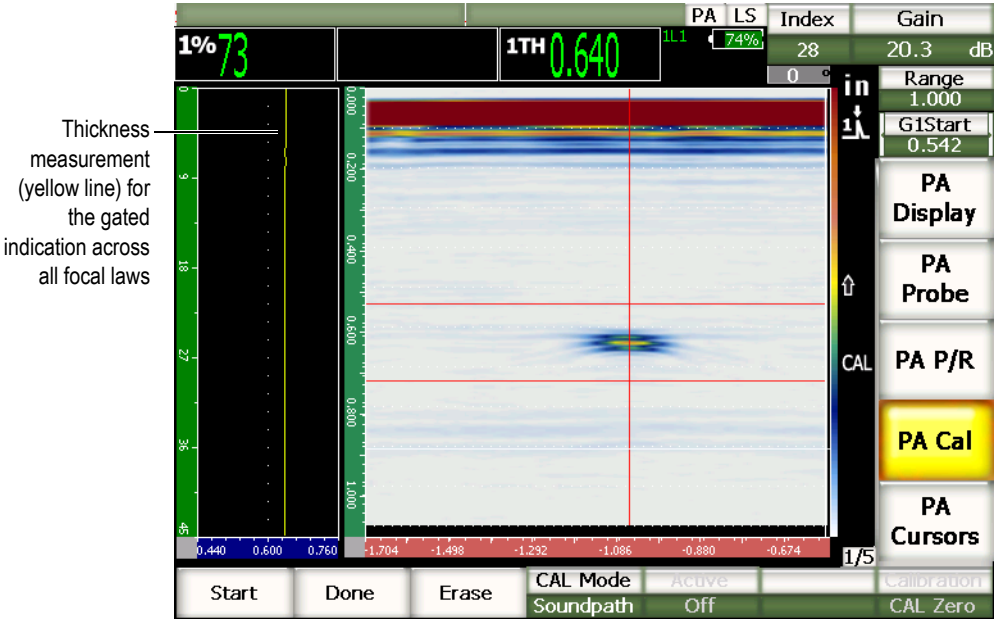

Figure 17-33 The wedge delay acquisition screen

9. If necessary, move the probe back and forth to acquire uncalibrated thickness-measurement data across all focal laws.

NOTE

When using a side-drilled hole to calibrate wedge delay, it is necessary to move the probe across the side-drilled hole to acquire a thickness measurement for all focal laws.

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew. Make multiple passes over the reflector.

10. Select **PA Cal > Erase** to clear the current wedge delay curve and redraw a new curve.

NOTE

If the yellow wedge delay curve saturates the screen, adjust the gain to a lower value and redraw the curve.

11. Select **PA Cal > Done** to accept the drawn line and to calculate the wedge delay.

    A **0CAL** flag displays on the bottom-right corner of the screen to indicate that the wedge delay calibration has been completed.

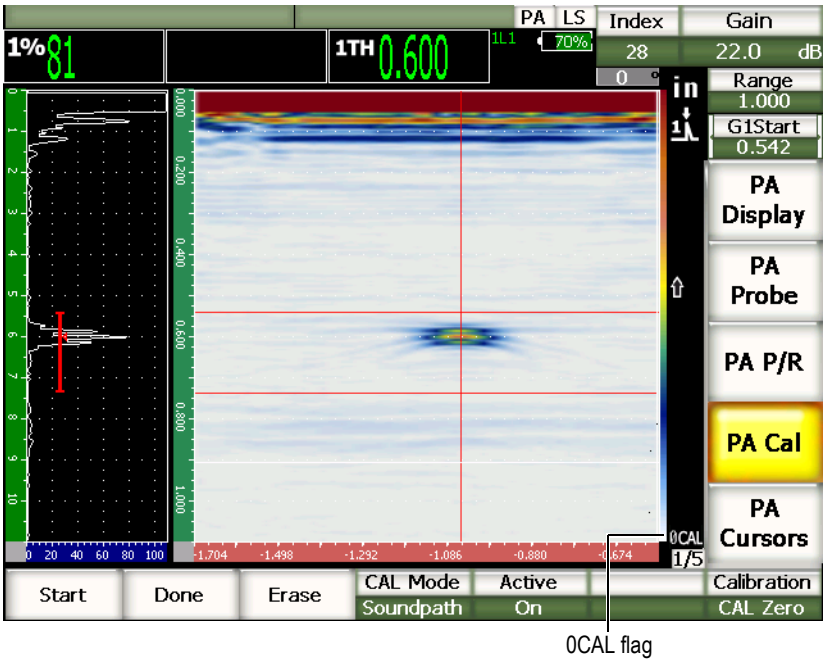

Figure 17-34 A completed wedge delay calibration

17.8.3 Calibrating the Sensitivity (Gain) with a Zero-Degree Probe

Sensitivity (gain) can be calibrated using a discrete reflector, such as a side-drilled hole or a back wall reflection. In the following example, the small side-drilled hole of the IIW block is used to calculate sensitivity (gain).

To calibrate the sensitivity with a zero-degree probe

1. Press **[RANGE]**, and then enter an appropriate range for the calibration.

   For this example, 1.00 in. (25.4 mm).
2. Select **PA CAL > Calibration = CAL Gain**.
3. Press **[ANGLE]**, and then adjust the selected focal law (index) to 25°.
4. Couple the probe to the IIW block over the side-drilled hole.
5. Use the **[GATE]** key to position gate 1 to surround only the reflection from the side-drilled hole.
6. Adjust the gain so that the echo amplitude is at approximately 80 %.

IMPORTANT

The gated region must capture the side-drilled hole indication for all focal laws. If the side-drilled hole indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate sensitivity (gain) for that/those focal law(s).

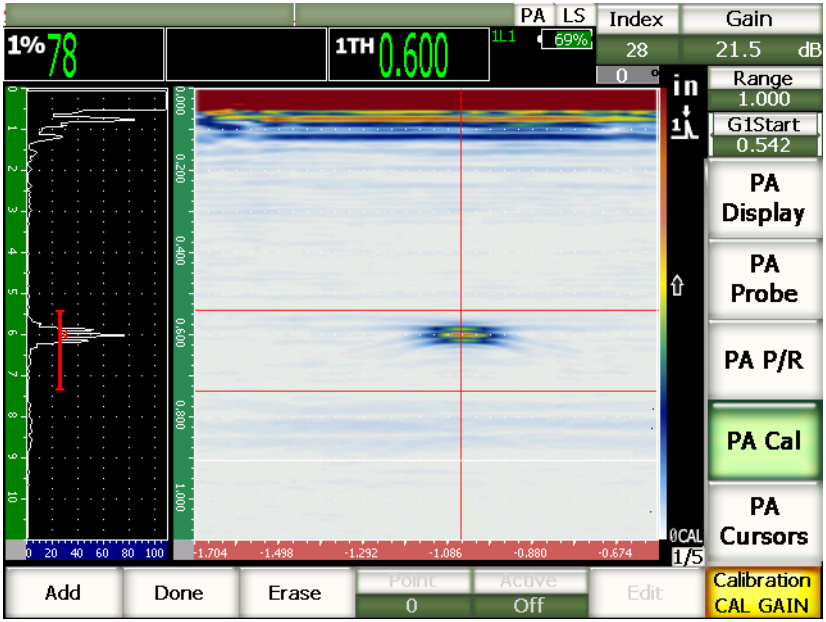

Figure 17-35 Example of a captured echo

7. Select **PA CAL > Add** to begin the calibration process.

   The A-scan at the top of the screen is replaced by a new view representing the amplitude reading (yellow line) for the gated indication across all focal laws (see Figure 17-36 on page 405). Ideally, the thickness reading line should be a straight line, which indicates that the instrument is making the same thickness measurement from the same reflector for each focal law (when that reflector is peaked up). In this example, the calibrated line should look like the one shown in Figure 17-36 on page 405.

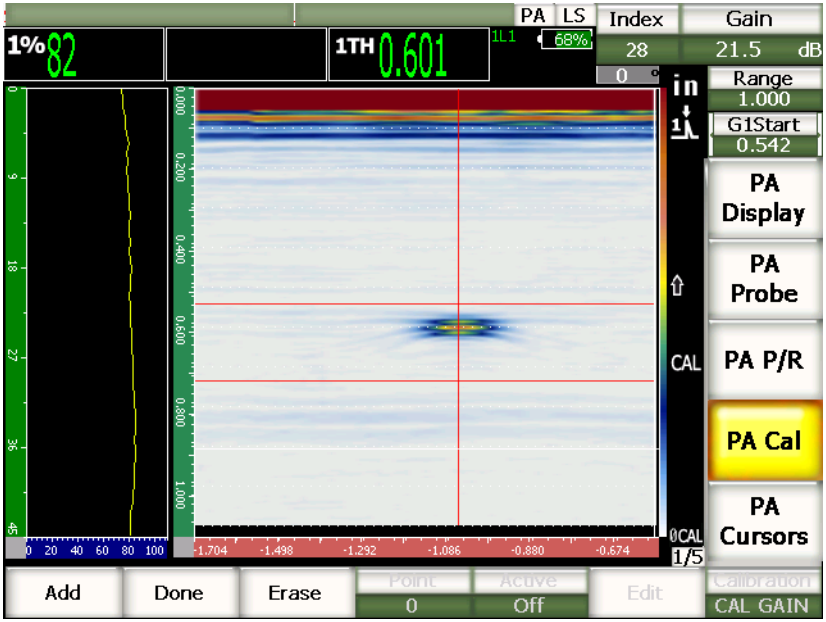

Figure 17-36 The CAL Gain acquisition screen

8. Move the probe back and forth over the side-drilled hole to acquire uncalibrated peak amplitude measurement data across all focal laws.

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew. Make multiple passes over the reflector.

---

9. Select **PA CAL > Erase** to clear the current gain curve and to redraw a new curve.

NOTE

If the yellow gain curve saturates the screen, adjust the gain to a lower value and redraw the curve.

---

10. Select **PA CAL > Done** to accept the drawn line and calculate sensitivity.

A **TVG** flag displays on the bottom-right corner of the screen to indicate that the sensitivity calibration has been completed (see Figure 17-11 on page 377).

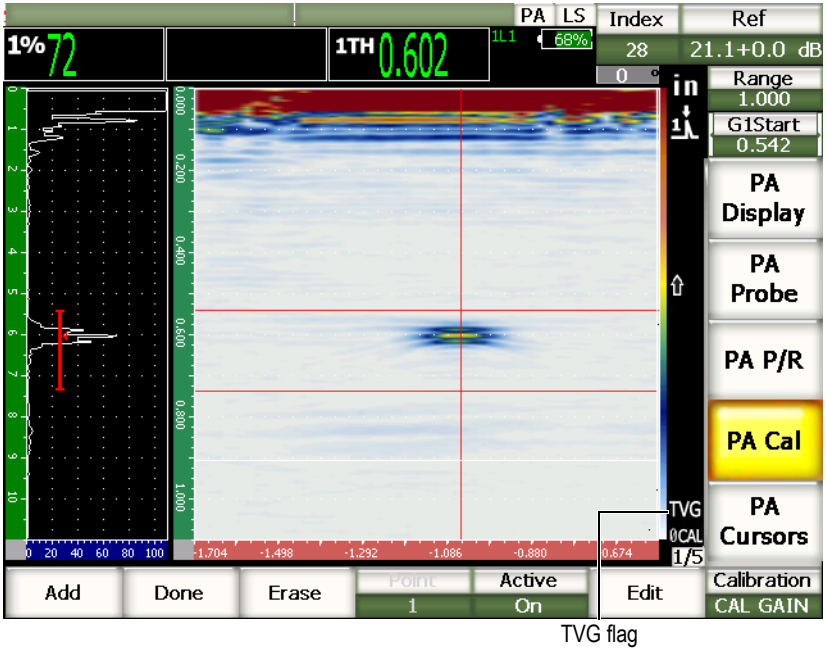

Figure 17-37 The completed gain calibration

NOTE

Sensitivity (gain) calibration can be performed before wedge delay calibration, if desired. In some cases, normalizing the amplitude response of a given reflector allows a more precise thickness measurement during wedge delay calibration. However, velocity calibration must always be the first calibration step.

17.9 Linear Scan Probe Calibration for Angle Inspection

The procedures of the following sections use an Olympus IIW Type I carbon-steel calibration block, part number TB7541-1.

To calibrate using an angle beam probe

1. Follow the initial setup procedure described in section “Getting Started” on page 363.
2. For the example of the following sections, select **PA Probe > Beam**. In the **Beam** setup page, highlight **Scan Type**, and then select **Linear Scan**.
3. Select the SA12-N55S wedge in the **Beam** setup page.
4. Set the **Angle** to 45°.

17.9.1 Calibrating the Velocity with an Angle Beam Probe

To calibrate the velocity with an angle beam probe

1. Press **[RANGE]**, and then enter an appropriate range for the calibration.

   For this example, 9 in. (228.6 mm).
2. Select **PA Cal > Calibration = CAL Velocity**.
3. Press **[ANGLE]**, and then adjust the selected focal law (index) to 25°.
4. Couple the probe to the test block at the 0 mark.

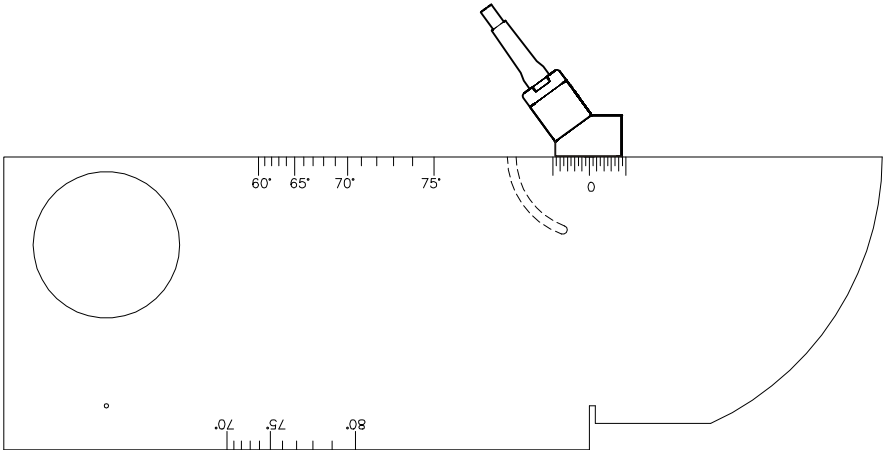

Figure 17-38 The IIW block with the probe

5. Move the probe forward and backward to bring the echo to its maximum amplitude (peak). Ensure that the echoes do not exceed 100 %. Reduce the gain setting if necessary.
6. Use the **[GATE]** key to position gate 1 around the first back wall echo.

TIP

If it is unclear from the L-scan, use the A-scan to position the gate start and width positions so that only the first back wall reflection is in the gated region.

---

7. Use the **[GATE]** key to position gate 1 so that it surrounds the first reflection from the arc of the block.

   This reflection should be close to 4 in. (101.6 mm).
8. Adjust the gain so that the echo amplitude is at approximately 80 %.

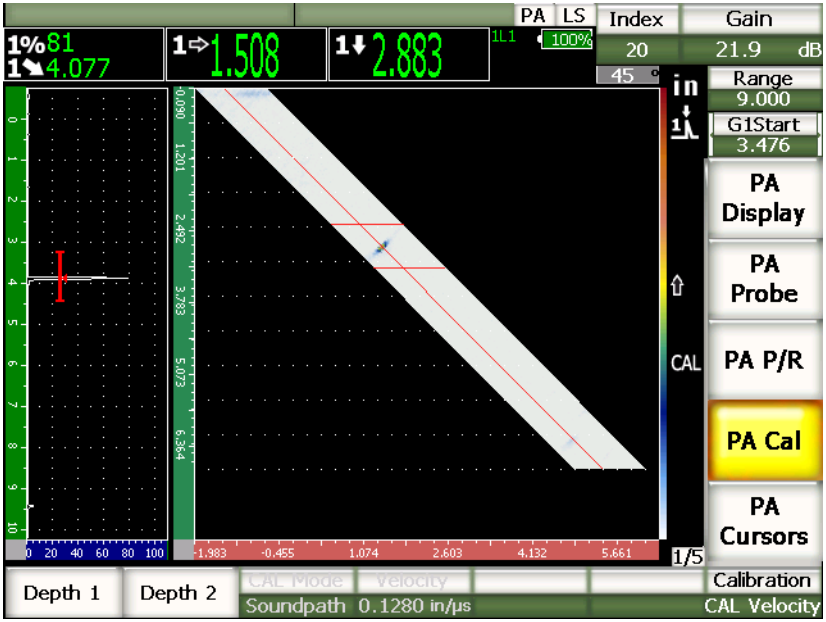

Figure 17-39 The gated calibration signal

9. When a steady reading is achieved, select **PA Cal > Depth 1**.
   The screen freezes and the **Enter Value For Thin Standard** dialog box appears.

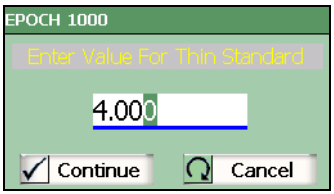

Figure 17-40 The Enter Value For Thin Standard dialog box

10. Adjust the value to match the known thickness of the gated indication (for this example, 4.000 in. [101.6 mm]), and then press **[CHECK]** to continue to the second calibration step.

NOTE

If for any reason you need to exit without acquiring calibration data, press **[ESCAPE]** to cancel.

Figure 17-41 The second gated calibration signal

11. Continue coupling the probe to the calibration block at the 0 mark.
12. Use the **[GATE]** key to position gate 1 so that the second echo reflection from the arc of the block is within the gated region.

    This reflection should be close to 9 in. (228.6 mm).
13. Adjust the gain so that the echo amplitude is at approximately 80 %.
14. When a steady reading is achieved, select **PA Cal > Depth 2**.

    The screen freezes and the **Enter Value For Thick Standard** dialog box appears.

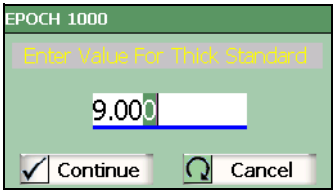

Figure 17-42 The Enter Value For Thick Standard dialog box

15. Adjust the value to match the known thickness of the gated indication (for this example, 9.000 in. [228.6 mm]), and then press **[CHECK]** to calculate and complete the calibration process.

17.9.2 Calibrating the Wedge Delay with an Angle Beam Probe

The wedge delay can be calibrated using a discrete reflector, such as a side-drilled hole or a back wall reflection. In the following procedure the first back wall of the arc of the IIW block is used to calculate the wedge delay.

To calibrate the wedge delay with an angle beam probe

1. Press **[RANGE]**, and then enter an appropriate range for the calibration.
   For this example, 6 in. (152.8 mm).
2. Select **PA Cal > Calibration = CAL Zero**.
3. Select **PA Cal > CAL Mode = Soundpath**.

NOTE

The wedge delay calibration can be performed using a reflector of known depth, such as a side-drilled hole. To use such a reflector, select **PA Cal > CAL Mode = Depth** and follow the instructions below using the known depth as the **Wedge Delay** value.

---

4. Press **[ANGLE]**, and then adjust the selected focal law (index) to 25°.
5. Couple the probe to the test block at the 0 mark.

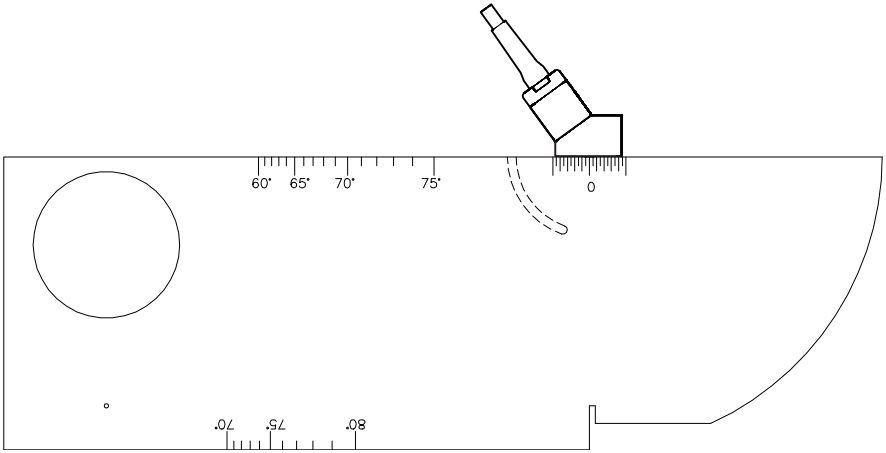

Figure 17-43 The probe coupled to the 0-mark of the IIW block

6. Use the **[GATE]** key to position gate 1 so that it surrounds the first reflection from the arc of the block. This reflection should be close to 4 in. (101.6 mm).
7. Adjust the gain so that the echo amplitude is at approximately 80 %.

