OLYMPUS®

EPOCH 1000 Series
User's Manual

910-269-EN — Revision B

June 2011

This document was prepared with particular attention to usage to ensure the accuracy of the information contained therein. It 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.

Table of Contents

List of Abbreviations

AC	alternating current	MEM	memory
AVG	average voltage gain	NDT	non-destructive testing
AWS	American Welding Society	OS	overshoot
BIP	beam index point	P/R	pulser/receiver
BYP	bypass	PA	phased array
CAL	calibration	PCL	printer control language
CSC	curved surface correction	PK	peak
DAC	distance amplitude correction	PN	part number
DC	direct current	PRF	pulse repetition frequency
DGS	distance gain size	R	receive
EFUP	environmental friendly usage period	RoHS	restriction of hazardous substances
EMC	electromagnetic compatibility	SDH	side-drilled hole
EN	English	T/R	transmit/receive
ESC	escape	TRIG	trigonometry
FBH	flat-bottom hole	TVG	time-varied gain
FSH	full-screen height	USB	universal serial bus
ID	identifier	UT	ultrasonic technology
IF	interface gate	VAC	volts alternating current
IIW	International Institute of Welding	VGA	video graphics adapter
IP	ingress protection	WEEE	waste electrical and electronics equipment
LCD	liquid crystal display		

Labels and Symbols

A rating plate with safety-related labels and symbols is attached under the instrument at the location shown in the following figure. If labels or symbols are missing or illegible, please contact Olympus.

Location of rating plate label
(see Table 1 on page 2)

LCD lamps contain mercury, Dispose of in accordance with Local, State or Federal Laws.(U.S.A.ONLY)

Table 1 Content of the rating plate label

Rating plate label:	
Contains:	
	The WEEE symbol indicates that the product must not be disposed of as unsorted municipal waste, but should be collected separately.
	The C-Tick label indicates that the product complies with the applicable standard and establishes a traceable link between the equipment and the manufacturer, importer or their agent responsible for compliance and for placing it on the Australian market.
	The China RoHS mark indicates the product's Environmental Friendly Usage 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 Series has been determined to be 15 years. **Note**: The Environmental Friendly Usage Period (EFUP) is not meant to be interpreted as the period assuring functionality and product performance.
	The direct current symbol
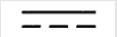
Table 1 Content of the rating plate label *(continued)*

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 the first unit (001) produced on the December 16, 2008.

⚠️　**DANGER**

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 the figure below indicates this electrical shock risk.

Warning symbol

BNC connector inner conductor
(LEMO 01 also available)

T/R   R
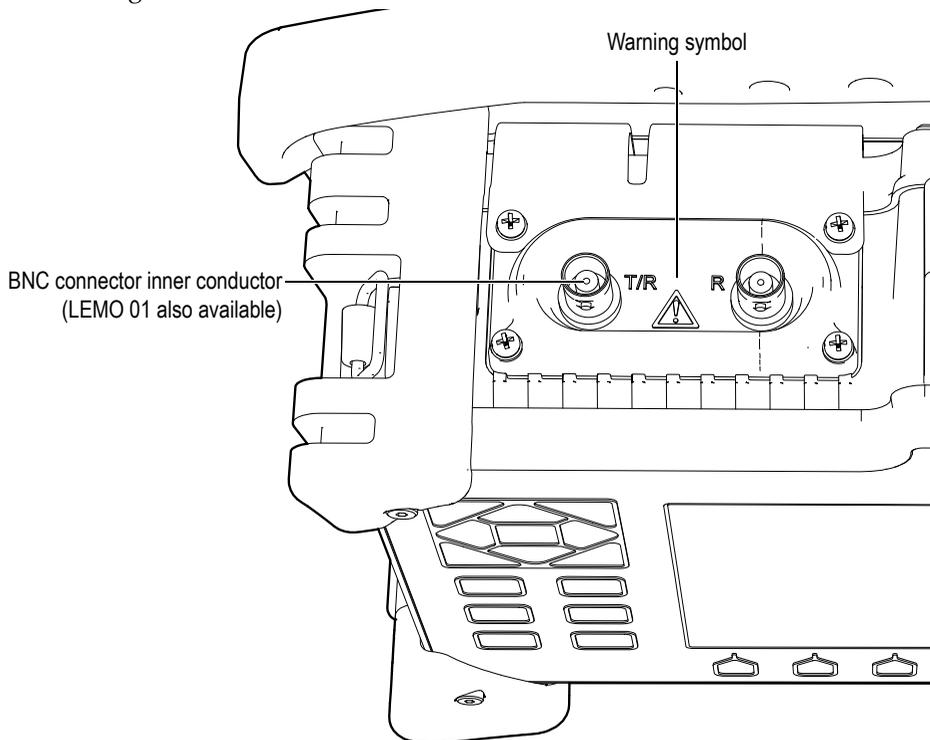
Important Information — Please Read Before Use

Intended Use

The EPOCH 1000 Series instruments are designed to perform nondestructive inspections of industrial and commercial materials.