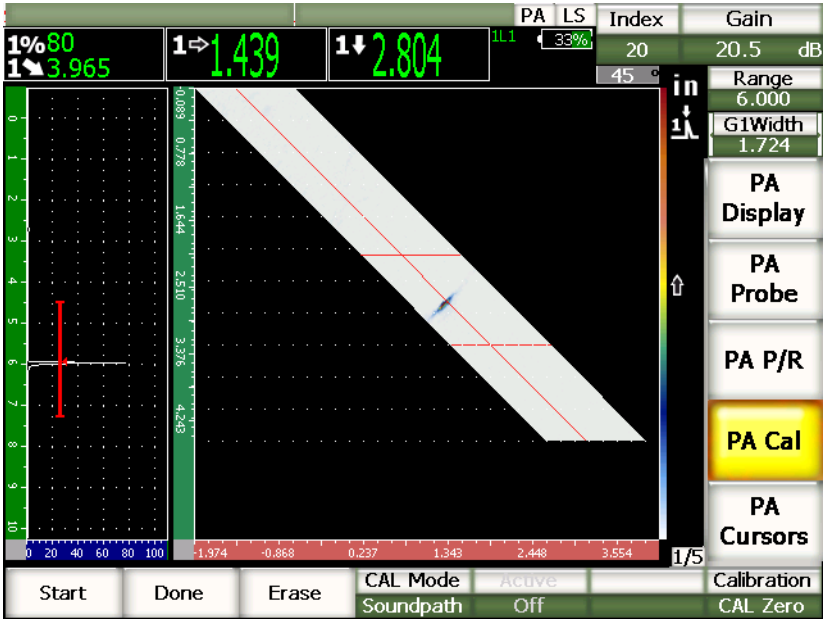

Figure 17-44 The first echo

IMPORTANT

The gated region must capture the wedge delay indication for all focal laws. If the wedge delay indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate wedge delay for that/those focal law(s).

8. Select **PA Cal > Start** to begin the calibration process.

   The screen freezes and the **Enter Value for Zero Cal** dialog box appears.

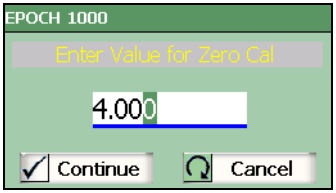

Figure 17-45 The Enter Value for Zero Cal dialog box

9. Adjust the value to match the known thickness of the gated indication (for this example, 4.000 in. [101.6 mm]), and then press **[CHECK]** to continue to the second calibration step.

   The A-scan on the left side of the screen is replaced by a new view representing the thickness reading (yellow line) for the gated indication across all focal laws. Ideally, this thickness reading line should be a straight line, which indicates that the instrument is making the same thickness measurement from the same reflector at each focal law. A dotted-line through the center of this small window represents the user-defined known value of the actual thickness measurement. In this example, the calibrated line should look like the one shown in Figure 17-46 on page 415.

Figure 17-46 The wedge delay acquisition screen

10. Move the probe forward and backward to acquire uncalibrated thickness measurement data across all focal laws.

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew. Make multiple passes over the reflector.

---

11. Select **PA Cal > Erase** to clear the current wedge delay curve and to redraw a new curve.

NOTE

If the yellow wedge delay curve saturates the screen, adjust the gain to a lower value and redraw the curve.

---

12. Select **PA Cal > Done** to accept the drawn line and calculate wedge delay.

A **0CAL** flag displays on the bottom-right corner of the screen to indicate that the wedge delay calibration has been completed (see Figure 17-47 on page 416).

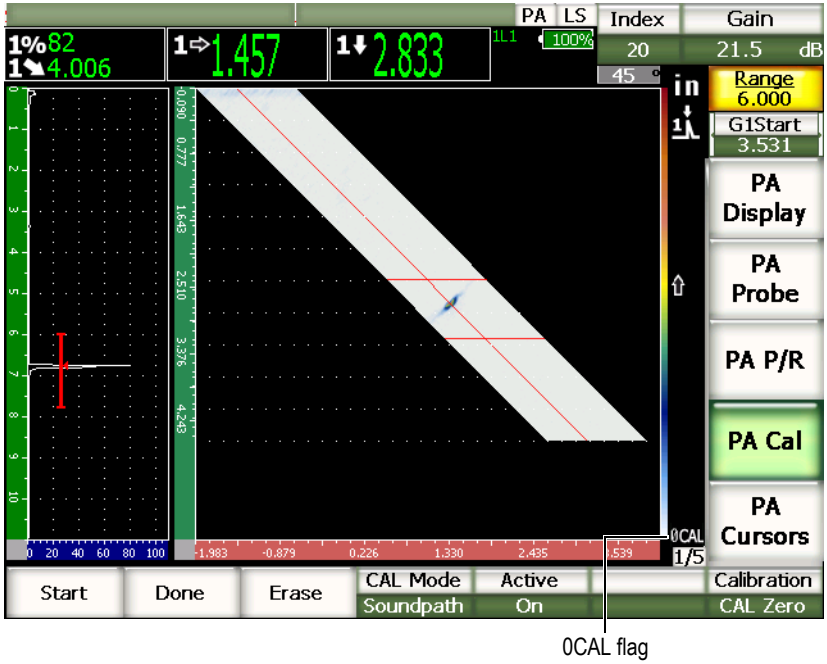

Figure 17-47 The completed wedge delay calibration

NOTE

When using a side-drilled hole to calibrate wedge delay, it is necessary to move the probe across the side-drilled hole to acquire a thickness measurement for all focal laws.

17.9.3 Calibrating the Sensitivity (Gain) with an Angle Beam Probe

Sensitivity (gain) can be calibrated using a discrete reflector, such as a side-drilled hole or a back wall reflection. In the example below, the small side-drilled hole of the IIW block is used to calculate sensitivity (gain).

To calibrate the sensitivity with an angle beam probe

1. Press **[RANGE]**, and then enter an appropriate range for the calibration.
2. EPOCH 1000For this example, 2 in. (50.8 mm).
3. Select **PA Cal > Calibration = CAL Gain**.
4. Press **[ANGLE]**, and then adjust the selected focal law (index) to 25°.
5. Couple the probe to the IIW block over the side-drilled hole.
6. Use the **[GATE]** key to position gate 1 to surround only the first reflection from the side-drilled hole.
7. Adjust the gain so that the echo amplitude is at approximately 80 %.

IMPORTANT

The gated region must capture the side-drilled hole indication for all focal laws. If the side-drilled hole indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate sensitivity (gain) for that/those focal law(s).

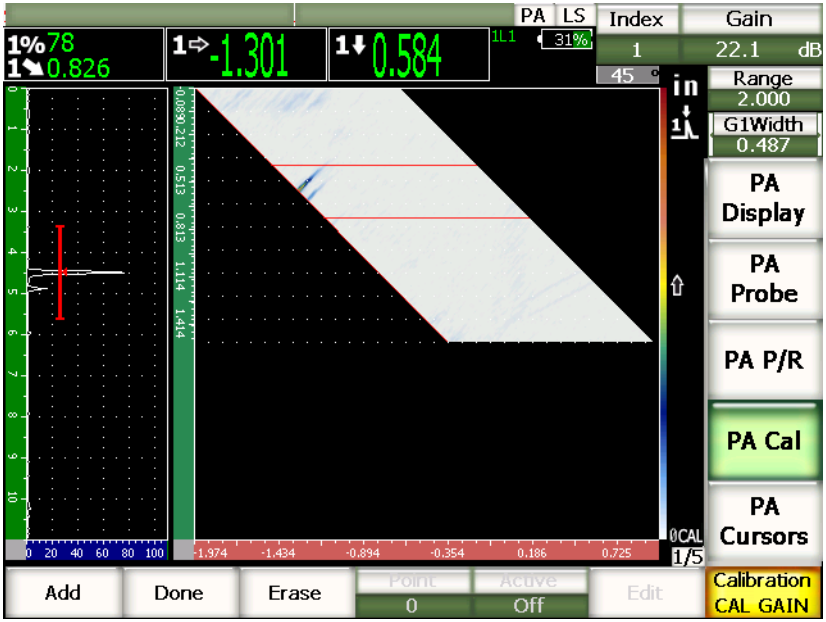

Figure 17-48 The captured echo

8. Select **PA Cal > Add** to begin the calibration process.

   The A-scan on the left side of the screen is replaced by a new view representing the amplitude reading (yellow line) for the gated indication across all focal laws. Ideally, this amplitude reading line should be a straight line, which indicates that the instrument is making the same amplitude measurement from the same reflector at each focal law (when that reflector is peaked up). In this example, the calibrated line should look like the one shown in Figure 17-49 on page 419.

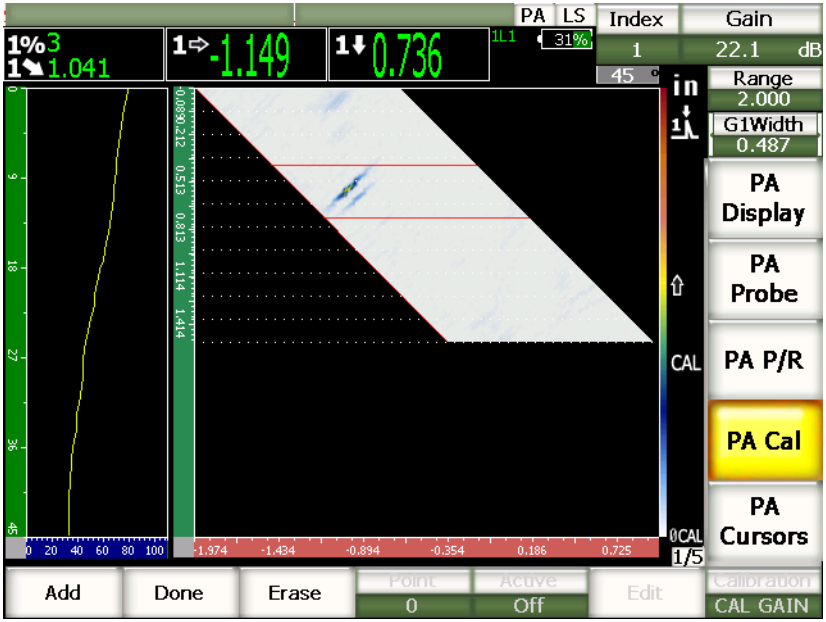

Figure 17-49 The Gain acquisition screen

9. Move the probe forward and backward over the side-drilled hole to acquire uncalibrated peak amplitude measurement data across all focal laws.

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew. Make multiple passes over the reflector.

10. Select **PA Cal > Erase** to clear the current gain curve and redraw a new curve.

NOTE

When the yellow gain curve saturates the screen, adjust the gain to a lower value and redraw the curve.

11. Select **PA Cal > Done** to accept the drawn line and calculate sensitivity.

A **TVG** flag displays on the bottom-right corner of the screen to indicate that the sensitivity calibration has been completed (see Figure 17-50 on page 420).

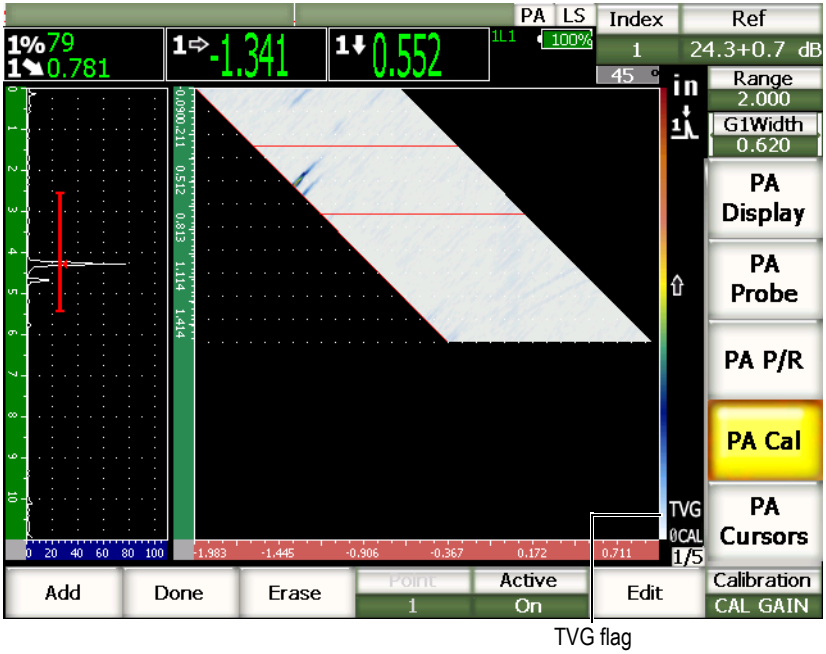

Figure 17-50 The completed gain calibration

TIP

Sensitivity (gain) calibration can be performed before wedge delay calibration, if desired. In some cases, normalizing the amplitude response of a given reflector allows a more precise thickness measurement during wedge delay calibration. However, velocity calibration must always be the first calibration step.

18. Software Features and Options (Phased Array Mode)

This chapter discusses the activation and operation of software features and options for the EPOCH 1000 Series phased array mode.

18.1 Defining Licensed and Unlicensed Software Features

The EPOCH 1000 Series comes standard with many software features that expand the instruments' capabilities beyond standard flaw detection. The following software features are standard components of the EPOCH 1000 Series phased array mode:

- Phased Array DAC/TVG
- Phased Array DGS/AVG
- AWS D1.1/D1.5 Weld Rating Software
- Weld Overlay
- Multi-Angle

There is also one software option available. This option is not a standard inclusion of the base instrument, and must be purchased and added to the unit. This option, linear scan and encoded C-scan, can be activated at the time of purchase of the instrument, or it can be activated remotely after purchase of the instrument.

To activate a software option

1. Select **Inst Setup > Status** to open the **Status** setup page.
2. Note the 16-character software serial number for your instrument that appears in the **S/N** parameter.
3. Contact Olympus to purchase the software option, providing the software serial number. Olympus provides an activation code.

4. Using the virtual keyboard, enter the activation code in the **Option key** box located above the virtual keyboard (see Figure 18-1 on page 422).

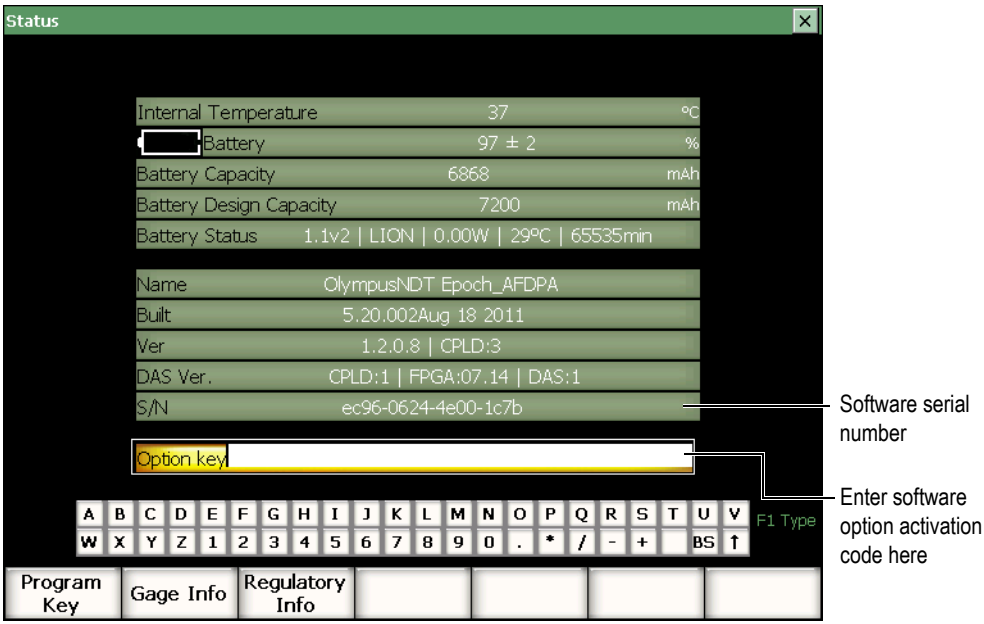

Figure 18-1 The Option key entry dialog box

5. When you are finished entering the activation code, select **Program Key** (see Figure 18-1 on page 422) to activate the option and return to the live screen.

18.2 Phased Array Dynamic DAC/TVG

A distance amplitude correction (DAC) curve is used to plot amplitude variations of signals from reflectors that are the same size but at different distances from the probe. Normally, these reflectors produce echoes of varying amplitude because of material attenuation and beam spread as the sound beam travels through the part. The purpose of the DAC curve is to graphically compensate for material attenuation, nearfield effects, beam spread, and surface roughness.

After a DAC curve is plotted, reflectors that are the same size as those used for creation of the curve will produce echoes that peak along the curve despite their different locations within the test piece. Similarly, reflectors that are smaller than those used to create the curve fall below the level, while larger reflectors exceed the curve level.

In a phased array instrument, DAC provides a reference curve that is applied to the selected angle A-scan. Indications can be identified from the S-scan image and then echoes at each angle can be evaluated from the A-scan curves.

When a DAC curve is created in the EPOCH 1000 Series instrument, the instrument also creates a time-varied gain (TVG) setup. TVG is used to compensate for the same factors as DAC, but the TVG setup amplifies the gain as a function of time (distance) to bring the reference reflectors to the same screen height (80 % FSH).

In phased array instruments, both DAC and TVG are set up by first normalizing gain across all focal laws in a scan using a single reference reflector, and then using multiple reference standards with equal size reflectors at different distances to create a matrix of echo amplitude versus sound path length through a range of distances, again across all focal laws.

You can customize DAC/TVG setups to your unique application requirements using the flexible DAC/TVG software feature for the EPOCH 1000 Series. The DAC/TVG feature incorporates several DAC/TVG modes that adhere to ASME, ASME III, and JIS sizing codes. The software offers direct control of gain, range, zero offset, and delay, as well as scanning gain and transfer correction. In addition, the DAC/TVG option provides a customizable DAC curve feature, and a user-defined TVG table to meet advanced and unique inspection needs.

18.2.1 Feature Activation and Reference Correct

Prior to the activation of any options associated with DAC/TVG, the instrument must be properly calibrated to the material being inspected. DAC/TVG can be activated in the **DAC/TVG** setup page accessible by selecting **Sizing Option > DAC/TVG**.

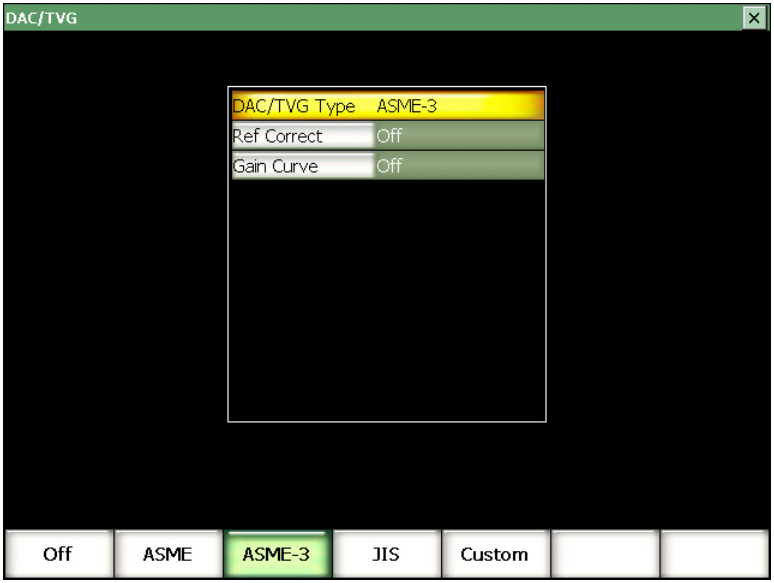

Figure 18-2 The DAC/TVG setup page

You may also choose to apply a feature known as **Ref Correct** (reference correction) to the digital analysis of the live A-scan and DAC/TVG option. When activated, the reference correction feature allows full gain manipulation of either the live echo peaks or the DAC curve while providing the % amplitude or dB comparison of the actual peak-to-curve ratio. In this way, you can use scanning gain, while maintaining an accurate measurement reading of the ratio of the gated peak to the DAC curve for sizing purposes. The gated echo amplitude is corrected back to the reference gain level for amplitude evaluation compared to the DAC curve.

You can also turn on a visual **Gain Curve** to show how the gain changes on the A-scan in a standard TVG (see Figure 18-3 on page 425). With this feature turned on, switch to TVG view after the DAC curve has been created to view the TVG curve along with the **Gain Curve**.

Figure 18-3 TVG view showing TVG and Gain curves

After the desired selection of DAC/TVG has been made (including activation of **Ref Correct** and **Gain Curve** where applicable), press the **[ESCAPE]** key to return to the live A-scan screen and begin DAC/TVG setup. Proper calibration is required prior to activation of the DAC/TVG feature for precise measurements.

When in the live A-scan mode, a new DAC Setup submenu appears in menu 4, dedicated to DAC/TVG features. This submenu allows access to several important functions that control DAC/TVG setup and operation.

To deactivate a DAC/TVG feature

◆ Select **DAC Setup = Off**.

In the following sections, all DAC/TVG modes are covered. The DAC/TVG setup procedure is the same for all modes. The setup is covered in detail in section “ASME III DAC Setup Example” on page 426. Any differences in the procedure to set up other DAC/TVG modes are discussed in the pertinent section for that particular mode.

18.2.2 ASME/ASME III DAC/TVG

The ASME DAC mode is a single DAC curve drawn from peak-to-peak on reference reflectors. The ASME III mode draws three DAC curves: one main curve from peak-to-peak on the reference-reflectors and two warning curves at −6 dB and −14 dB compared to the main curve.

18.2.3 ASME III DAC Setup Example

After you have selected the desired DAC mode, the live display should appear.

If a GAIN calibration has already been performed, you can choose whether to use this GAIN calibration as the first point on the DAC curve.

After exiting the DAC/TVG activation menu, the instrument will default to the PA CAL group, with the Calibration type automatically set to DAC. Creating a PA DAC curve is very similar to performing a PA Gain calibration (see "Calibrating the Sensitivity (Gain) with an Angle Beam Probe" on page 388 for additional information).

To create a PA DAC setup

1. Move gate 1 to surround the echo, and then select **PA Cal > Add**.

   The A-scan is replaced by a new view representing the amplitude reading (yellow line) for the gated indication across all focal laws. Ideally, this amplitude reading line should be a straight line, which indicates that the instrument is making the same amplitude measurement from the same reflector at each focal law (when that reflector is peaked up).

IMPORTANT

The gated region must capture the desired flaw indication for all focal laws. If the flaw indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate sensitivity (gain) for that/those focal laws. Also, it is critical to avoid collecting amplitude information from other sources during DAC setup.

---

2. Move the probe forward and backward over the side-drilled hole to acquire uncalibrated peak amplitude measurement data across all focal laws.

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew. Make multiple passes over the reflector.

3. Select **PA Cal > Erase** to clear the current gain curve and redraw a new curve.

TIP

When the yellow gain curve saturates the screen, adjust the gain to a lower value and redraw the curve.

4. Select **PA Cal > Done** to accept the drawn line and add the DAC point to the curve.

TIP

EPOCH 1000 Series instruments allow you to bring each echo used to create a DAC curve to 80 % FSH before acquiring the point. This feature can help create a more precise DAC curve, especially in the far-field. Select **DAC Setup > 1-Auto** or **[2ndF]**, **[GATE]** to activate auto-80 % for each indication before capturing the point.

When a point is captured, the DAC curve will automatically draw to the recently captured point (see Figure 18-4 on page 428).

Figure 18-4 Capturing a DAC point

5. Repeat steps 1 to 4 for each point on the DAC curve.

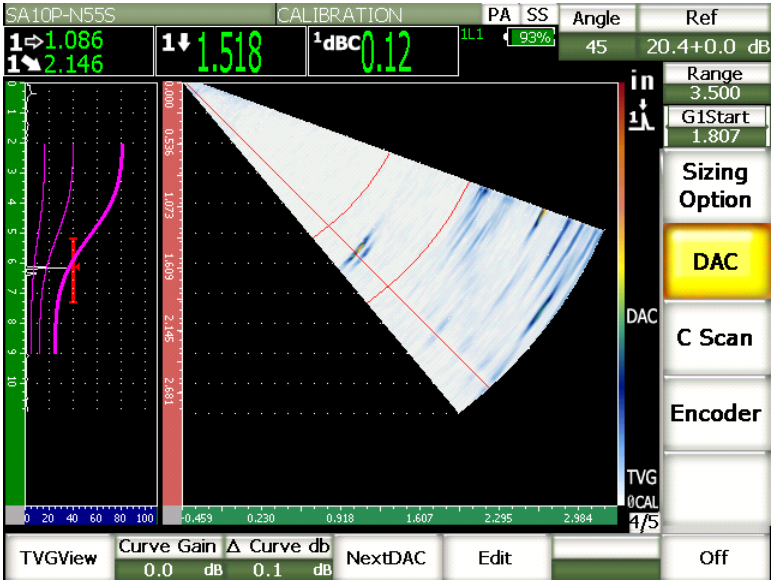

Figure 18-5 Completed PA DAC curve

6. When the DAC curve is complete (see Figure 18-5 on page 429), select the **DAC** submenu to enter inspection mode.

   The instrument now provides a new set of parameters under the **DAC** submenu:

   TVGView (DAC View) [see Figure 18-6 on page 430]

   This function allows you to toggle between the DAC curve acquired and the corresponding TVG setup based on the DAC curve information.

Figure 18-6 DAC curve in TVG view

Curve Gain

This adjustment allows you to manipulate the screen height/gain of both the DAC/TVG curve as well as the echoes on screen. It also enables amplitude-to-curve comparison at code compliant screen levels across the time base.

Δ Curve dB

This setting controls the steps by which **Curve Gain** is adjusted. Possible steps are 0.1 dB, 1.0 dB, 2.0 dB, 3.0 dB, 6.0 dB, and 12.0 dB.

Next DAC/TVG

This function cycles through the available DAC curves (if more than one is available) for amplitude comparison with on-screen echoes. The selected DAC or TVG curve will appear as a double thickness line.

Edit

Allows you to edit the TOF and Gain of any individual DAC point acquired during setup. For conventional procedure compliance, it is critical to have accurate curves represented at 45, 60, and 70 degrees. The **Edit** function uses a TVG table format for simplicity, and makes the overall DAC acquisition

process faster. High angles (such as 70 degrees) often require editing for precision.

To edit individual DAC points

1. Select **DAC > Edit** to enter the Edit mode.
2. Press **[ANGLE]** to select the desired angle/focal law.
3. Select **TVG Table > Edit** to enter the TVG table (see Figure 18-7 on page 431).

Figure 18-7 Editing DAC points

4. Use the arrow keys to navigate to cells within the table.

   A purple square (top) and red crosshair (bottom) on the live A-scan indicates the TOF position of the selected row in the table.
5. Use the knob to increase/decrease the gain of each point at critical angles to meet 80 % exactly.
6. When finished, select **TVG Table > Exit** to leave the Edit mode.

18.2.4 Gain Adjustment Options

The EPOCH 1000 Series DAC/TVG software features three separate types of gain adjustment for each DAC/TVG setup. These gain adjustments allow for better inspection precision, easy manipulation of curves and live peak information, and transfer correction.

18.2.4.1 Scanning Gain

To quickly find and identify potential defects, it is commonly required by code to increase the gain (scanning gain) on the EPOCH 1000 Series instrument from the reference (calibration) gain for scanning purposes. However, once a potential defect is identified, this gain is usually removed to view the reflector at **Ref** gain level, set at calibration. The DAC/TVG software for the EPOCH 1000 Series is fully capable of adding temporary scanning gain for inspection purposes. This scanning gain only affects the live A-scan and does not adjust the level of the DAC curve(s) set up on screen (see Figure 18-8 on page 433).

To add temporary scanning gain

1. Press **[GAIN]**.
2. Increase or decrease the scanning gain.
3. Press **[ESCAPE]** twice to return to the **Basic** submenu.
4. Select **Basic > Scan dB** to toggle between the base (reference) gain and the adjusted scanning gain.
5. Select **Basic > Off** to turn scanning gain off completely.

Figure 18-8 ASME III DAC with 3 dB scanning gain

NOTE

When reference correction is active (see Figure 18-9 on page 434), the digital comparison between a captured reflector and the DAC curve is accurate even with the scanning gain applied to the inspection, provided that the gated echo is not saturated. Figure 18-9 on page 434 shows the same setup as above but with reference correction active. Notice that the scanning gain has been removed from the dB-to-curve measurement in location 5. The instrument compares the echo height to the DAC curve, compensates for the added scanning gain, and reports the true-amplitude comparison.

Figure 18-9 ASME III with 3 dB scanning gain and reference correction active

18.2.4.2 Curve Adjustment Gain (DAC Gain or TVG Gain)

The overall gain level of the entire DAC curve and TVG line setup can be adjusted higher or lower from the reference gain. Most inspection codes do not permit reflectors to be sized below 20 % FSH. Therefore, to inspect beyond a certain depth/sound path time within a part, it is necessary to raise the gain of both the live A-scan and the DAC curve to continue the inspection. This is accomplished on EPOCH 1000 Series instruments using the curve gain (DAC curve adjustment gain).

To adjust the curve gain

1. Select **TVG > Δ Curve dB**, and then choose the desired increment of the gain adjustment.
2. Select **TVG > Curve Gain**, and then adjust the curve gain by the selected increment either positive or negative.

Figure 18-10 on page 435 shows a DAC setup with DAC gain in use to provide accurate echo amplitude measurement by placing the echo close to 80 % FSH.

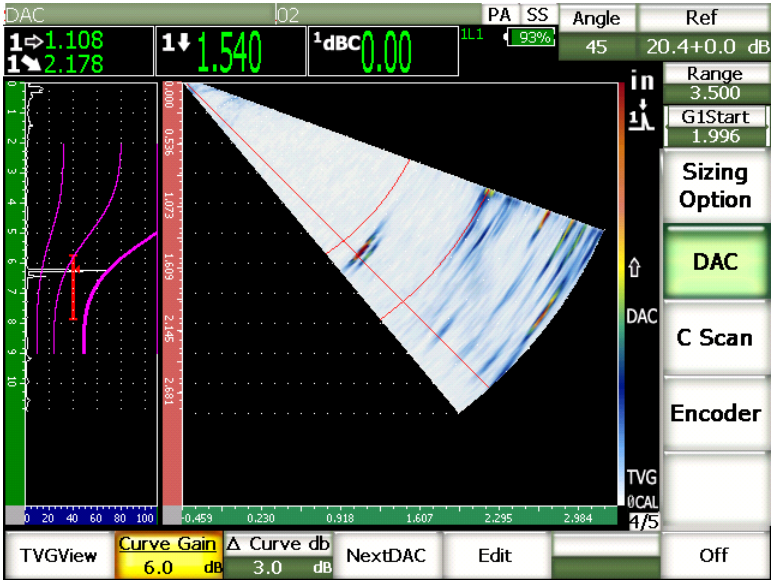

Figure 18-10 DAC curves with adjusted gain

18.2.4.3 Transfer Correction

Transfer correction is an adjustment in the reference gain setting during calibration of the instrument, and is typically added when the surface conditions of a calibration block and the test piece are different. The coupling conditions on the test surface can often cause signal loss after calibrating a DAC curve, which results in inaccurate comparisons of the test reflectors with the calibrated DAC curve. You can easily adjust EPOCH 1000 Series instruments for this potential difference by adding transfer correction to the calibrated base gain after completing the DAC curve setup.

To add transfer correction to a completed DAC curve

1. Press **[GAIN]**.
2. Bring the scanning gain to the desired level for transfer correction.
3. When the desired scanning gain is displayed, select **Basic > Add** to add the scanning gain to the base gain and to apply the transfer correction.

18.2.5 JIS DAC

The Japanese Industrial Standard (JIS) DAC mode meets the requirements of JIS Z3060. The JIS DAC curve setup is identical to the standard DAC/TVG setup. However, there are some minor functionality differences when compared to other DAC/TVG modes:

- Only the main DAC curve is viewable in TVG mode.
- Any of the six curves can be used to trip the alarm when in the JIS DAC mode. Additionally, you can set the alarm to positive or negative.

To select the curve to be used as the alarm reference level

◆ Activate the JIS DAC mode, and then select **TVG > Next DAC**.

The selected curve appears as a double thickness line. Once a curve has been selected, an alarm can be activated and set to be either a positive or a negative threshold detection.

18.2.6 Custom DAC Curves

The DAC/TVG software option for the EPOCH 1000 Series features a customizable DAC curve setup that allows you to define up to six additional reference curves from the primary curve at varying levels from −24 dB to +24 dB. The **Custom DAC Curves** option is ideal for unique sizing inspections and procedure development. The **Custom DAC Curve** function also allows the option of either a straight-line connection or a curved, polynomial connection of each point of the DAC curve to meet various international or customer-specific requirements.

To activate and set up the customized curves

1. Select **Sizing Options > DAC/TVG** to open the **DAC/TVG** setup page.
2. Set the **DAC/TVG Type** parameter to **Custom** (see Figure 18-11 on page 437).
3. Select the **Curve Type** (polynomial [curved] or straight-line segments) [see Figure 18-11 on page 437].
4. Select the **No Of Curves** to be used in addition to the main curve (for example, if six curves are activated, you see seven curves in total) [see Figure 18-11 on page 437].
5. For each warning curve, select **Curve<*n*> dB**, and then set the value compared to the main curve (see Figure 18-11 on page 437).
6. Press **[ESCAPE]** to return to the live screen to begin capturing DAC points.

Figure 18-11 The custom DAC setup page

The custom DAC setup and functionality are the same as the ASME and ASME III discussed earlier in this section. Figure 18-12 on page 438 shows a completed custom DAC setup.

Figure 18-12 Completed custom DAC

After the custom DAC curve points have been captured and completed, you have full capability to toggle between DAC and TVG views, to manipulate **Range**, **Delay**, **CAL Zero**, and **Angle**, and also to add necessary scanning gain, curve gain adjustment or transfer correction. The TVG view of any custom DAC curve includes the user defined reference curves as well as the primary DAC curve. Custom DAC curve also incorporates the reference correction functionality, if desired.

18.3 Phased Array DGS/AVG

The EPOCH 1000 Series onboard DGS/AVG option permits complete DGS/AVG setups to be performed on the instrument. With the DGS/AVG method, you can size defects based upon a calculated DGS/AVG curve for a given probe, material, and reflector size. This method requires that you only have one reference reflector in order to create a DGS curve for flaw sizing. This is much different than the DAC or TVG method that requires that you have representative defects at various depths within a part in order to create a curve for flaw sizing.

All required data for building DGS/AVG curves is obtained from the PA probe ID and wedge information. The onboard DGS/AVG option provides you with rapid setup times and easy flaw size evaluation. This software option has been designed to meet EN 583-2:2001 requirements. It is extremely important that you are familiar with this specification and others, and qualified according to local standards, to properly use this instrument function. Since the curves used for defect sizing are calculated based upon many variables, a proper instrument setup is required for accurate results. In standard sectorial scans, the EPOCH 1000 Series applies the DGS/AVG curve at the 0°, 45°, 60°, and 70° focal laws. For linear scans, the DGS/AVG curve is applied at the angle of the scan.

18.3.1 Option Activation and Setup

Prior to activation of the DGS/AVG option, the instrument must be properly calibrated to the material being inspected. You can then activate the DGS/AVG option in the **DGS/AVG** setup page by selecting **Sizing Option > DGS**.

The **DGS/AVG** page is used to establish the following DGS setup parameters (see Figure 18-13 on page 439).

Figure 18-13 The DGS/AVG setup page

NOTE

Due to PA probe automatic recognition and wedge selection during beam setup, probe information does not need to be configured in the DGS/AVG screen.

DGS/AVG

Activate/deactivate the DGS/AVG function.

Reflector Type

Defines the type of reflector to be used to acquire a reference indication to build the DGS/AVG curve.

- Side-drilled hole (SDH)
- K1-IIW block arc
- K2-DSC block arc
- Flat-bottom hole (FBH)

Reflector Dia.

Used for FBH and SDH reflector types only. This allows you to define the diameter of the flat-bottom hole (FBH) or side-drilled hole (SDH) used as a reference-reflector. This size setting is required to properly position the DGS/AVG curve.

DeltaVt

Transfer correction value, used to compensate in amplitude differences as a result of coupling variation (surface condition) from the calibration block to the test piece. EN 583-2:2001 provides methods for calculating transfer correction.

Reg. Level

The height of the main DGS/AVG curve. The curve represents the expected amplitude response across a thickness range from a flat-bottom hole whose diameter is equal to the registration level. This is usually equal to the critical flaw size for the application.

Warning Level

This is the position of the secondary DGS/AVG “warning” curve compared to the position of the main DGS/AVG curve. If this value is set to zero, the warning curve is turned off.

Focal Laws

Displays the specific focal laws to which the DGS/AVG curve will be applied. There are certain parameters that are used to generate the curve that are different at each of these angles. If these values are being used, they must be calculated for each of the different focal laws.

The following DGS parameters must be entered separately for each focal law:

DeltaVk

Used for angle beam inspections with reference-reflector K1-IIW or K2-DSC blocks only. This correction value for the angle beam probe can be found listed on the DGS/AVG diagram for the selected probe.

NOTE

For some phased array DGS probes, the **DeltaVk** value will automatically populate.

AcvSpecimen

This is the attenuation value in dB/m for the test piece (specimen). In some cases, it is necessary to calculate the relative attenuation within the test piece and enter the value here.

AcvCalBlock

This is the attenuation value in dB/m for the calibration block. In some cases, it is necessary to calculate the relative attenuation within the calibration block and enter the value here.

You must have been trained to know when it is necessary to apply values to **AcvSpecimen** and **AcvCalBlock**. These values affect the shape of the DGS/AVG curve and, therefore, affect the accuracy of defect sizing. A suggested method for the measurement of relative attenuation can be found in section “Relative Attenuation Measurement” on page 447.

When you have correctly completed the selections in the **DGS/AVG** setup page, press **[ESCAPE]** to return the live display.

To complete the DGS/AVG curve setup

1. Couple the probe to the calibration block and obtain a reflection from the selected reference-reflector.
2. Move gate 1 to surround the echo, and then press **[2ND F]**, **[GATE] (AUTO XX%)** to bring the reference-reflector to 80 % FSH.

3. Select **PA Cal > Add**.

   The A-scan is replaced by a new view representing the amplitude reading (yellow line) for the gated indication across all focal laws. Ideally, this amplitude reading line should be a straight line, which indicates that the instrument is making the same amplitude measurement from the same reflector at each focal law (when that reflector is peaked up).

IMPORTANT

The gated region must capture the desired flaw indication for all focal laws. If the flaw indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate sensitivity (gain) for that/those focal laws. Also, it is critical to avoid collecting amplitude information from other sources during DAC setup.

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4. Move the probe forward and backward over the side-drilled hole to acquire uncalibrated peak amplitude measurement data across all focal laws (see Figure 18-14 on page 442).