⚠️ **DANGER**

Do not use the EPOCH 1000 Series instruments for any purpose other than their intended use. In particular, do not use the instruments for the inspection or examination of human or animal body parts.

Instruction Manual

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

Keep this instruction manual in a safe, accessible location.

Instrument Compatibility

Only use the EPOCH 1000 Series instrument 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

Using incompatible equipment can result in a malfunction and/or in equipment damage.

Repair and Modification

The EPOCH 1000 Series instruments do not contain any user-serviceable parts.

 CAUTION

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

Safety Symbols

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

 General warning symbol:

This symbol is used to alert you to potential hazards. All safety messages that follow this symbol shall be obeyed to avoid possible harm.

High voltage warning symbol:

This symbol is used to alert you to potential electric shock hazards higher than 1,000 volts. All safety messages that follow this symbol shall be obeyed to avoid possible harm.

Safety Signal Words

The following safety symbols may 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, could 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, could 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.

Notes Signal Words

The following safety symbols may 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 that 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 that provides hints on how to use effectively the capabilities of the product.

Safety

Before applying power to the EPOCH 1000 Series, verify that the correct safety precautions have been taken (see the following warnings.) In addition, note the external markings on the instrument that are described in the "Important Information — Please Read Before Use" section.

Warnings

⚠️ **General Warnings**

- Carefully read the instructions contained in the user's manual prior to powering on the instrument.
- Keep the user's 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 the user's 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 a dangerous electric shock, do not perform any service unless qualified to do so. For any problem or question regarding this apparatus, contact Olympus or an authorized Olympus representative.

WARNING

- Before powering on the instrument, you must connect the protective earth terminal of the instrument to the protective conductor of the (mains) power cord. The mains plug shall only be inserted in 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).
- Whenever it is likely that the ground protection is impaired, you must turn off the instrument and secure it against any unintended operation.
- The instrument must be connected only to a power source corresponding to the type indicated on the rating plate.

WEEE Directive

In accordance with European Directive 2002/96/EC 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 Environmental Friendly Usage 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 Series has been determined to be 15 years.
Note: The Environmental Friendly Usage Period (EFUP) is not meant to be interpreted as the period assuring functionality and product performance.

EMC Directive Compliance

FCC (USA) Compliance

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, may 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 period and with conditions specified in the *Olympus NDT 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 reception for evidence of external or internal damage that might have occurred during shipment. Notify the carrier making the delivery immediately of any damage, because the carrier is normally liable for damage in shipment. Preserve packing materials, waybills, and other shipping documentation in order to establish a damage claim. After notifying the carrier, contact Olympus for assistance with the damage claim and equipment replacement, if necessary.

This instruction manual attempts to teach 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 more 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 all products 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: www.olympus-ims.com.

Preface

The preface contains the following topics:

- Product Description
- EPOCH 1000 Series Models
- About This Document
- Audience
- Typographical Conventions
- If You Have Documentation Comments
- Revision History

Product Description

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

The EPOCH 1000/1000iR/1000i features many performance, durability, and operational enhancements when compared to previous EPOCH flaw detector instruments. These enhancements include:

- Case sealed to 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 1000/1000iR/1000i 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 1000iR 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 1000i Advanced UT + Phased Array Built-in

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

About This Document

This document is the user's manual for the EPOCH 1000/1000iR/1000i. 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 1000/1000iR/1000i
- Managing the data logger and data communication features
- Using software options

Audience

This document is intended for operators of the EPOCH 1000/1000iR/1000i. 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 1000/1000iR/1000i 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 16 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.
[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.

If You Have Documentation Comments

Olympus is always interested in improving its documentation. We value your comments about the manual and other Olympus documentation.

Complete the survey in section "Documentation Comments" on page 353 of this document.