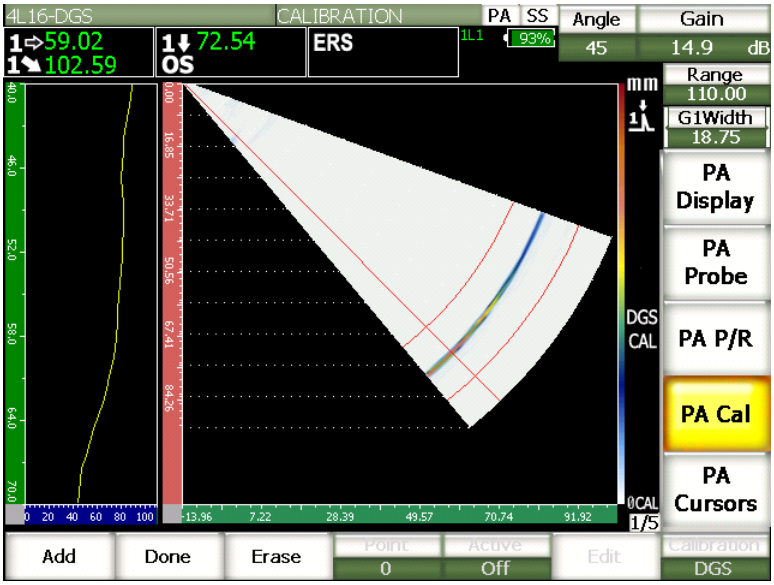

Figure 18-14 Capturing the DGS reference reflector

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew. Make multiple passes over the reflector.

5. Select **PA Cal > Erase** to clear the current gain curve and redraw a new curve.

TIP

When the yellow gain curve saturates the screen, adjust the gain to a lower value and redraw the curve.

6. Select **PA Cal > Done** to accept the drawn line and complete the DGS curve.

   After capturing the reference-reflector, the EPOCH 1000 Series instrument automatically calculates the DGS/AVG curve(s) and displays them at the correct registration level amplitude on the screen (see Figure 18-15 on page 443).

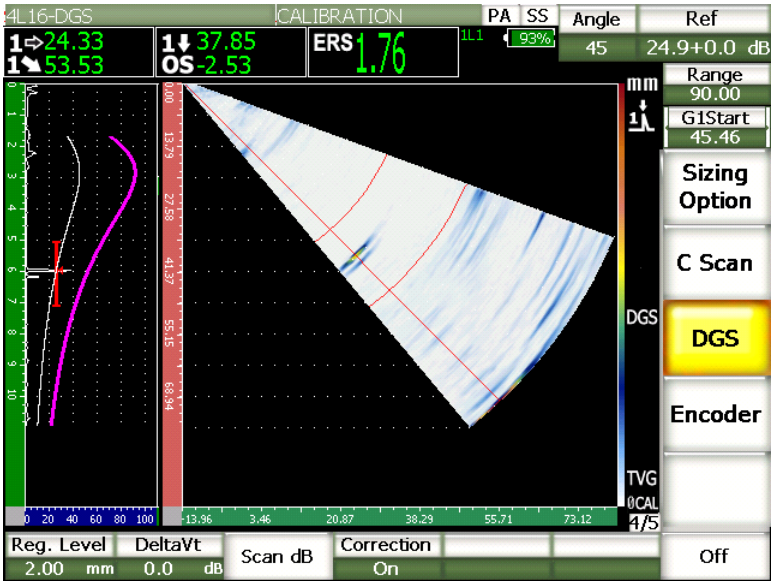

Figure 18-15 DGS/AVG curves on the screen

A unique feature of phased array DGS/AVG on the EPOCH 1000*i* is the ability to interpolate image gain correction across all angles and sound paths based on the reference reflector.

This gain correction allows the DGS/AVG user to gain the benefits of higher probability of detection through the sector scan image while still maintaining mathematically correct DGS/AVG curves at standard A-scan angles for sizing.

To turn gain correction on or off

◆ Select **DGS > Correction**.

18.3.2 Measurement Warnings and Limitations

The EPOCH 1000 Series DGS/AVG function incorporates several measurement value warnings and limitations based on the live setup of the inspection. These are designed to eliminate incorrect measurements or warn you that a measurement could be incorrect. These include:

- When the echo amplitude exceeds the full screen height of the display, both the equivalent reflector size (ERS) and overshoot (OS) measurements become blank.
- When the DGS/AVG curve exceeds the full screen height of the display, both the ERS and OS measurements become blank.
- If the echo is measured before the beginning of the DGS/AVG curve, both the ERS and OS measurements display loss of signal (LOS).
- When an echo is measured beyond the 10th division of the screen, both the ERS and OS measurements display loss of signal.
- If the ERS measurement exceeds the effective diameter of the probe in use, the ERS measurement turns red.
- If the echo amplitude is measured below 10 % full screen height, both the ERS and OS measurements are red.

18.3.3 Curve Adjustment Options

After a DGS/AVG curve has been calculated on the EPOCH 1000 Series instrument, it is possible to make adjustments to that curve during an inspection. These adjustments include gain adjustments allowing proper defect scanning and code-compliant defect sizing, as well as reference-reflector adjustments.

18.3.4 Transfer Correction

Transfer correction is an adjustment in the reference gain setting during calibration of the instrument. It is typically added when the surface conditions of a calibration block and the test piece are different. The coupling conditions on the test surface can often cause signal loss after calibrating a DGS/AVG curve, which results in inaccurate comparisons of the test reflectors with the calibrated DGS/AVG curve. You can easily adjust EPOCH 1000 Series instruments for this difference by adding transfer correction to the calibrated base gain after completing the DGS/AVG curve setup.

The transfer correction can be added during initial setup of the DGS/AVG curve (**DeltaVt** value), but typically this factor is unknown until after the setup is completed.

To add transfer correction to a completed DGS/AVG curve

- Select **DGS > DeltaVt** to adjust the value of the transfer correction. When adjusting transfer correction, the curve height should remain constant, but the echo height changes.

18.3.5 DGS/AVG Curve Gain

The overall gain level of the entire DGS/AVG curve can be adjusted higher or lower from the reference gain. Most inspection codes do not permit reflectors to be sized below 20 % FSH. Therefore, to inspect beyond a certain depth/sound path time within a part, it is necessary to raise the gain of both the live A-scan and the DGS/AVG curve to continue the inspection. This is accomplished on the EPOCH 1000 Series instrument using DGS/AVG curve-adjustment gain.

To adjust the DGS/AVG curve gain

1. Press **[GAIN]**.
2. Adjust the curve gain.

   The curve-gain difference is added/subtracted from the instrument's base (reference) gain.

NOTE

DGS/AVG curve gain adjustments are applied to both the echo height and curve height to maintain the amplitude ratio and, therefore, the sizing comparisons.

Figure 18-16 on page 446 shows a DGS/AVG setup with curve gain in use to provide accurate echo-amplitude measurement by placing the echo close to 80 % FSH.

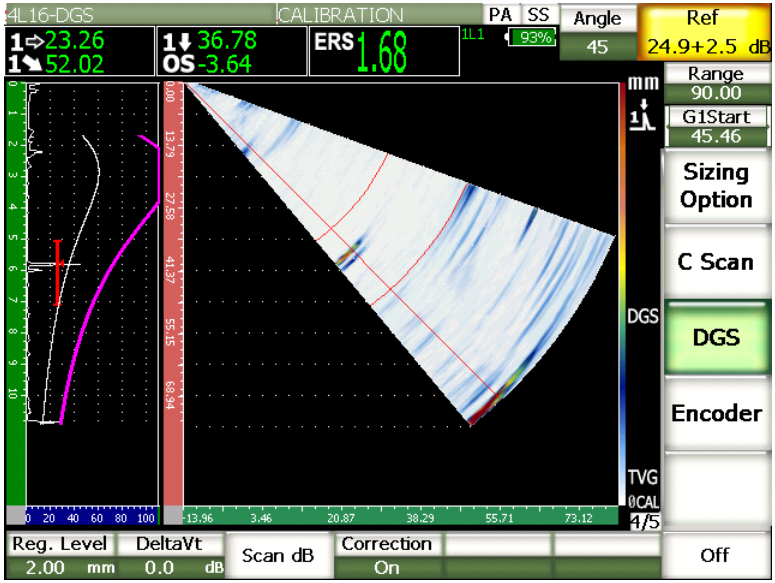

Figure 18-16 Gain curve adjusted DGS

18.3.6 Registration Level Adjustment

The registration level of the DGS/AVG curve defines the height of the main curve. The curve height represents the amplitude from a flat-bottom hole with a diameter of the registration level at different depths. This is usually equal to the critical flaw size for the application. The EPOCH 1000 Series allows you to adjust this registration level during a live inspection.

NOTE

This curve-height adjustment is possible because the DGS/AVG curves are calculated based on a captured reference-reflector and mathematical probe data. This allows EPOCH 1000 Series instruments to plot the attenuation curve (in steel) for a particular size reflector without having to acquire individual data points, as is required in a DAC/TVG setup. This is one of the key advantages of the DGS/AVG sizing technique over the DAC/TVG sizing technique.

To adjust the registration level

- Select **DGS > Reg. Level** to adjust the current registration-level value.

18.3.7 Relative Attenuation Measurement

There are several methods for measuring the ultrasonic attenuation within a material. Often the procedure measures absolute attenuation in a material. This usually requires an immersion test setup and a time-consuming set of measurements. For the purpose of flaw sizing with the DGS/AVG method, under certain conditions, it may be suitable to measure relative attenuation in the test piece or calibration block as needed. This section outlines one method of relative attenuation measurement that is simple and has been found to be generally effective. There might be more suitable methods available. You must decide the most appropriate method to arrive at the values for **AcvSpecimen** and **AcvCalBlock** based on the application and local requirements.

Measurements:

Δ Vg = Gain difference between two successive back wall echoes (d and 2d)

Δ Ve = From DGS/AVG diagram. Gain difference on back wall curve from d to 2d

Calculations:

$$\Delta Vs = \Delta Vg - \Delta Ve \text{ (mm)}$$

Sound attenuation coefficient:

$$\alpha = \Delta Vs / 2d * 1000 \text{ (dB/m)}$$

18.4 AWS D1.1/D1.5 Rating Software

The AWS D1.1 software feature for the EPOCH 1000 Series has been created to assist you in performing inspections covered under the American Welding Society D1.1 (or D1.5) Structural Welding code for steel. This code provides inspectors with a method to classify discontinuities found in welds using ultrasonic inspection. This code uses the following formula to develop an indication rating for a reflector found during an inspection:

$$A - B - C = D$$

where:

A = Discontinuity indication level (dB)

B = Reference indication level (dB)

C = Attenuation factor: 2 * (sound path in inches − 1 in.) [dB]

D = Indication rating (dB)

The AWS D1.1 inspector must use the indication rating (D) that is calculated based on A, B, and C when referencing to an “Ultrasonic Acceptance — Rejection Criteria” table produced by the AWS in order to classify the severity of the discontinuity that has been located. As an inspection is performed, you are required to develop an AWS report that lists the values for all variables listed above as well as probe information, discontinuity length and location, and the overall evaluation of the discontinuity. The EPOCH 1000 Series instrument automatically calculates a D weld rating for gated echoes at 45, 60, and 70 degrees.

For further details regarding the test equipment, methods, interpretation, and classification requirements for these inspections, please refer to the AWS D1.1 Code Book.

Olympus has developed the AWS D1.1 software option for the EPOCH 1000 Series with the goal of simplifying inspector tasks and lowering the overall inspection time. This is accomplished by having the EPOCH 1000 Series instrument perform some required calculations automatically and also by permitting the inspector to document discontinuities in the EPOCH 1000 Series data logger for reporting purposes.

18.4.1 Option Activation

Prior to activation of the AWS weld rating software, the instrument must be properly calibrated to the material being inspected. If desired, calibration for sensitivity/Gain can be performed as part of the AWS option setup.

To activate the AWS software feature

- Select **Sizing Option > AWS D1.1 = On** (see Figure 18-17 on page 449).

Figure 18-17 Activating the AWS feature

After activation, you must set a reference level (Ref B) in order to begin an inspection. This number represents the gain level necessary to bring the echo from a reference reflector to the desired reference level for the inspection. The reference reflector is often a side-drilled hole in the calibration block used for the angle beam calibration. Other reference-reflectors can be used, provided that they meet AWS requirements for these inspections. As with phased array gain calibration, the reference reflector sensitivity level must be set for each focal law.

To set the reference level

◆ Select **AWS Setup > Ref Level**, and then adjust to the desired value.

To store a Ref B value

1. Couple the probe to the calibration block and obtain a reflection from the selected reference-reflector.
2. Move gate 1 to surround the echo, and then press **[2ND F]**, **[GATE] (AUTO XX%)** to bring the reference reflector to the desired reference level.
3. Select **AWS Setup > Add**.

   The A-scan is replaced by a new view representing the amplitude reading (yellow line) for the gated indication across all focal laws. Ideally, this amplitude reading line should be a straight line, which indicates that the instrument is making the same amplitude measurement from the same reflector at each focal law (when that reflector is peaked up).

IMPORTANT

The gated region must capture the desired flaw indication for all focal laws. If the flaw indication is out of the gated region for any focal law during calibration, the instrument does not properly calculate sensitivity (gain) for that/those focal laws. Also, it is critical to avoid collecting amplitude information from other sources during AWS setup.

---

4. Move the probe forward and backward over the side-drilled hole to acquire uncalibrated peak amplitude measurement data across all focal laws.

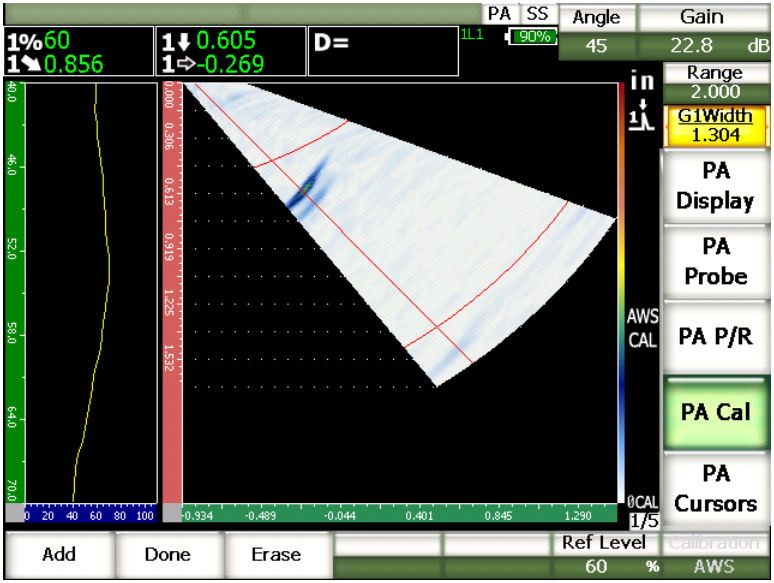

Figure 18-18 Capturing the AWS reference reflector

TIP

To acquire the most accurate curve, move the probe slowly. Use a guide when possible to avoid probe skew. Make multiple passes over the reflector.

5. Select **AWS Setup > Erase** to clear the current curve and redraw a new curve.

TIP

When the yellow gain curve saturates the screen, adjust the gain to a lower value and redraw the curve.

6. Select **AWS Setup > Done** to accept the drawn line and complete the AWS calibration

   After capturing the reference-reflector, the EPOCH 1000 Series instrument automatically stores this information as the “B” value for AWS calculations.

When the **Ref B** value has been stored, the instrument displays a live D rating of the gated indication from the test specimen. This live D value, which represents the defect indication rating used with the published “AWS Acceptance - Rejection Criteria” tables to classify a potential flaw, can be viewed as a separate measurement reading in one of the six boxes. To activate and view this measurement, see “Reading Setup Page” on page 82.

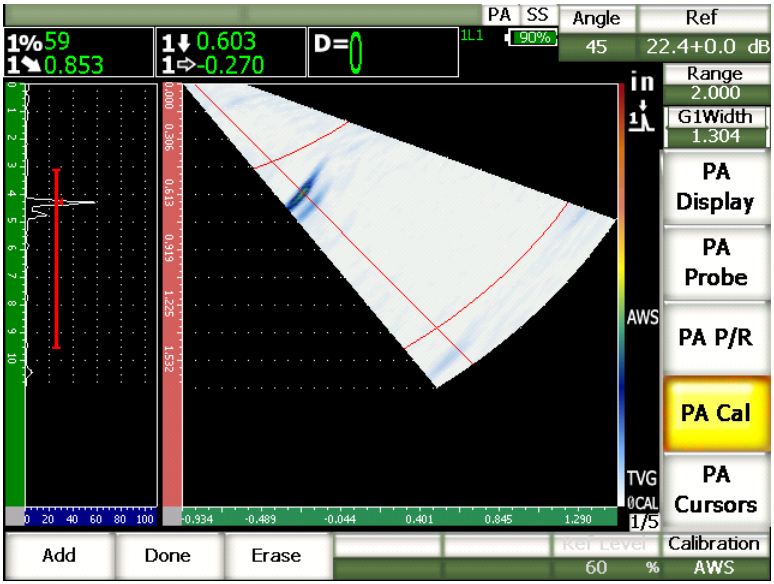

Figure 18-19 Active AWS with D rating

18.4.2 Scanning Gain

AWS codes require that you enter a certain amount of scanning gain to the **Ref B** gain value. This allows you to locate flaws that might be smaller or deeper in the test piece than the reference flaw.

To add scanning gain

1. Use the **[GAIN]** key to adjust the scanning-gain value necessary to perform the inspection as outlined by the AWS Code.
2. Select **AWS > Scan dB** to toggle on and off the scanning gain as necessary.

NOTE

To display a D indication rating value, the gated echo must peak at an amplitude less than 110 % FSH. Often, you simply have to turn off the scanning gain to bring the echo peak onto the screen. In some cases, further gain adjustments may be necessary.

18.4.3 Calculating A and C Values

When a gated echo with a peak below 100 % FSH is present, the EPOCH 1000 Series instrument automatically calculates the A and C values necessary to provide a D indication rating value. For A, the EPOCH 1000 Series instrument automatically calculates the required dB value to bring the gated echo to 80 % FSH. To calculate C, the instrument uses the data in the sound path calculator to generate an attenuation factor.

NOTE

For this calculation to be accurate, you must enter the correct thickness for the test piece.

The A, B, and C values can also be displayed as individual measurements in one of the six measurement boxes. To activate and view these measurements, see “Reading Setup Page” on page 82.

By pressing **[SAVE]**, you can now save the data for this discontinuity in the EPOCH 1000 Series data logger. For general data logger information, see chapter “Managing the Data Logger” on page 187. At the bottom of an ID saved with AWS D1.1 active, you can see the values for A, B, C, and D. This data is viewable in the file review window.

While using the EPOCH 1000 Series instrument and the AWS D1.1 software feature, it is your responsibility to take into account any inspection conditions that could cause variations in the displayed indication rating (D value), as well as interpret the meaning of echo indications and reported D values corresponding to these indications properly.

18.5 Linear Scan and Encoded C-scan Option

The encoded C-scan software option is an added cost option to the standard EPOCH 1000*i* instrument. This option adds the capability for both encoded and timed C-scans and linear scans, and increases the phased array configuration from the standard 16:16 to 16:64.

Encoded C-scans allow you to map data within a gated region relative to probe position providing a planar map of features within the test piece. Using this option, C-scans can be created from both linear and sector scan data. C-scan creation from sector scans makes this software option especially helpful in weld inspection as you can view gated data over a sweep of angles at multiple probe positions.

Linear scanning allows you to create a fixed-angle image the same size as the probe width in one dimension.

18.5.1 Required Equipment

In order to create encoded C-scans using the encoded C-scan option, you will need the following equipment:

- Encoded C-scan software option (EP1000I-ECSCAN, U8140141)
- Mini Wheel encoder (ENC1-2.5-DE, U8780197) or similar
- Encoder adaptor cable (CABL-10016-0008, U8801209)
- 5L16-A10P (U8330661) or 5L64-A12 (U8330593) probe (or equivalent)
- Encoder compatible wedges — Special phased array wedges are required for use with encoded scans with the A10, A10P and A12 style probes. These wedges have threaded inserts for connecting to encoders.

18.5.2 Creating an Encoded C-Scan from a Sectorial Scan

To create an encoded C-scan, begin with a fully calibrated S-scan. Encoded C-scans can be created from an angled or zero degree S-scan.

To properly position your gate

1. Set the gate display mode to in the **Gate Setup > Setup** submenu (see "Depth Gate Mode" on page 353 for additional information on true depth gates).
2. Adjust the **G1Start** and **G1Width** parameters to capture the desired depth within the test piece.

TIP

Leg indicators can be useful when collecting data for an entire skip distance at once.

IMPORTANT

Make sure that the gate is still capturing data at higher focal laws or you will not have a complete C-scan. If not, increase your range!

---

3. Attach the encoder to the probe so that the encoder wheel turns when the probe is moved.

To set up your C-scan

1. Select **C Scan > C Scan = On** to turn on C-scan.

   After the C-scan is turned on, additional C-scan parameters will display in the submenu.
2. Select **C Scan > Setup** to enter the setup page (see Figure 18-20 on page 456).

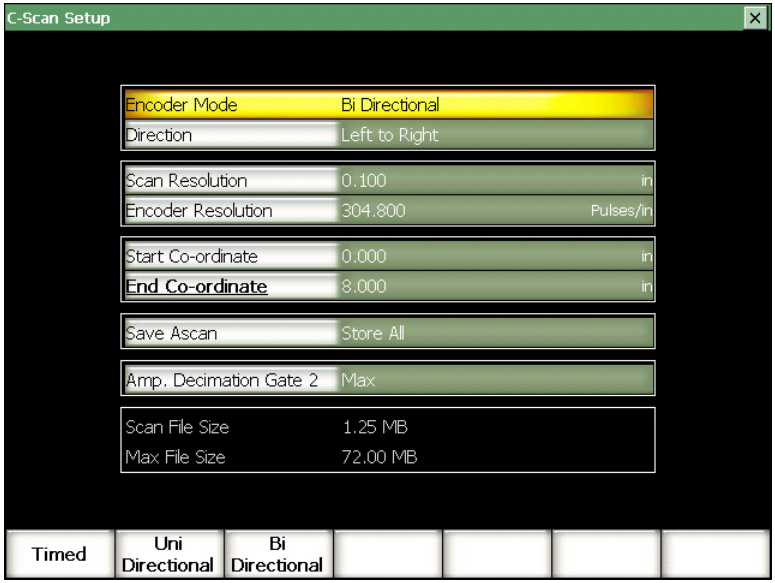

Figure 18-20 The C-scan Setup page

3. In the **Encoder Mode** box, choose **Uni-directional** or **Bi-directional**.
4. In the **Direction** box, choose a scan direction (this will determine the display view of the A-scan and C-scan image).
5. Set your **Scan Resolution** for your C-scan. This parameter will determine maximum scanning speed.
6. Enter the proper **Encoder Resolution** to ensure proper distance values are collected during the scan.

NOTE

The resolution for the Mini Wheel encoder is 12 pulses/mm (304.8 pulses/in.). If this value is unknown, see “Encoder Calibration” on page 469 for a complete encoder calibration procedure.

---

7. Set the desired **Start Co-ordinates** and **End Co-ordinates** for the scan.
8. Choose whether to **Save Ascan** images.

9. If Gate 2 is being used, select the amplitude decimation factor in the **Amp. Decimation Gate 2** box.

NOTE

For encoded C-scans, gate 1 amplitude compression is automatically set to maximum and depth compression for gates 1 and 2 is set to minimum.

---

10. The current **Scan File Size** based on the selected parameters is displayed. This parameter cannot exceed the **Max File Size** of approximately 70 MB.
11. Press the **[ESCAPE]** key to return to the live screen.

To begin acquiring data for your C-scan

1. Select **C Scan > Mode = Start**.

   OR

   Select **C Scan > Mode**, and then press **[CHECK]**.
2. Move your encoder and probe along your test piece at the appropriate scan rate so that you do not receive a LOS measurement (see Figure 18-21 on page 457).

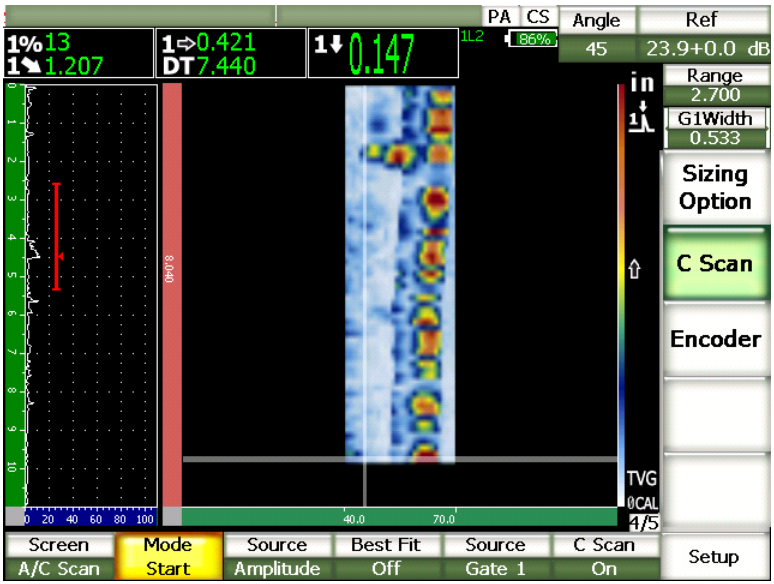

Figure 18-21 Acquired C-scan

18.5.3 Creating an Encoded C-Scan From a Linear Scan

To create an encoded C-scan

1. Begin with a fully calibrated linear scan. Both zero-degree and angled linear scans can be used.
2. Adjust the **G1Start** and **G1Width** parameters to capture the desired depth within the test piece.
3. If you are using a second gate for back wall monitoring, adjust the **G2Start** and **G2Width** parameters to surround the back wall echo.
4. Attach the encoder to the probe so that the encoder wheel turns when the probe is moved.
5. Enter the proper **Encoder Resolution** to ensure proper distance values are collected during the scan.

NOTE

The resolution for the Mini Wheel encoder is 12 pulses/mm (304.8 pulses/in.). If this value is unknown, see “Encoder Calibration” on page 469 for a complete encoder calibration procedure.

To set up your C-scan

1. Select **C Scan > C scan = On** to turn on C-scan.

   After the C-scan is turned on, additional C-scan parameters will display in the submenu.
2. Select **C Scan > Setup** to enter the setup page (see Figure 18-22 on page 459).

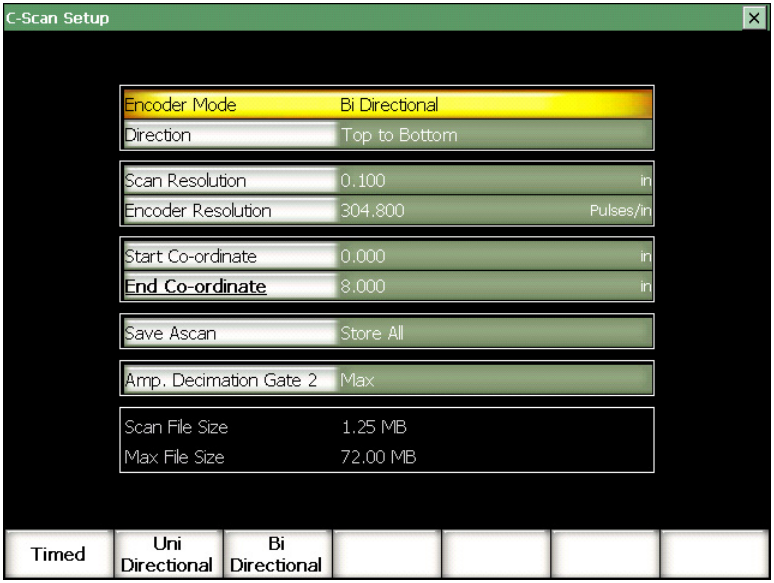

Figure 18-22 The C-scan Setup page

3. In the **Encoder Mode** box, choose **Uni-directional** or **Bi-directional**.
4. In the **Direction** box, choose a scan direction (this will determine the display view of the A-scan and C-scan image).
5. Set your **Scan Resolution** for your C-scan. This parameter will determine maximum scanning speed.
6. Enter the proper **Encoder Resolution** to ensure proper distance values are collected during the scan.

NOTE

The resolution for the Mini Wheel encoder is 12 pulses/mm (304.8 pulses/in.). If this value is unknown, see “Encoder Calibration” on page 469 for a complete encoder calibration procedure.

---

7. Set the desired **Start Co-ordinates** and **End Co-ordinates** for the scan.
8. Choose whether to **Save Ascan** images.

9. If Gate 2 is being used, select the amplitude decimation factor in the **Amp. Decimation Gate 2** box.

NOTE

For encoded C-scans, gate 1 amplitude compression is automatically set to maximum and depth compression for gates 1 and 2 is set to minimum.

The current **Scan File Size** based on the selected parameters is displayed. This parameter cannot exceed the **Max File Size** of approximately 70 MB.

10. Press the **[ESCAPE]** key to return to the live screen.

To begin acquiring data for your C-scan

1. Select **C Scan > Mode = Start**.

   OR

   Select **C Scan > Mode**, and then press **[CHECK]**.

2. Move your encoder and probe along your test piece at the appropriate scan rate so that you do not receive a LOS measurement (see Figure 18-23 on page 460).

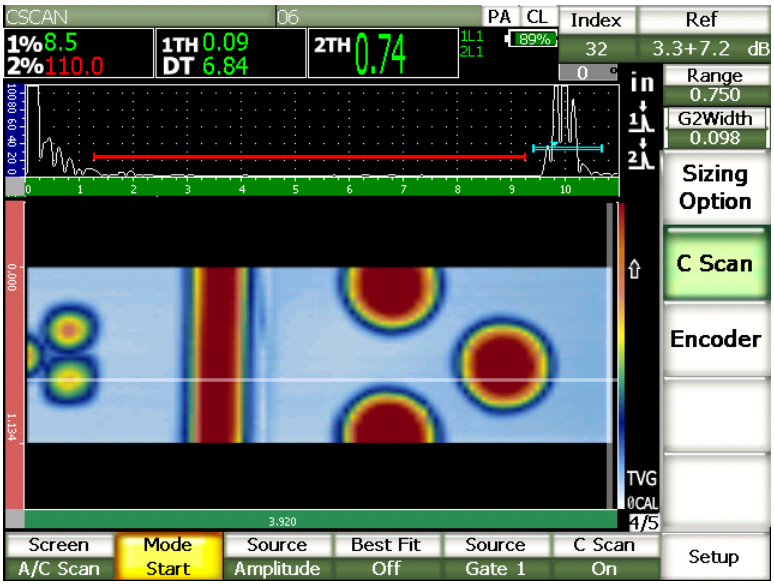

Figure 18-23 An acquired C-scan

18.5.4 Creating a Timed C-Scan From a Linear Scan

To create a timed C-scan

1. Begin with a fully calibrated linear scan. Both zero-degree and angled linear scans can be used.
2. Adjust the **G1Start** and **G1Width** parameters to capture the desired depth within the test piece.
3. If you are using a second gate for back wall monitoring, adjust the **G2Start** and **G2Width** parameters to surround the back wall echo.

To set up your C-scan

1. Select **C Scan > C scan = On** to turn on C-scan.

   When the C-scan is turned on, additional C-scan parameters will display in the submenu.
2. Select **C Scan > Setup** to enter the setup page (see Figure 18-24 on page 461).

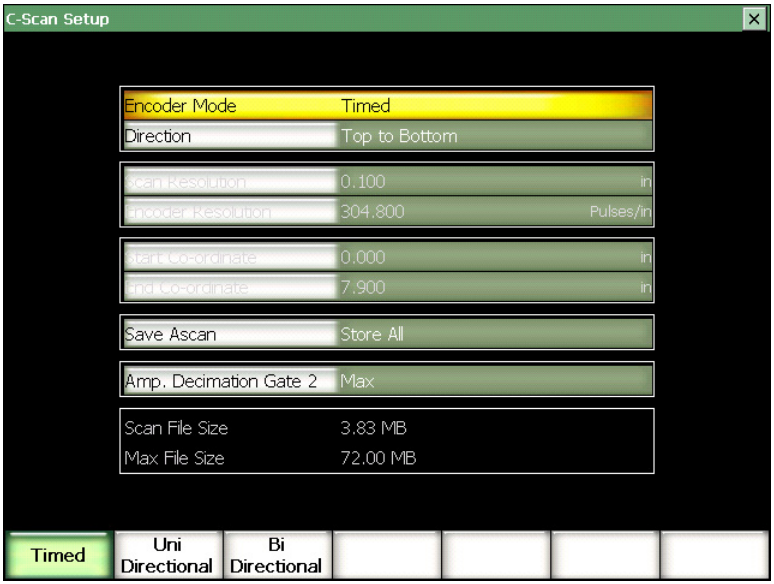

Figure 18-24 The C-scan Setup page

3. In the **Encoder Mode** box, select **Timed**.
4. In the **Direction** box, choose a scan direction (this will determine the display view of the A-scan and C-scan image).
5. Choose whether to **Save Ascan** images for each point on the C-scan.

   The current **Scan File Size** based on the selected parameters is displayed. This parameter cannot exceed the **Max File Size** of approximately 70 MB.
6. Press the **[ESCAPE]** key to return to the live screen.

To begin acquiring data for your C-scan

1. Select **C Scan > Mode = Start**.

   OR

   Select **C Scan > Mode**, and then press **[CHECK]**.

   Once started, the scan will automatically move at a fixed rate along the timed axis.
2. Move your probe along your test piece to capture C-scan data (see Figure 18-25 on page 462).

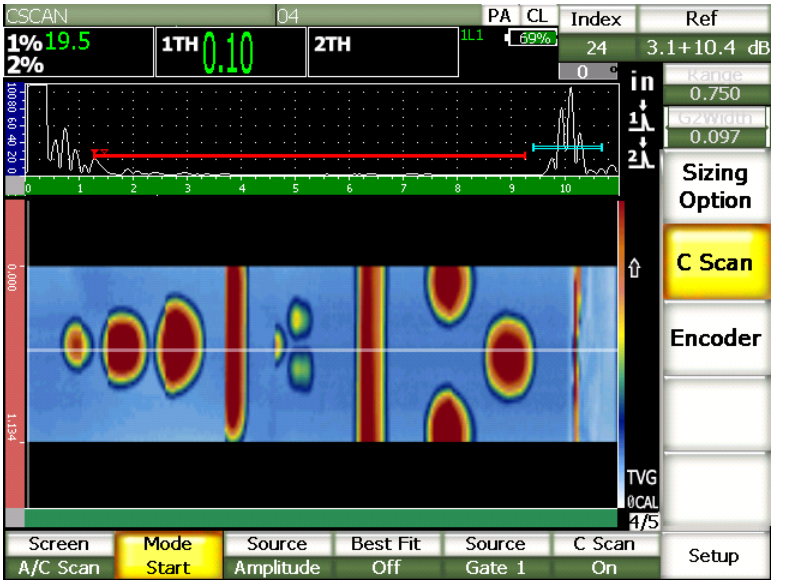

Figure 18-25 An acquired timed C-scan

18.5.5 Reviewing Acquired C-Scan Data

After you have completed a C-scan, you can review the acquired data and source scans in Review mode. Review mode also provides image and sizing cursors for basic visual analysis.

18.5.5.1 Entering Review Mode

To review a finished scan, or to pause and review your acquired data, freeze your scan to go to Review mode. When the scan is unfrozen you can continue the scan from the point where the scan was frozen.

To freeze the scan and enter Review mode

◆ Press **[FREEZE]**.

An "F" icon displays to the left of the scan to indicate that you are reviewing a frozen scan (see Figure 18-26 on page 464).

OR

Select **C Scan > Mode = Stop**.

OR

Press **[CHECK]** when **C Scan > Mode** is selected.

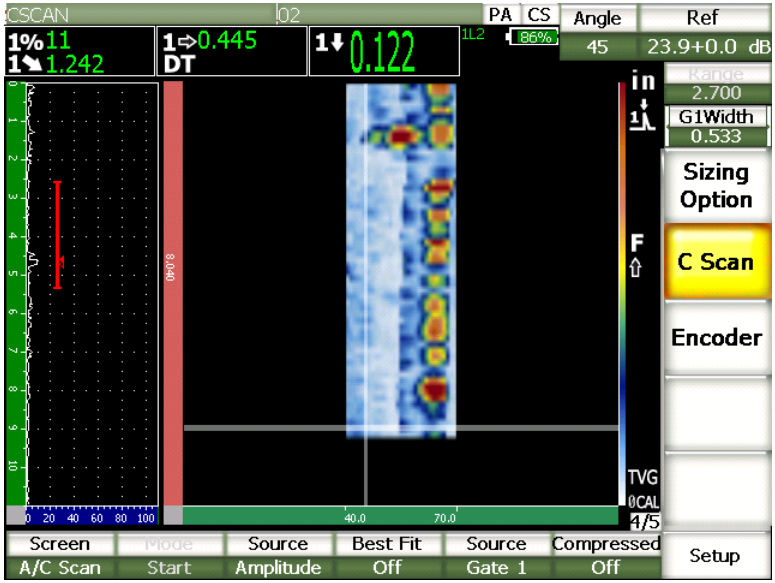

Figure 18-26 A frozen encoded C-scan

After the C-scan has been stopped, you will need to save and recall the scan in order to review the data (refer to “Open Function” on page 201 for information about saving and recalling scans). When the C-scan is restarted, it will create a new scan from the start point rather than resume from the last captured point.

18.5.5.2 Image Cursors

Image cursors, available while in Review mode, allow you to individually select all points on the C-scan. If selected in C-scan setup, a compressed A-scan will be stored for each point on the C-scan. The image cursors are displayed as white lines on the C-scan image, and are used to choose a particular C-scan point to view the A-scan image.

The distance traveled (D.T.) cursor selects a specific distance or timed point along the scan axis. For encoded C-scans, the D.T. cursor will select a specific encoder position along the scan axis in inches or millimeters. For timed C-scans, this cursor will correspond to a specific screen pixel along the scan axis.

To adjust the D.T. cursor

- Select **PA Cursors > D.T.** (see Figure 18-27 on page 465).

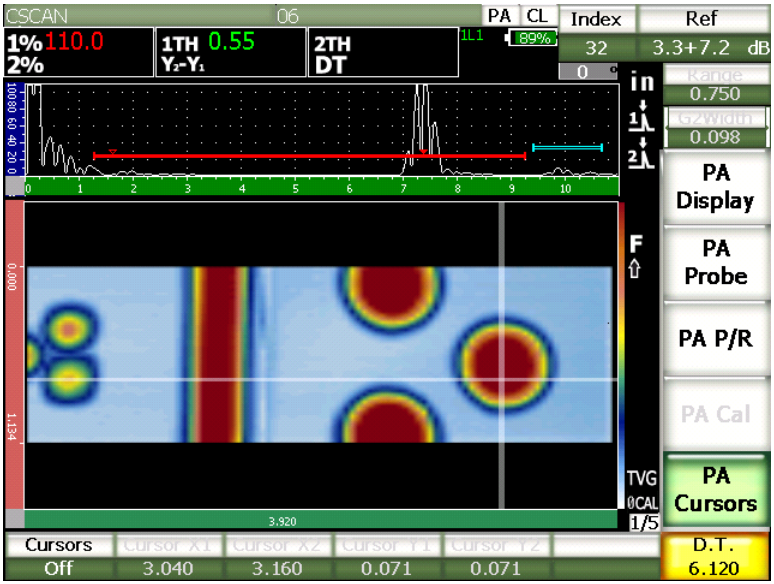

Figure 18-27 Adjusting the D.T. cursor

The Angle or Index cursor selects a specific focal law or aperture along the probe. For C-scans created from S-scans, the Angle cursor is used to select a specific focal law within the selected angle range of the sector scan. For C-scans created from linear scans, the Index cursor selects a particular aperture group of elements along the length of the probe.

To adjust the Angle/Index cursor

- Press the **[ANGLE]** key (see Figure 18-28 on page 466).