Revision History

Publication dates are updated when a change is made to the documentation. In addition, the document number is also changed to reflect the revision. Table 3 on page 17 shows a list of revisions for this document.

Table 3 Revision history

Date	Part number	Release version
June 2011	910-269-EN	Revision B
February 2009	910-269-EN	Revision A

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.

This section covers the following topics:

- Hardware Overview
- Front Panel User Interface
- USB Keyboard and Mouse Control
- Connectors
- Various Hardware Features
- Environmental Ratings

1.1 Hardware Overview

Figure 1-1 on page 20 shows the EPOCH 1000 Series instrument and identifies its main components.
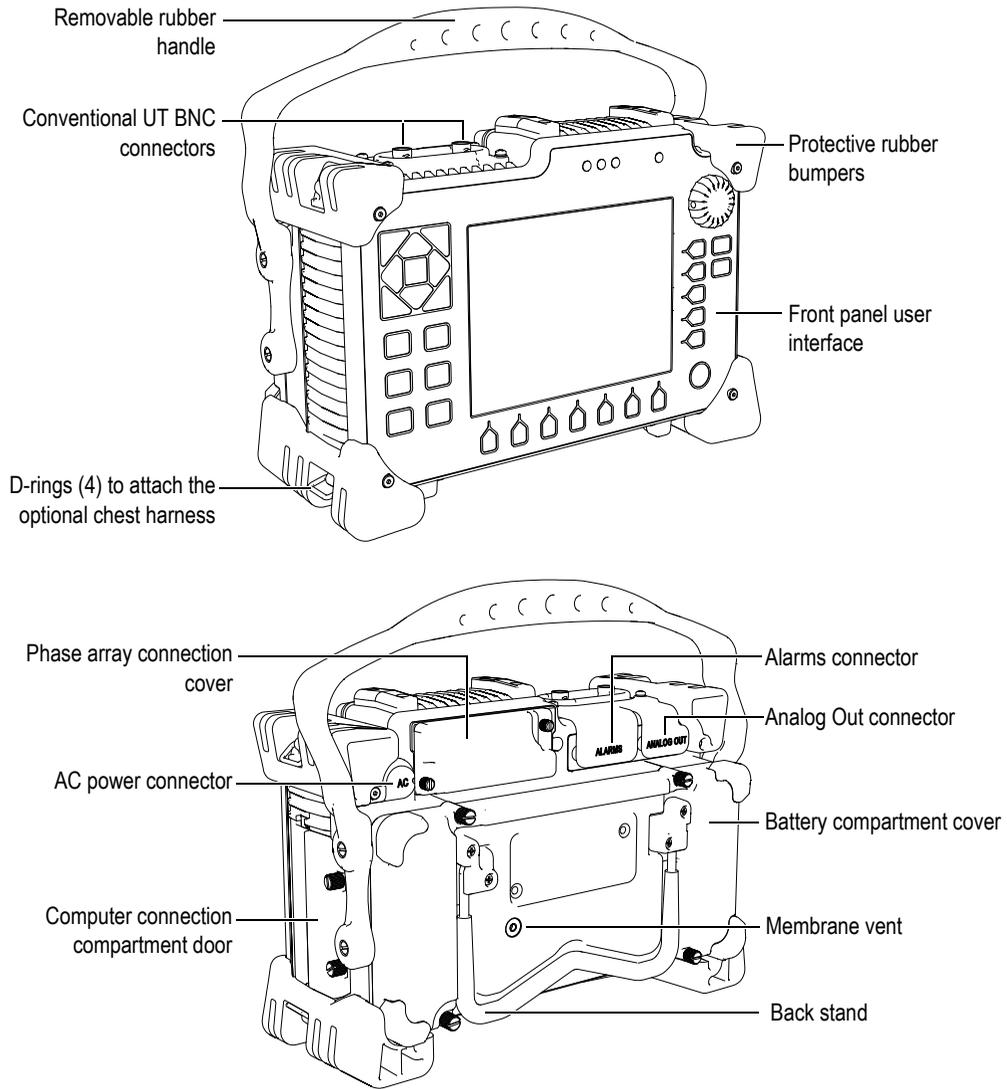
Figure 1-1 Overview of the EPOCH 1000i hardware