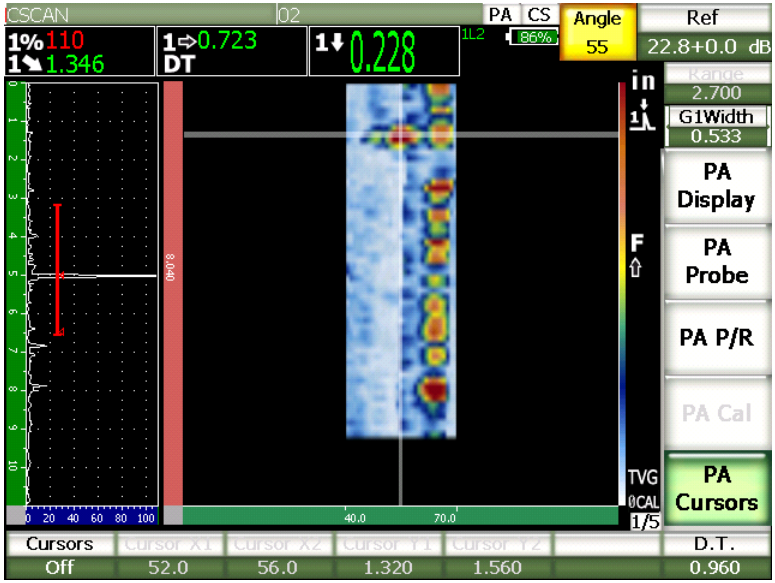

Figure 18-28 Adjusting the Angle cursor

18.5.5.3 Viewing Source Sectorial or Linear Scan Images

In Review mode, you can view the S-scan or linear scan from which a C-scan point was generated. After selecting the specific C-scan point using the image cursors, simply adjust the **C Scan > Screen** view to display the sector or linear scan for the selected C-scan point (D.T., Index/Angle).

NOTE

You will not be able to adjust gate position or range on the stored C-scan or linear scans. C-scan information is only stored for the gated region.

18.5.5.4 Sizing Cursors

Phased array sizing cursors are also available for basic flaw sizing on the C-scan image.

Based on your screen view, the X and Y cursors will correspond to focal law (angle) or position along the probe (index) and distance traveled (scan axis).

To turn on the sizing cursors

- Select **PA Cursors > Cursors = On**.

  The X and Y cursors can then be adjusted to take measurements in both directions along the scan. If you selected Auto measurement mode, the relevant cursor measurements will be displayed in the measurement boxes above the scan.

NOTE

Timed C-scans do not provide position information along the scan axis, so cursors in this direction are not used for flaw sizing.

To more clearly view the area being sized, you can choose to shade the area surrounded by the X and Y sizing cursors.

To shade the sizing area

- Select **Display Setup > Contrast**.

  As the contrast is increased, the sizing area will become darker shaded in blue (see Figure 18-29 on page 468).

NOTE

This contrast feature also controls the contrast of the weld overlay if it is being used.

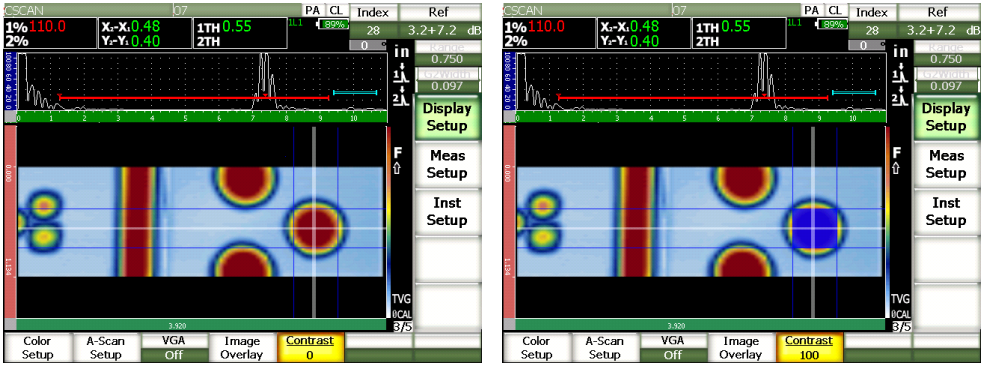

Figure 18-29 Adjusting the contrast

18.5.5.5 Changing Gate Source Data

Depth and amplitude data for gates 1 and 2 are collected when a C-scan is created (see Figure 18-30 on page 468).

After acquiring a C-scan, you can adjust both **C Scan > Source** parameters to view other relevant C-scan data.

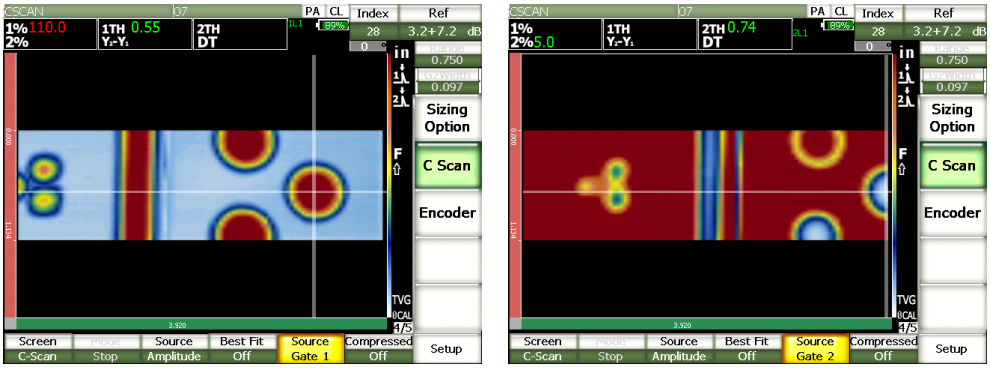

Figure 18-30 Amplitude C-scans for gate 1 and 2

18.5.5.6 Compressed View

Encoded C-scans allow for data collection for lengths longer than the screen width, so you can compress a C-scan to view the entire scan on screen all at once (see Figure 18-31 on page 469).

To turn compressed view on

- Select **C Scan > Compressed = On**.

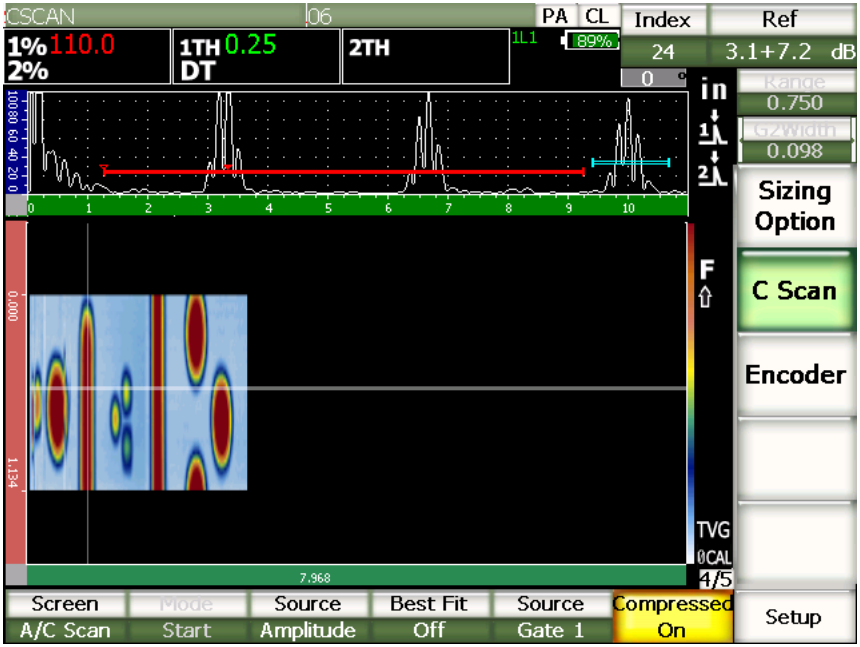

Figure 18-31 Compressed view

18.5.6 Encoder Calibration

Before creating an encoded C-scan, you must determine the correct encoder resolution to ensure accurate distance traveled data. This is done through an encoder calibration process. In addition to the encoder, probe, and wedge, you will need a ruler.

To perform the encoder calibration

1. Attach the encoder to your probe and wedge.
2. Select **Encoder > Calibration** to access the **Encoder Calibration** page (see Figure 18-32 on page 470).

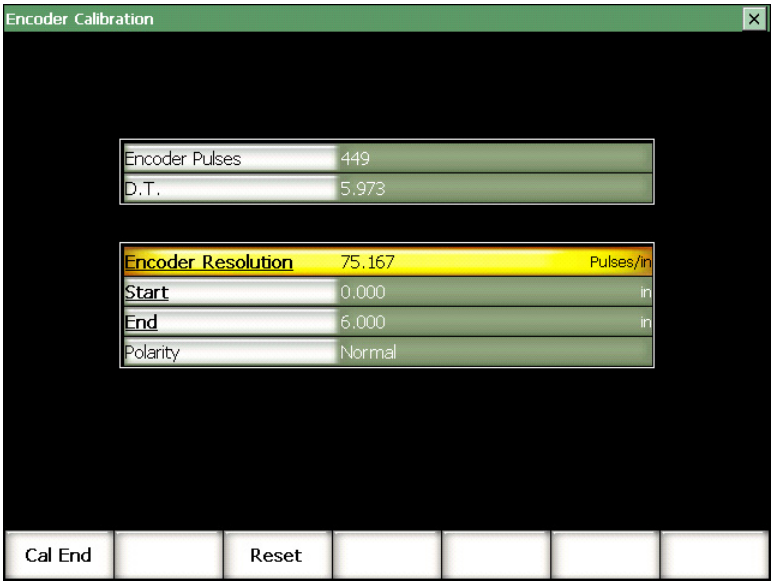

Figure 18-32 The Encoder Calibration page

3. Press **[P3]** to reset the **Encoder Pulses** and **D.T.** values.
4. Set the **Start** and **End** points to be used for the calibration.

NOTE

Using a greater calibration distance, at least 150 mm (6 in.), will increase encoder resolution accuracy as error is averaged over a larger distance.

5. Position the front of the probe at the zero mark (start point) on your ruler.
6. Press **[P1] Cal Start** to begin the calibration.
7. Move the probe until the front is at the end point on your ruler.

8. Press **[P1] Cal End** to complete the calibration.

   After the calibration has been completed, the newly calculated **Encoder Resolution** will display. This value will automatically populate to the C-scan setup menu.
9. Press the **[ESCAPE]** key to return to the live screen.

18.6 Weld Overlay

Weld Overlay is a standard inclusion on the EPOCH 1000*i*, providing a visual reference of a weld profile on the phased array display. You can input the basic components of your weld geometry to display a representation of the weld on the screen along with the live sector or linear scan. When specific weld geometry has been set up, the weld centerline cursor allows manual positioning of the overlay on the phased array scan image. Weld setups can be named and stored on the EPOCH 1000*i* for easy recall during future use.

18.6.1 Feature Activation

The Weld Overlay feature is available beginning with version 1.2.0.2 of EPOCH 1000 Series firmware. If you are running an older version of firmware you will need to upgrade your instrument to make this feature available (for information on firmware upgrades please visit our website at www.olympus-ims.com or contact your local sales representative).

To access Weld Overlay

1. Select **Display Setup > Image Overlay** to access the **Display** setup page (see Figure 18-33 on page 472).

Figure 18-33 The Display setup page

2. Set the **Weld Overlay** parameter to **On**.
3. Select **Overlay Name**, and then select a previously created weld template.
   OR
   Refer to "Creating a Weld Template" on page 473 to create a new template.
4. Set the **Weld Rotation** to 0 or 180 degrees, based on your desired orientation.
5. Choose the **Weld Color** from the listed colors.
6. Press **[ESCAPE]** to return to the main screen.

18.6.2 Creating a Weld Template

To create a weld template

1. Select **Display Setup > Image Overlay**.
2. On the **Display** setup page, select **Weld Overlay**, and then press **Setup** (see Figure 18-34 on page 473).

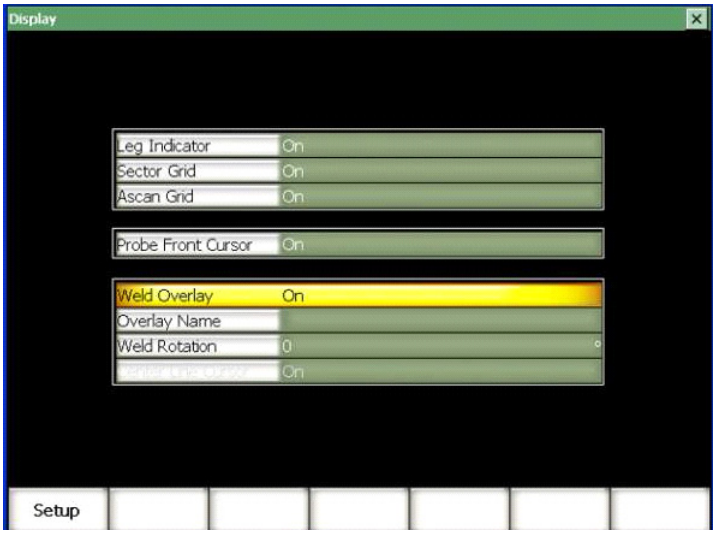

Figure 18-34 Weld Overlay parameter in the Display page

The **Weld Overlay Setup** page appears.

NOTE

When using Weld Overlay, it is recommended to turn on the probe front cursor, as the centerline (CL) cursor is measured from this point.

---

3. Select **Overlay Name**, and then press **Add** (see Figure 18-35 on page 474).

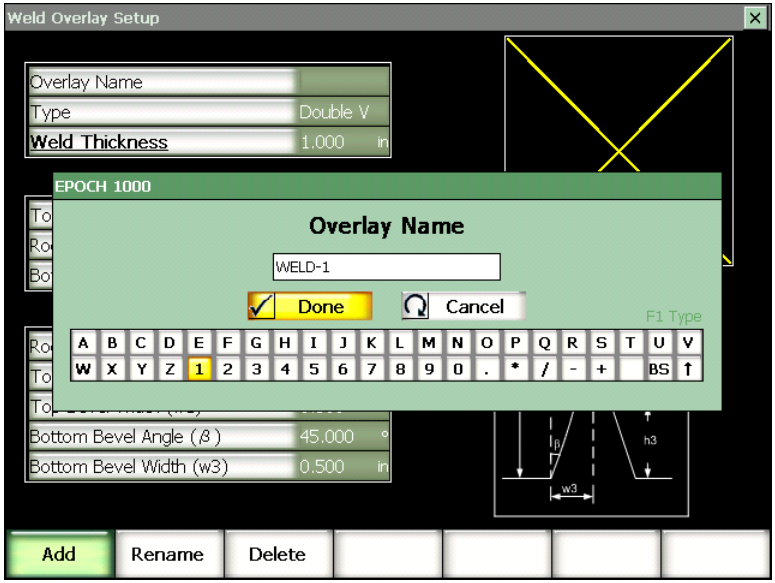

Figure 18-35 Adding the Overlay Name

4. Name the overlay using the virtual keypad (see Figure 18-35 on page 474).
5. When finished, press **[CHECK]**.
6. Select the **Weld Type** (Single V or Double V).

   A preview of the weld type and the corresponding input parameters will display on the screen (see Figure 18-36 on page 475).

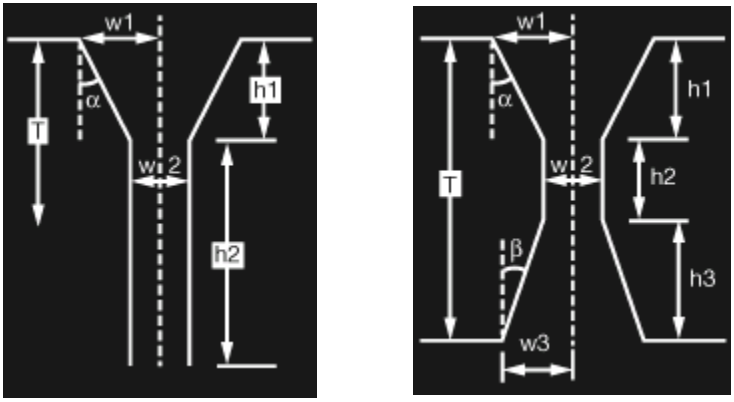

Figure 18-36 Single V and Double V weld diagrams (Symmetric)

7. Set the **Symmetry** for the weld. You can create a Symmetric weld, or a weld that opens to the Left or to the Right.

NOTE

Asymmetric weld profiles (Right and Left) are available beginning with version 1.3.1.0 of EPOCH 1000 Series firmware. Previous version of firmware will only allow for symmetric weld geometries.

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8. Enter the weld geometry parameters for the chosen weld type. These parameters are referenced in the weld drawings using the variables below.

- T = Weld thickness
- h1 = Top bevel height
- h2 = Root gap height
- h3 = Bottom bevel height (Double V only)

NOTE

The total thickness of the weld must equal the sum of the bevel and root gap heights:

$$T = h1 + h2 + h3$$

Root gap and bevel widths are dependent on the bevel angle values.

- w2 = Root gap width
- α = Top bevel angle
- w1 = Top bevel width
- β = Bottom bevel angle (Double V only)
- w3 = Bottom bevel width (Double V only)

18.6.3 Weld Overlay Operation

Weld Overlay can be displayed over both sector and linear scan images, either live or in C-scan review mode.

The centerline (CL) cursor is used to position the weld overlay on the phased array sector or linear scan image. The centerline is measured from the front of the probe, so turning the probe front cursor on is helpful when using weld overlay.

To adjust the centerline cursor

◆ From the live screen, select **PA Cursors > CL Cursor** from the live screen (see Figure 18-37 on page 477).

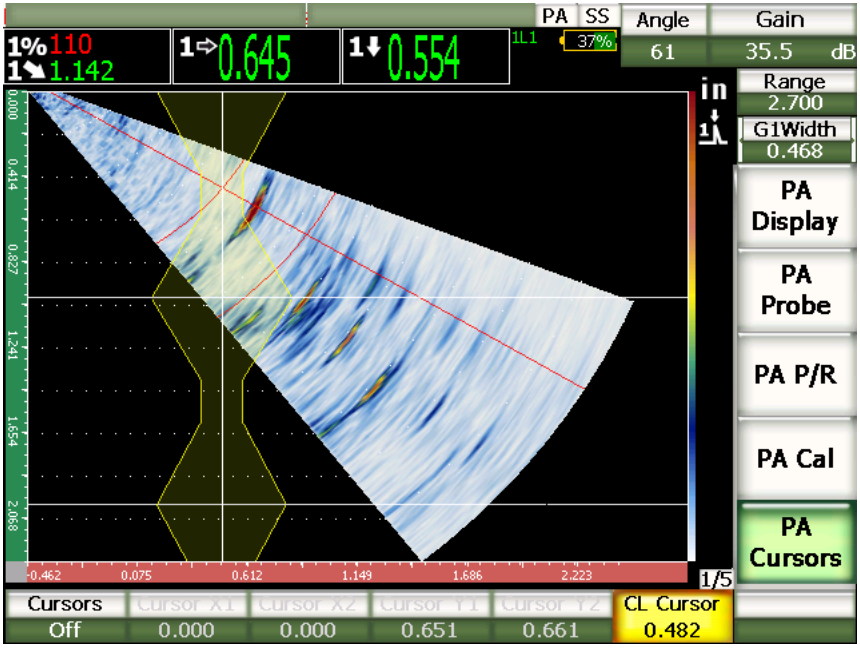

Figure 18-37 Adjusting the centerline (CL) cursor

NOTE

The contrast of the overlay can be adjusted by selecting select **Display Setup > Contrast** (see Figure 18-38 on page 478).

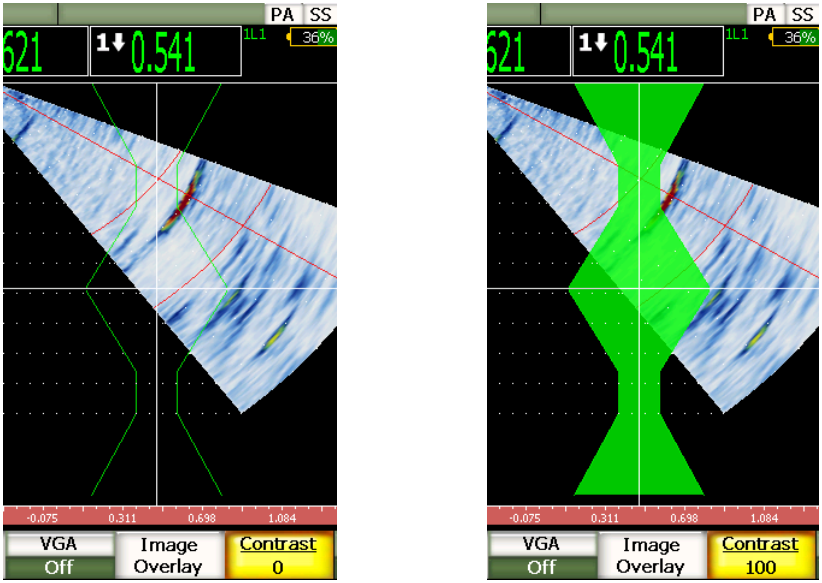

Figure 18-38 Adjusting weld overlay contrast levels

The color of the overlay can be adjusted in the **Display Setup > Image Overlay** submenu by selecting **Weld Color** (see Figure 18-39 on page 479). Available colors are: white, black, green, yellow, red, and blue.

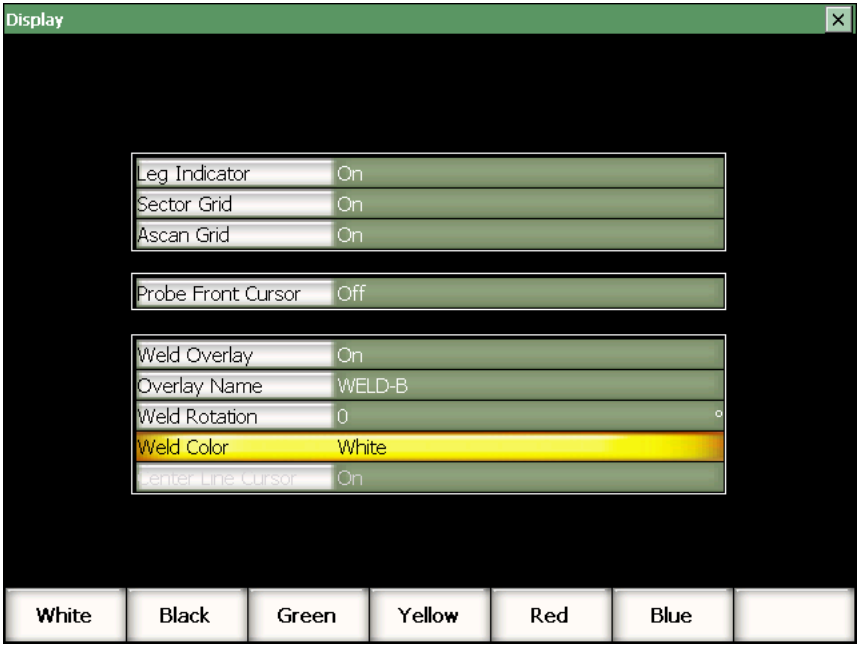

Figure 18-39 Adjusting the weld overlay color

18.7 Multi-Angle

The EPOCH 1000*i* phased array mode includes a standard feature called Multi-Angle. This feature enables you to designate any three angles, or focal laws, available in the sector scan as “visible” focal laws. The A-scans from each of the three designated angles are overlaid, one on top of the other, in the A-scan window, enabling you to view all three A-scans at the same time. Each individual angle is color-coded for ease of use. This feature is perfect for inspectors using conventional sizing methods requiring evaluation at 45°, 60°, and 70°.

18.7.1 Feature Activation

The Multi-Angle feature allows you to select any three focal laws within the selected sector scan range as “visible” focal laws.

To select the focal laws for Multi-Law

1. Select **Display Setup > A-Scan Setup**.
2. In the **A-Scan** setup page, set the **Ascan** parameter to **Multi-Angle** (see Figure 18-40 on page 480).

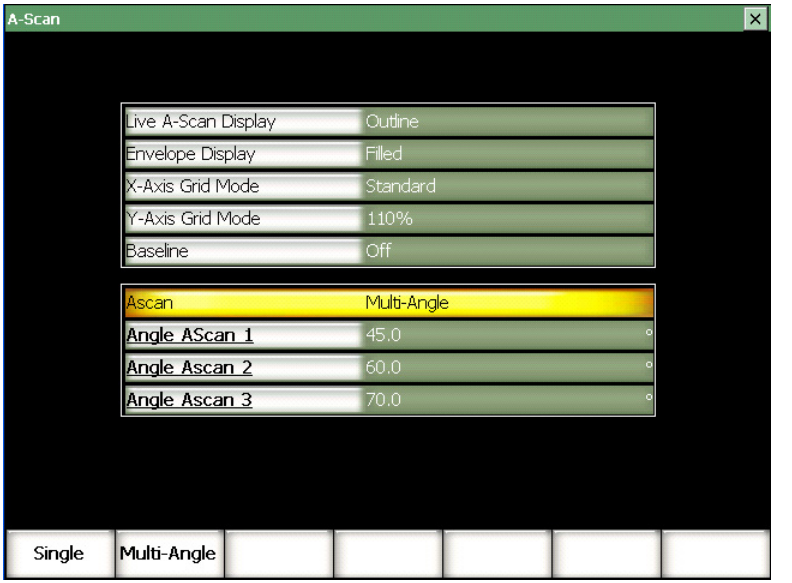

Figure 18-40 Multi-Angle feature setup

3. Use the arrow keys to select the desired “visible” angles.
4. Press **[ESCAPE]** to return to the main screen.

After you have chosen the specific angles for Multi-Angle, toggle between single A-scan and Multi-Angle from the main screen by selecting **PA Display > Ascan** (see Figure 18-41 on page 481).

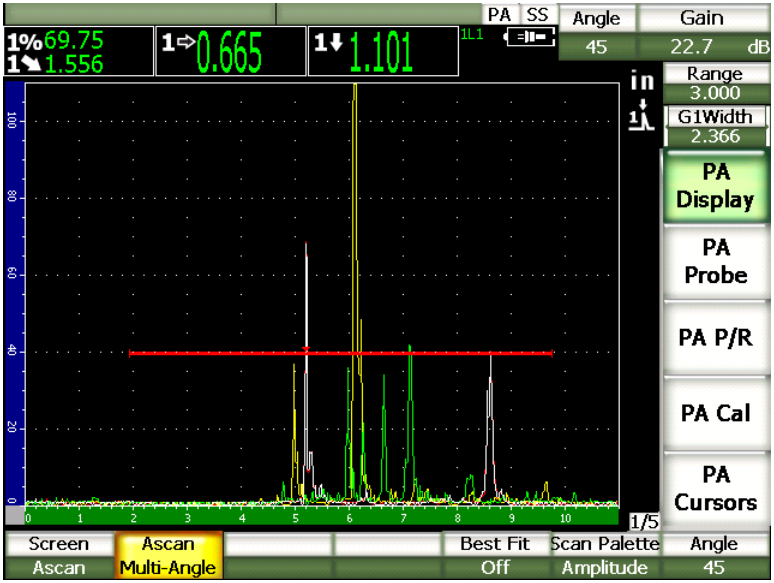

Figure 18-41 Activating Multi-Angle from the main screen

18.7.2 Multi-Angle A-Scan Display

When Multi-Angle is active, multiple A-scans are displayed on the screen in different colors. The three selected "visible" A-scans are color-coded as follows (see Figure 18-42 on page 482):

- Red: Lowest number angle (ex.: 45 degrees)
- Yellow: Middle number angle (ex.: 60 degrees)
- Green: Highest number angle (ex.: 70 degrees)

The active/selected angle is always displayed in white. The remaining angles have the same colors as listed above.

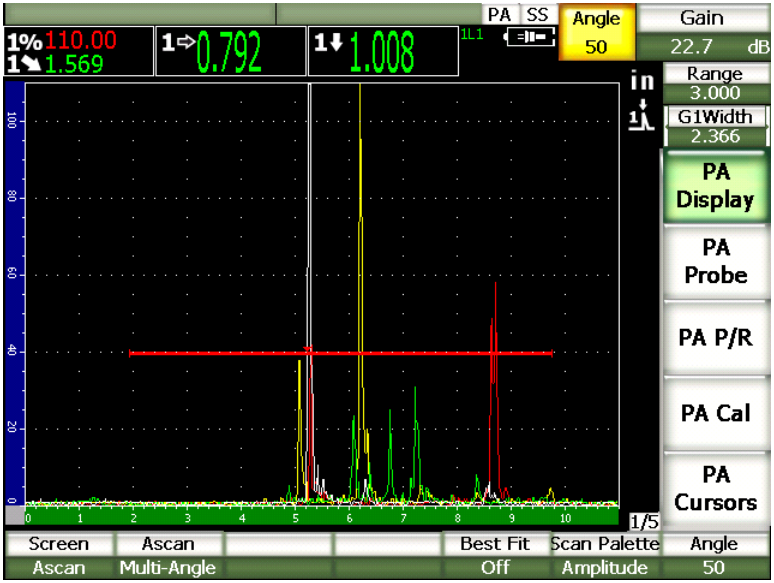

Figure 18-42 Multi-Angle display

With coarse adjustment, adjusting the focal law will scroll through the three selected angles. Adjusting with fine adjustment will adjust the angle over the full S-scan range.

19. Maintenance and Troubleshooting

19.1 Instrument Cleaning

When needed, wash the instrument only with mild soap and water on a damp cloth.

19.2 Verifying O-Ring Gaskets and Seals

EPOCH 1000 Series instruments contain seals that are used to protect the internal hardware from the environment. These include:

- Battery compartment cover seal
- Computer connection compartment door seal
- Membrane vent
- Main O-ring seals between the top and bottom half of the instrument and the aluminum heat-sink band
- Phased array connection cover seal
- Conventional probe gasket

Regularly clean and verify the state of the above seals and gaskets to ensure the integrity of the hardware protection.

19.3 Protecting the Display

EPOCH 1000 Series instruments include a clear-plastic sheet protecting the display window. Leave the clear-plastic sheet in place when using your instrument to continuously protect the display. Clear-plastic sheet replacements are available from Olympus in packages of 10 (PN: EP1000-DP).

CAUTION

The display window is permanently bonded to the upper-half of the instrument case to fully seal the instrument. If the display window becomes damaged, the entire upper-half of the case must be replaced, along with the instrument direct-access keypad.

19.4 Annual Calibration

Send your EPOCH 1000 Series instrument once a year to an Olympus service center for annual calibration. The service includes calibration, as well as o-ring gasket and membrane seal evaluation and replacement as needed to assure environmental durability. Contact Olympus for details.

19.5 Trouble Shooting

Symptom	The **[On/Off]** power key is the only operational front panel key. Nothing happens when pressing other keys.
Possible cause	The **All Lock** function is active, locking all front panel keys.
Solution	Turn the instrument power Off and On to unlock the keys.
Symptom	Several software functions are unavailable.
Possible cause	The **Cal Lock** function is active, locking all front panel keys.
Solution	Turn the instrument power Off and On to unlock the keys.

Symptom The signal display is frozen. Possible cause **Meas Setup > Trigger = External** or **Single**. In these modes, the instrument only fires when an external command is active. Solution Select **Meas Setup > Trigger = Internal**. If using either the **External** or the **Single** modes, ensure that the external system is activating the firing at the desired rate.
Symptom The instrument does not start when the **[ON/OFF]** power key is pressed (following a software update). Possible cause Interrupted, incomplete, or corrupted software update. Solution 1. Remove the battery from the EPOCH 1000 Series instrument, as well as the AC line power. 2. Replace the battery in the EPOCH 1000 Series instrument. 3. Start the instrument.
Symptom The instrument indefinitely stays in the start-up process. Possible cause Corrupted data. Solution Force a hard instrument reset.

20. Specifications

20.1 General and Environmental Specifications

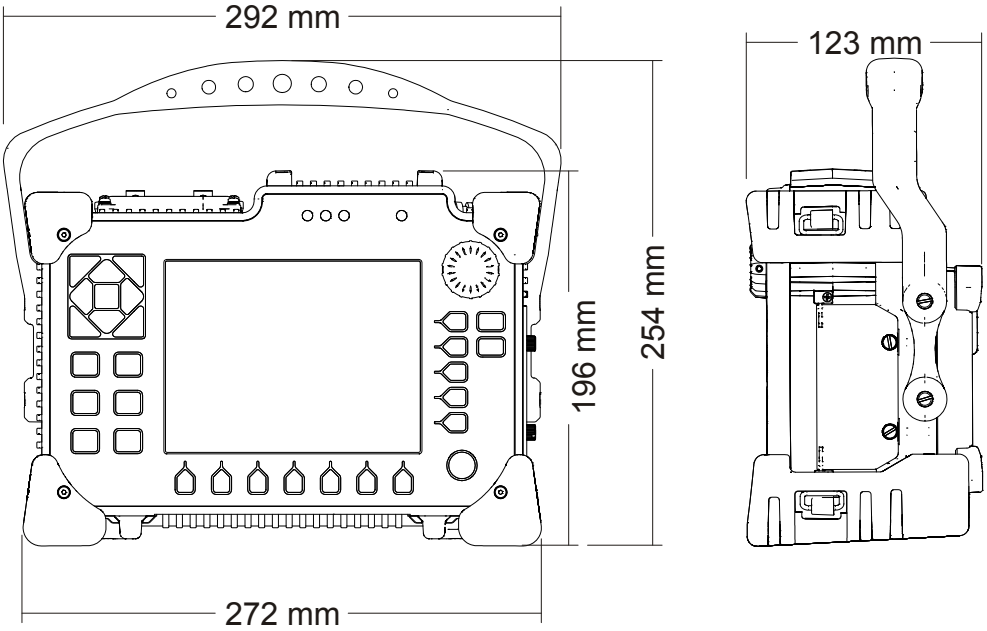

Figure 20-1 Overall EPOCH 1000 Series dimensions

Table 28 General specifications

Parameter	Value
Overall dimensions (W × H × D)	292 mm × 196 mm × 123 mm (11.5 in. × 7.7 in. × 4.8 in.) [see Figure 20-1 on page 487]
Weight	3.67 kg (8.1 lb), including lithium-ion battery
Keypad	English, International, Japanese, Chinese
Languages	English, Spanish, French, German, Italian, Japanese, Chinese, and Russian
Transducer connections	BNC or LEMO 01
Data storage	Onboard up to 10000 IDs with waveform, standard 2 GB CompactFlash card (removable)
Battery type	Single lithium-ion rechargeable standard
Battery life	8 hours (conventional UT mode) 7 hours (phased array mode)
Power requirements	AC Mains: 100 VAC to 120 VAC, 200 VAC to 240 VAC, 50 Hz to 60 Hz
Display type	Full VGA (640 × 480 pixels) transflective color LCD, 60 Hz update rate
Display dimensions (W × H, Diagonal)	132.5 mm × 99.4 mm, 165.1 mm (5.2 in. × 3.9 in., 6.5 in.)
Warranty	1 year limited

Table 29 Environmental ratings specifications

Parameter	Value
IP rating	Designed to meet the requirements of IP66
Explosive atmosphere	MIL-STD-810F Procedure 1, NFPA 70E, Section 500, Class 1, Div. 2, Group D
Shock tested	IEC 60068-2-27, 60 *g*, 6 µs H.S., multiple axes, 18 total
Vibration tested	Sine vibration, IEC 60068-2-6, 50 Hz to 150 Hz at 0.03 in. DA or 2 *g*, 20 sweep cycles
Drop tested	MIL-STD-810F 4.5.5 Procedure IV - Transit Drop
Operating temperature	−10 °C to 50 °C (−14 °F to 122 °F)
Battery storage temperature	−20 °C to 60 °C (−4 °F to 140 °F)

20.2 Channel Specifications

Table 30 EPOCH 1000*i* phased array specifications

Parameter	Value
Focal laws	61
Physical probe	64 elements
Virtual probe	16 elements
Video filtering	Off, Low, High
Display modes	A-scan, S-scan, Linear scan, C-scan, A-scan plus image
Image update rate	60 Hz update for all A-scans 20 Hz update for all images

Table 31 Pulser specifications

Pulser	EPOCH 1000/1000*iR*/1000*i* (conventional UT mode)	EPOCH 1000*i* (PA mode)
Pulser	Tunable square wave	
PRF	5 Hz to 6 000 Hz in 5 Hz increments	Automatic. Maximum 1520 Hz
Energy settings	50 V to 475 V in 25 V increments	40 V or 80 V
Pulse width	Adjustable from 45 ns to 5000 ns (0.1 MHz) with PerfectSquare technology	Adjustable from 45 ns to 1000 ns with PerfectSquare technology
Damping	50 Ω, 100 Ω, 200 Ω, and 400 Ω	Not applicable
Pulser delay	Not applicable	0 µs to 10 µs, 2.5 ns resolution

Table 32 Receiver specifications

Parameter	EPOCH 1000/1000*iR*/1000*i*	EPOCH 1000*i*
Gain	0 dB to 110 dB	0 dB to 80 dB
Maximum input signal	20 Vp-p	250 mVp-p per channel
Receiver input impedance	400 Ω ±5 %	50 Ω ±10 %
Receiver bandwidth	0.2 MHz to 26.5 MHz at −3 dB	0.5 MHz to 12.5 MHz at −3 dB

Table 32 Receiver specifications *(continued)*

Parameter	EPOCH 1000/1000*iR*/1000*i*	EPOCH 1000*i*
Receiver delay	Not applicable	0 µs to 10 µs, 2.5 ns resolution
Digital filter settings	Standard filter set (EN12668-1 Test & Compliant): 7 filters Advanced Filter Set (not tested to EN12668-1): 30 filters	Automatic by probe
Rectification	Fullwave, positive half wave, negative half wave, RF	
Reject	0 % to 80 % full-screen height (FSH) with visual warning	
Amplitude measurement	0 % to 110 % FSH with 0.25 % resolution	

Table 33 Calibration specifications

Parameter	EPOCH 1000/1000*iR*/1000*i*	EPOCH 1000*i*
Automated calibration	• Velocity, zero offset • Straight beam (first back wall or echo-to-echo) • Angle beam (sound path or depth)	• Velocity, zero offset • Sensitivity using sound path or depth
Test modes	Pulse echo, dual, or through transmission	Pulse echo
Units	mm, in., or µs	
Range	3.33 mm to 26808 mm (0.131 in. to 1054.1 in.) at 5900 m/s (0.2320 in./µs)	61 focal laws, 3.33 mm to 390.95 mm (0.131 in. to 15.373 in.) at 5 900 m/s (0.2320 in./µs)
Velocity	635 m/s to 15240 m/s (0.0250 in./µs to 0.6000 in./µs)	
Zero offset	0 µs to 750 µs	Not applicable
Display delay	−59 mm to 25400 mm (−2.323 in. to 1 000 in.)	0 to max range
Refracted angle	0° to 85° in 0.1° increments	61 angular focal laws, 0.5°, 1°, 1.5°, or 2° increments, adjustable from −80° to 80°

Table 34 Gates specifications

Parameter	EPOCH 1000/1000*iR*/1000*i*	EPOCH 1000*i*
Measurement gates	2 fully independent gates for amplitude and time-of-flight measurements	
Interface gate	Optional, with gate 1 and gate 2 tracking	Not applicable
Gate start	Variable over entire displayed range	
Gate width	Variable from gate start to end of displayed range	
Gate height	Variable from 2 % to 95 % FSH	
Alarms	• Positive and negative threshold • Minimum depth • LOS on optional IF gate	• Positive and negative threshold (for selected focal law) • Minimum depth (for selected focal law)
Reference cursors	2 reference cursors for A-scans	2 reference cursors for A-scans 4 reference cursors for images

Table 35 Measurements specifications

Parameter	EPOCH 1000/1000*iR*/1000*i*	EPOCH 1000*i*
Measurement readings	6 boxes available (manual or auto selection)	
Gate 1	Thickness, sound path, projection, depth, amplitude, time-of-flight, min./max. depth, min./max. amplitude	
Gate 2	Same as gate 1	
IF gate (optional)	Thickness	
Echo-to-echo	Standard. Choose between Gate2-1, Gate2-IF, Gate1-IF	Not applicable
Other measurements	Overshoot (dB) value for DGS/AVG, ERS (equivalent reflector size) for DGS/AVG, AWS D1.1/D1.5 rating (D), reject value	
DAC/TVG	Standard	
DAC points	Up to 50 points, 110 dB dynamic range	Up to 20 points, 40 dB dynamic range
Special DAC modes	20 % to 80 % DAC, Custom DAC (up to 6 curves)	Custom DAC (up to 6 curves)

Table 35 Measurements specifications *(continued)*

Parameter	EPOCH 1000/1000*iR*/1000*i*	EPOCH 1000*i*
TVG table	Up to 50 points, 110 dB dynamic range, compatible with IF gate at all PRF settings	Up to 20 points, 40 dB dynamic range
Curved surface correction	Standard. Tube of bar OD correction for angle beam measurements	

20.3 Input/Output Specifications

Table 36 on page 492 provides the specifications for the input output signals.