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, and 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.
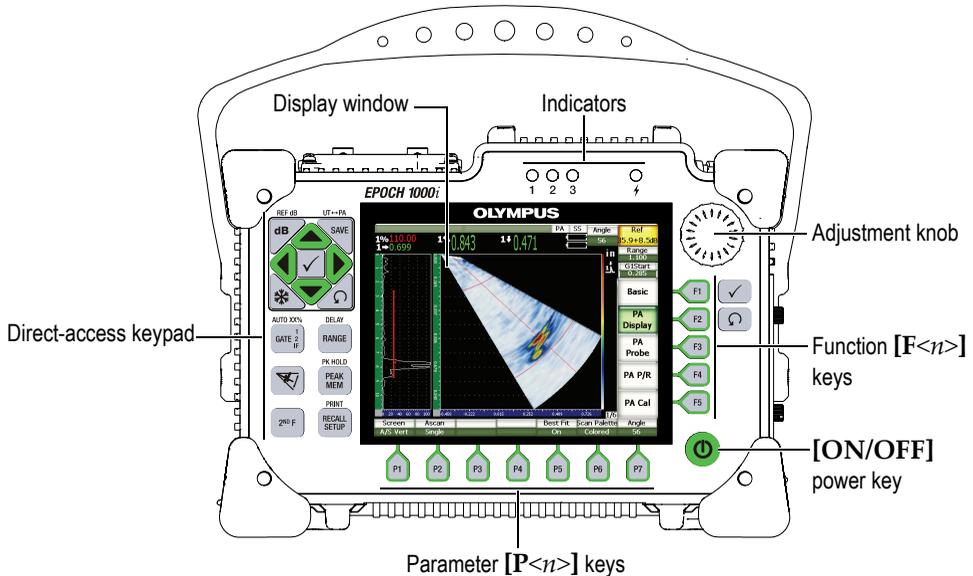
Figure 1-2 The EPOCH 1000i hardware user interface elements

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 1.2.4 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.
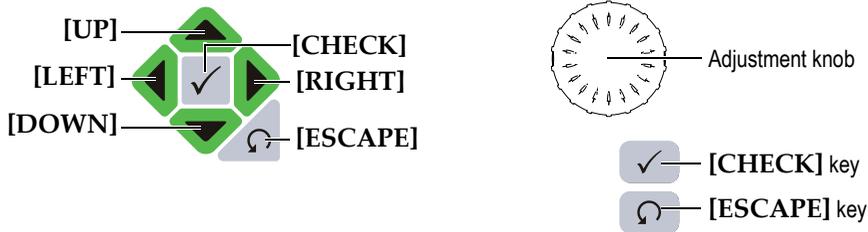
Figure 1-3 General purpose keys and knob

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

- When a submenu is highlighted, **[CHECK]** enters 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**).

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

The EPOCH 1000 Series handles adjustments and/or the activation of most software functions via an intuitive menu system. 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 **PA Display** software button and activates the corresponding function.
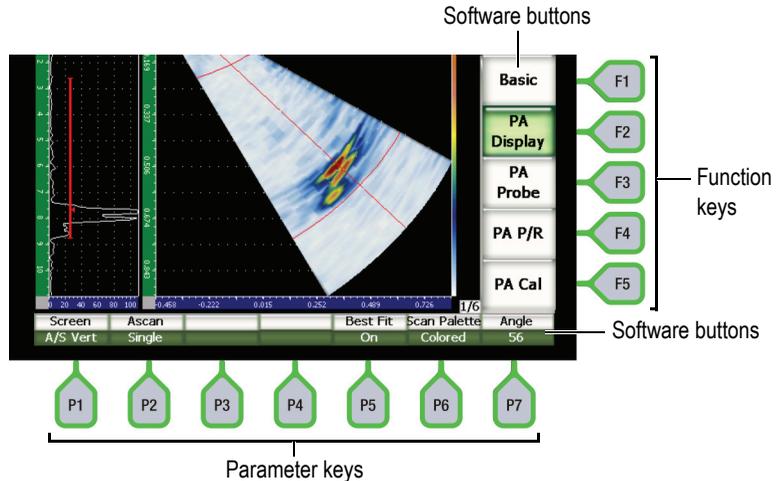
Figure 1-4 [F<*n*>] and [P<*n*>] keys pointing to software buttons

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 parameter values, 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 direct-access keypad. Figure 1-5 on page 25 shows the keypad in its EPOCH 1000iR and EPOCH 1000i configurations and provides indication of the differences for the EPOCH 1000 configuration. There are two differences between the direct-access keypad of conventional only versus conventional and phased array flaw detector models:

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

The direct-access keypad is available in English, Japanese, Chinese, and international versions.