Table 36 Input/output specifications

Parameter	Value
USB ports	1 USB client, 3 USB hosts (USB 1.1)
Video output	VGA output standard
RS-232	Yes
Analog outputs	4 analog outputs, selectable 1 V/10 V full scale, 4 mA max.
Alarm outputs	6 alarm outputs, 5 V TTL, 10 mA
Trigger I/O	Trigger input: 5 V TTL Trigger output: 5 V TTL, 10 mA
Encoder outputs	2-axis encoder line (quadrature)

Table 37 on page 492 describes all the connections available on the ALARMS 26-pin D-sub connector. Table 38 on page 493 describes all the connections available on the ANALOG OUT 9-pin D-sub connector.

Table 37 Pinout of the ALARMS connector

Pin	Signal	Description
1	+5 V	+5 V voltage
2	+5 V	+5 V voltage
3	GND	Ground
4	GND	Ground
5	ALARM COMBINED	Combined alarms

Table 37 Pinout of the ALARMS connector *(continued)*

Pin	Signal	Description
6	ALARM GATE1	Gate 1 alarm
7	ALARM GATE 2	Gate 2 alarm
8	ALARM GATE 3	IF gate alarm
9	SPARE OUT 0	Spare output 0
10	ALARM CLK	Alarm clock
11	EXT TRIG OUT	External trigger output
12	SPARE OUT 1	Spare output 1
13	GND	Ground
14	GND	Ground
15	ENCD INT X	X-axis encoder increment
16	ENCD DIR X	X-axis encoder direction
17	ENCD DIR Y	Y-axis encoder direction
18	ENCD INT Y	Y-axis encoder increment
19	SPARE IN 0	Spare input 0
20	EXT TRIG IN	External trigger input
21	SPARE IN 1	Spare input 1
22	SPARE IN 2	Spare input 2
23	NO CONNECT	No connection
24	NO CONNECT	No connection
25	GND	Ground
26	GND	Ground

Table 38 Pinout of the ANALOG OUT connector

Pin	Signal	Description
1	ANALOG OUT 1	Analog output 1
2	ANALOG OUT 2	Analog output 2
3	GND	Ground
4	GND	Ground
5	ANALOG OUT 3	Analog output 3
6	ANALOG OUT 4	Analog output 4
7	GND	Ground

Table 38 Pinout of the ANALOG OUT connector *(continued)*

Pin	Signal	Description
8	GND	Ground
9	NO CONNECT	No connection

Table 39 Pinout of the VGA/RS232 connector

Pin	Signal
1	VGA_RED
2	VGA_GREEN
3	VGA_BLUE
4	RS232_TXD
5	GND
6	GND
7	GND
8	GND
9	RS232_DTR
10	GND
11	RS232_RXD
12	RS232_DSR
13	VGA_HSYNC
14	VGA_VSYNC
15	GND

NOTE

For RS-232 communication with most PCs, a null modem cable is required between the PC and the EPOCH 1000 Series RS232 cable.

20.4 Probe and Wedges Specifications

The EPOCH 1000*i* supports a series of phased array probes to meet the demands of critical inspections (see Table 40 on page 495). These probes include standard weld inspection probes, specialized probes for specific code compliance, and a standard 64-element probe (used with other Olympus phased array products) for linear scanning.

Table 40 EPOCH 1000*i* supported PA probes[a]

Part	Usage/Code compliance	Frequency (MHz)	Number of elements	Pitch	Active aperture (mm)	Elevation (mm)	Dimensions in mm (in.) L × W × H		
2.25L8-A10P	General purpose	2.25	8	1.2	9.6 × 10	10	22.5 (0.89)	15.6 (0.61)	20.0 (0.79)
5L16-A10P		5.0	16	0.6	9.6 × 10	10	22.5 (0.89)	15.6 0.61)	20.0 (0.79)
10L16-A10P		10.0	16	0.6	9.6 × 10	10	22.5 (0.89)	15.6 (0.61)	20.0 (0.79)
2.25L16-AWS1	AWS D1.1/D1.5	2.25	16	0.94	15 × 15	16	37.6 (1.48)	25.4 (1.0)	17.8 (0.70)
2L8-DGS1	Europe, Integral Wedge/ DGS/AVG	2.0	8	1	8 × 9	9	27.3 (1.07)	16.8 (0.66)	22.3 (0.88)
4L16-DGS1		4.0	16	0.5	8 × 9	9	27.3 (1.07)	16.8 (0.66)	22.3 (0.88)
5L64-A12	General purpose	5.0	64	0.6	9.6 × 10[b]	10	44.6 (1.76)	22.5 (0.89)	20.0 (0.79)

a. All probes supplied with 2.5 m cable and OmniScan style connector. For other variations contact Olympus.
b. For 16-element pulse group

Table 41 EPOCH 1000*i* supported Wedges

Part	Matching probes	Nominal refracted beam angle (in steel)	Sweep (°)	Probe orientation	Dimensions in mm (in.) L × W × H		
SA10P-0L	2.25L8-A10P 5L16-A10P 10L16-A10P	0° LW	−30 to 30	Normal	25.4 (1.0)	23.1 (0.91)	20.0 (0.79)
SA10P-N55S	2.25L8-A10P 5L16-A10P 10L16-A10P	55° SW	30 to 70	Normal	23.0 (0.91)	23.2 (0.91)	14.2 (0.56)
SAWS-0L	2.25L16-AWS	0° LW	−30 to 30	Normal	38.0 (1.49)	37.6 (1.48)	40.0 (1.57)
SAWS-N55S	2.25L16-AWS	55° SW	30 to 70	Normal	45.3 (1.78)	38.0 (1.49)	30.3 (1.19)

Table 41 EPOCH 1000*i* supported Wedges *(continued)*

Part	Matching probes	Nominal refracted beam angle (in steel)	Sweep (°)	Probe orientation	Dimensions in mm (in.) L × W × H		
SA12-0L	5L64-A12	0° LW	−30 to 30	Normal	61.8 (2.43)	23.0 (0.91)	53.4 (2.1)
SA12-N55S	5L64-A12	55° SW	30 to 70	Normal	58.0 (2.28)	23.0 (0.91)	23.0 (0.91)

Appendix A: Sound Velocities

Table 42 on page 497 lists the ultrasonic velocity in a variety of common materials. This is only a guide. The actual velocity in these materials might vary significantly due to a variety of causes, such as composition, preferred crystallographic orientation, porosity, and temperature. For maximum accuracy, establish the sound velocity in a given material by first testing a sample of the material.

Table 42 Ultrasonic velocities in a variety of common materials

Material	V (in./μs)	V (m/s)
Acrylic resin (Perspex)	0.107	2730
Aluminum	0.249	6320
Beryllium	0.508	12900
Brass, naval	0.174	4430
Copper	0.183	4660
Diamond	0.709	18000
Glycerin	0.076	1920
Inconel	0.229	5820
Iron, Cast (slow)	0.138	3500
Iron, Cast (fast)	0.220	5600
Iron oxide (magnetite)	0.232	5890
Lead	0.085	2160
Lucite	0.106	2680
Molybdenum	0.246	6250
Motor oil (SAE 20/30)	0.069	1740

Table 42 Ultrasonic velocities in a variety of common materials *(continued)*

Material	V (in./μs)	V (m/s)
Nickel, pure	0.222	5630
Polyamide (slow)	0.087	2200
Nylon, fast	0.102	2600
Polyethylene, high density (HDPE)	0.097	2460
Polyethylene, low density (LDPE)	0.082	2080
Polystyrene	0.092	2340
Polyvinyl chloride, (PVC, hard)	0.094	2395
Rubber (polybutadiene)	0.063	1610
Silicon	0.379	9620
Silicone	0.058	1485
Steel, 1020	0.232	5890
Steel, 4340	0.230	5850
Steel, 302 austenitic stainless	0.223	5660
Steel, 347 austenitic stainless	0.226	5740
Tin	0.131	3320
Titanium, Ti 150A	0.240	6100
Tungsten	0.204	5180
Water (20 °C)	0.0580	1480
Zinc	0.164	4170
Zirconium	0.183	4650

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Appendix B: Glossary

Table 43 Glossary

Term	Definition
Acoustic impedance	A material property defined as the product of sound velocity (C) and the material's density (d).
Acoustic interface	The boundary between two media of different acoustic impedance.
Acoustic zero	The point on the data display that represents the entry surface of the specimen.
Amplifier	An electronic device that increases the strength of a signal fed into it by obtaining power from a source other than the input signal.
Amplitude	Referring to an indication on the data display, the vertical height of an indication measured from the lowest to the highest point on the indication.
Angle beam transducer	A transducer that transmits or receives the acoustic energy at an angle to the surface to set up shear waves or surface waves in the part being inspected.
A-scan	Pulse-echo format wherein the data display shows the pulse travel time in the horizontal direction (left to right) representing the corresponding sound paths. The vertical direction (bottom to top) displays the maximum value of the acoustic pressure echo amplitude received by the probe.

Table 43 Glossary *(continued)*

Term	Definition
Attenuation	The loss in acoustic energy that occurs between any two points of travel. This loss may be caused by absorption, reflection, scattering, and other phenomena.
Back or back wall echo	The echo received from the side of the specimen opposite the side to which the transducer is coupled. This echo represents the thickness of the specimen at that point.
Background noise	Extraneous signals caused by sources within the ultrasonic testing system and the material being tested.
Beam-index point (BIP)	For an angle beam probe, the point where the sound leaves the wedge and enters the specimen.
Cal. block velocity	Material sound velocity for the calibration block.
Couplant	A material (usually a liquid or gel) used between the transducer and the test specimen to eliminate air from this space and thus facilitate the passage of sound waves into and out of the specimen.
Critical defect	Either the largest tolerable defect or the smallest intolerable defect. The critical defect size is usually given by a specification or code.
Cross talk	An unwanted condition affecting dual element transducers in which acoustic energy travels from the transmitting crystal to the receiving crystal by routes other than the intended path through the material.
Damping (control)	A variable resistance across the pulser circuit output which shapes the excitation pulse. Typically it is used to change pulse characteristics to optimize either penetration (low damping) or near-surface resolution (high damping).
Damping material	Any gel, rubber-like substance, or other material that when used in the transducer results in a shorter ringing time of the piezoelectric crystal.

Table 43 Glossary *(continued)*

Term	Definition
Decibel (dB)	A unit which compares levels of power. Two power levels P1 and P2, are said to differ by n decibels when: $$n = 10 \log_{10}\left(\frac{P_2}{P_1}\right)$$ This unit is often used to express sound intensities. In this case, P2 is the intensity of the sound under consideration and P1 is the intensity the reference level.
Delay control	Subcircuit of the sweep generator that allows a variably adjustable time period from the sending of the trigger pulse to the start of the sweep across the data display.
Detectability	The ability of a test system (instrument and transducer) to detect or "see" a given size reflector. This is also known as "sensitivity."
Distance amplitude correction (DAC)	A method of flaw evaluation that uses a test block with a known size reflector at varying known distances from the transducer. This allows you to plot a curve on the data display that represents the amplitude of that size reflector throughout a given distance range. This curve compensates for the loss of energy caused by beam spreading and attenuation.
Dual element probe	A probe containing two piezoelectric elements, one that transmits and one that receives.
Dynamic range	The ratio of maximum to minimum reflective areas that can be distinguished on the data display (usually based on decibel ratios).
First critical angle	The minimum incident angle in the first medium at which the refracted longitudinal wave is eliminated from the test specimen.
Flaw	A discontinuity that may be undesirable but does not necessarily call for rejection.

Table 43 Glossary *(continued)*

Term	Definition
Frequency	The number of complete cycles produced by an oscillating body.
Gain	Used in electronics with reference to an increase in signal power; usually expressed as the ratio of the output power to the input power in decibels.
Gate	An electronic baseline display used to electronically monitor portions of the displayed range with reference to distance or amplitude.
Hertz (Hz)	The derived unit of frequency defined as the frequency of a periodic phenomenon of which the period is one second; equal to one cycle per second. Symbol Hz 1 kilohertz (kHz) = 10^3 cycles per second 1 Megahertz (MHz) = 10^6 cycles per second
Immersion testing	A test method, useful for testing irregularly shaped parts, in which the part to be tested is immersed in water (or other liquid) so that the liquid acts as a couplant. The transducer is also immersed in the liquid, but not in contact with the part being tested.
Incidence, angle of	The angle between a sound beam striking an acoustic interface and the normal (that is, perpendicular) to the surface at that point. Usually designated by the Greek symbol α (alpha).
Indication	The signal displayed on the data display signifying the presence of a sound wave reflector in the part being tested.
Indication (defect) level	The number of decibels of calibrated gain that must be set on the instrument to bring the indication (defect) echo signal to peak at the reference line on the screen.
Initial pulse (IP)	The pulse of electrical energy sent by the pulser to the transducer.

Table 43 Glossary *(continued)*

Term	Definition
Leg	In angle beam testing, the path the shear wave travels in a straight line before being reflected by the opposite surface of the material being tested.
Linearity, vertical, or amplitude	The characteristics of an ultrasonic test system indicating its ability to respond in a proportional manner to a range of echo amplitudes produced by specified reflectors.
Linearity, horizontal, or distance	The characteristics of an ultrasonic test system indicating its ability to respond in a proportional manner to the time at which echo signals produced by specified reflectors appear.
LOS	Acronym for loss of signal.
Longitudinal wave	Mode of wave propagation characterized by particle movement parallel to the direction of wave travel.
Main bang	Term used to describe the initial pulse voltage.
Mode conversion	Changing a portion of sound beam energy into a wave of a different mode due to refraction at incident angles other than zero degrees. In NDT, this usually involves conversion of longitudinal waves into shear waves or surface waves.
Peaking up	Maximizing the height of any indication displayed on the data display by positioning the main axis of the sound beam directly over the reflector.
Penetration	The ability of the test system to overcome loss in acoustic energy due to the material; that is, the ability of the sound beam to by-pass small reflectors such as grain boundaries and porosity in the specimen.

Table 43 Glossary *(continued)*

Term	Definition
Piezoelectric elements	A family of materials (such as lead metaniobate, quartz, lithium sulfate) that possess the characteristic ability to produce: a) A voltage differential across their faces when deformed by an externally applied mechanical force; and, b) A change in their own physical configuration (dimensions) when an external voltage is applied to them.
Probe	A probe containing only multiple piezoelectric elements, which is used to both transmit and receive sound.
Pulse repetition rate or pulse repetition frequency (PRF)	The frequency with which the clock circuit sends its trigger pulses to the sweep generator and the transmitter, usually quoted in terms of pulses per second (PPS).
Range	The distance represented by the entire horizontal data display.
Receiver	The circuit of a flaw detector that receives both the initial pulse voltage from the transmitter and the returning echoes (as voltages) from the transducer. By passing these incoming signals through certain subcircuits, the signals are rectified, filtered, and amplified with the results sent to the screen for display.
Reference echo	The echo from a reference-reflector.
Reference level	The number of decibels of calibrated gain that must be set on the instrument to bring the reference-reflector signal to peak at the reference line on the data display.
Reference line	A predetermined horizontal line (usually dictated by specifications) on the data display representing some percentage of total data display height, at which reference echoes and indication echoes are compared.
Reference-reflector	A reflector of known size (geometry) at a known distance, such as a flat-bottom hole.

Table 43 Glossary *(continued)*

Term	Definition
Refraction, angle of	The angle of sound reflection in the wedge that is equal to the angle of incidence (also in the wedge.) The angle of reflectance is measured from the normal to the reflected sound beam.
Registration level?	The minimum detectable flaw size.
Reject (control)	Also known as suppression, this limits the input sensitivity of the amplifier in the receiver. “Grass” or scattering noise can be reduced or eliminated from the data display by its use. On most analog instruments it also destroys the vertical linearity relationship between echo heights.
Resolution	The ability of the test system (instrument and transducer) to distinguish reflectors at slightly different depths.
Scanning level	The number of decibels of calibrated gain above the reference level that are added to ensure seeing potentially significant reflectors at the end of the V-path in a weld inspection.
Second critical angle	The minimum incident angle in the first medium at which the refracted shear wave leaves the body of the test specimen.
Sensitivity	The ability of the test system (instrument and transducer) to detect a given size reflector at a given distance.
Signal-to-noise ratio	The ratio of amplitudes from the smallest defect considered significant and those caused by random factors, such as grain scattering or instrument noise.
Skip-distance	In angle beam testing, the surface distance that represents one V-path of sound in the material.
Sound beam	The characteristic shape of the ultrasonic wave sent into the material.

Table 43 Glossary *(continued)*

Term	Definition
Sound path distance	The distance from the transducer beam index point to the reflector located in the specimen, measured along the actual path that the sound travels. Sometimes referred to as angular distance in angle beam testing.
Straight beam probe (Normal beam probe)	A probe which transmits the sound into the material perpendicular to the entry surface.
Surface wave	Mode of wave propagation characterized by an elliptical movement of the particles (molecules) on the surface of the specimen as the wave front moves forward, this movement penetrating the specimen to a depth of one wavelength.
Through transmission	A test method in which the vibrations emitted by one transducer are directed toward, and received by, another transducer. The ratio between quantity of vibration sent and received is a measure of the integrity, or quality of the material being tested.
Time-varied gain (TVG)	Circuit that automatically adjusts the gain so that the echo amplitude of a given size reflector is displayed at a constant data display height regardless of the distance to that given size reflector.
Transducer	A probe containing only one piezoelectric element, which is used to both transmit and receive sound.
Transmitter	Circuit of the flaw detector that sends the initial pulse voltage to both the transducer and receiver.
Ultrasonic	Of or relating to frequencies above the human audible range; for example, above 20 000 cycles/s (20 kHz).
V-path	The angular distance sound travels, measured from the top surface of the material to the bottom, and reflecting back up to the top surface.
Vertical B	The larger length (if rectangular) of the actual crystal. The software computes the “effective length” automatically.

Table 43 Glossary *(continued)*

Term	Definition
Wavelength	The distance between similar points on successive wave fronts; such as the distance between any two successive particles of the oscillating medium that are in the same phase. It is denoted by the Greek letter λ (lambda).

Appendix C: Parts List

Table 44 EPOCH 1000 Series ultrasonic flaw detector

Part	Description
EP1000I-B-UEE-L	EPOCH 1000 flaw detector with BNC connectors, HW I/O, US power supply, English keypad, and large transport case option

Table 45 Items included with the EPOCH 1000 Series (spares can be purchased)

Part	Description
EPXT-BAT-L	Lithium-ion battery
EP-MCA-X	Charger/adaptor (“X”= power cord configuration)
910-269	EPOCH 1000 Series User’s Manual (910-269-EN)
EP1000-TC-S	Heavy-duty transport case, small version, hand-held
EP1000-TC-L	Heavy-duty transport case, large style with two wheels and handle

Table 46 Instrument software options

Part	Description
EP1000-IG	EPOCH 1000 interface gate software
EP1000-FG	EPOCH 1000 floating gate software

Table 46 Instrument software options *(continued)*

Part	Description
EP1000-BSCAN	EPOCH 1000 conventional UT encoded B-scan software
EP1000I-ECSCAN	EPOCH 1000*i* linear scan and encoded C-scan software

Table 47 GageView PRO interface program and accessories

Part	Description
GAGEVIEW-PRO-KIT-USB	GageView PRO interface program
GAGEVIEW-PRO	GageView PRO interface program (software only)

Table 48 Optional hardware accessories

Part	Description
EP4P-C-USB-6	USB client cable
EPXT-EC	External stand-alone battery charger
EP4-CH	Chest harness
EPXT-C-VGA-6	VGA output cable
EP1000-C-RS232-6	RS-232 communications cable
EP1000-C-HWIO-6	Hardware I/O cable for analog/alarm outputs and RS-232 communication

Table 49 Spare parts

Part	Qty.	Description
EP1000-DP	Package of 10	Clear plastic protecting sheets for the EPOCH 1000 display window

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