REF dB   UT↔PA —— EPOCH 1000iR and EPOCH 1000i only

EPOCH 1000 only

EPOCH 1000iR and EPOCH 1000i only
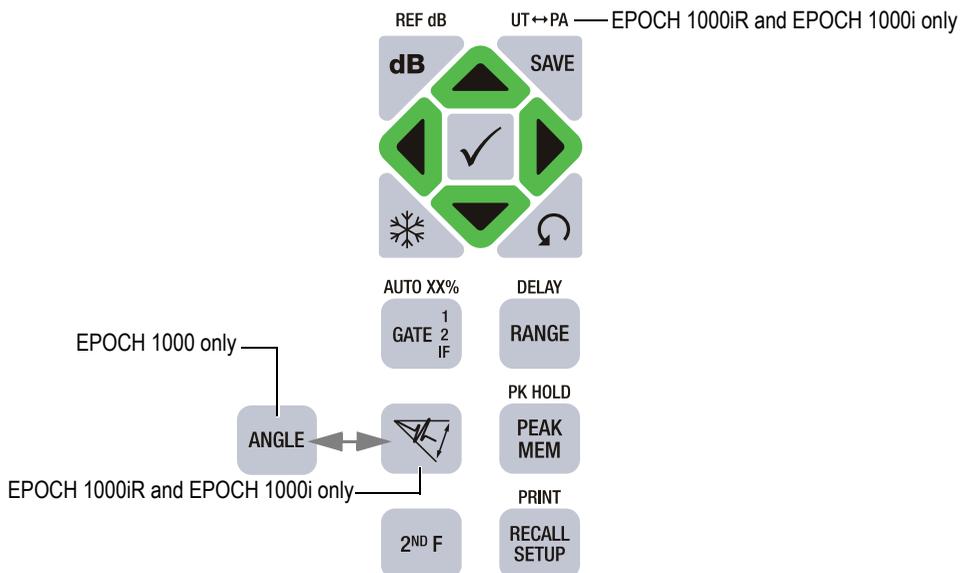
Figure 1-5 The English direct-access keypad with model differences

Table 4 on page 25 presents a description of each of the key for the English version of the keypad.

Table 4 English keypad key description

English	Function
REF dB **dB**	**[GAIN]**
	Adjusts system sensitivity.
	[2ⁿᵈ F], [GAIN] (REF dB) (EPOCH 1000i only)
	Locks the reference gain level and allows the scanning gain to be used.
UT↔PA **SAVE**	**[SAVE]**
	Saves to the selected File and ID.
	[2ⁿᵈ F], [SAVE] (UT-PA)
	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 4 English keypad key description *(continued)*

English	Function
AUTO XX% GATE 1 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 section 4.2 on page 90).
DELAY RANGE	**[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 1000i only) Allows adjustment of the current focal law (PA mode) or angle (UT mode)
ANGLE	**[ANGLE]** (EPOCH 1000 only) Allows adjustment of current angle.
PK HOLD PEAK MEM	**[PEAK MEM]** Activates the peak memory function (see section 5.2 on page 102).
	[2ⁿᵈ F], [PEAK MEM] (PK HOLD) Activates the peak hold function (see section 5.3 on page 104).
2ND F	**[2ⁿᵈ F]** Accesses the second function identified above the keypad keys when pressed and released.
PRINT RECALL SETUP	**[RECALL SETUP]** Allows access to quick calibration file recall (see section 10.3.5 on page 183).
	[2ⁿᵈ F], [RECALL SETUP] (PRINT) Prints reports to compatible printer connected to a USB port.

1.2.5 About Indicators

The EPOCH 1000 Series instruments provide one power and three alarm indicator lights (see Figure 1-6 on page 27). The indicators are located on the front panel above the display window (see Figure 1-2 on page 21).

Interface gate alarm indicator
Gate 2 alarm indicator
Gate 1 alarm indicator
1   2   3
Power indicator
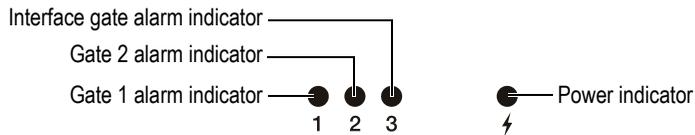
Figure 1-6 Front panel indicator lights

The alarm indicators illuminate in red when the corresponding gate alarm is triggered. Refer to section 6.9 on page 120 for information on gate alarms.

Refer to Table 6 on page 40 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 the EPOCH 1000 Series 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.

Some key control notes are as follows:

- The USB keyboard control allows 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

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

1.4.1   Conventional Transducer Connections

The 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 28).
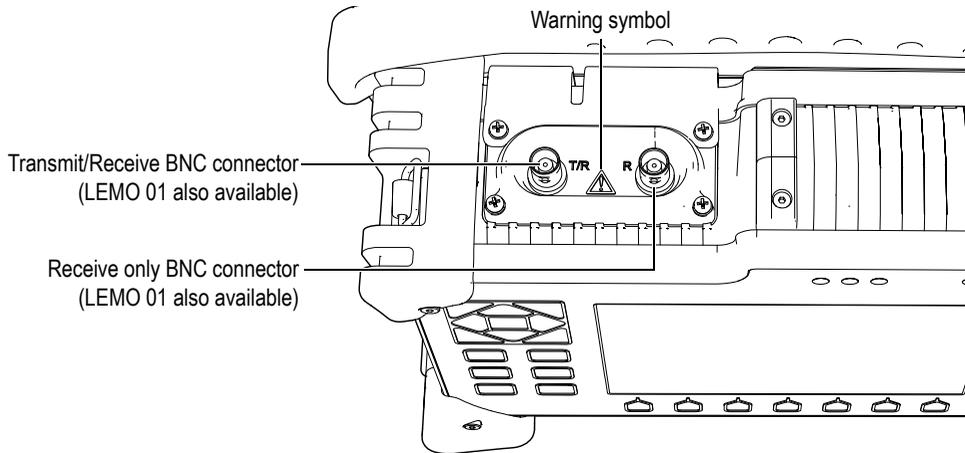
Figure 1-7 Location of the conventional transducer connectors

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.

⚠️ **DANGER**

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 28 indicates this electrical shock risk.

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

The EPOCH 1000iR and EPOCH 1000i come standard with one phased array transducer connector located at the back of the instrument (see Figure 1-8 on page 29).

This connector is also used with 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 19.4 on page 318 for specifications of compatible PA probes.
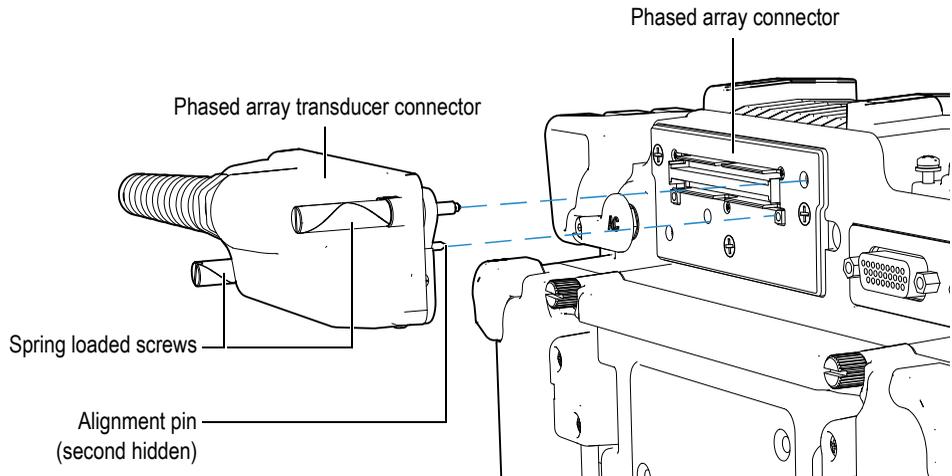
Figure 1-8 The connector for the phased array (PA) probe

The phased array transducer connector features two alignment pins to ensure proper connection to any phased array probe (see Figure 1-8 on page 29). 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.

To connect a phased array transducer

1. Align the two guide pins on the phased array transducer with the guide-pin holes on the instrument connector (see Figure 1-8 on page 29).
2. Securely fit the transducer onto the instrument connector.
3. Tighten both spring-loaded retention screws on the phased array transducer.

Phased Array Connection Cover

The phased array transducer connector is not sealed for environmental hazards. When a phased array transducer 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 1000iR and EPOCH 1000i include a protective cover to protect the phased array transducer connector when not in use. The protective cover includes a gasket for environmental seal, and attaches over the phased array transducer connector using two thumb screws (see Figure 1-9 on page 31).

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.

Thumb screws (2)

Protective cover over the phased array connector

Alternative location for the protective cover
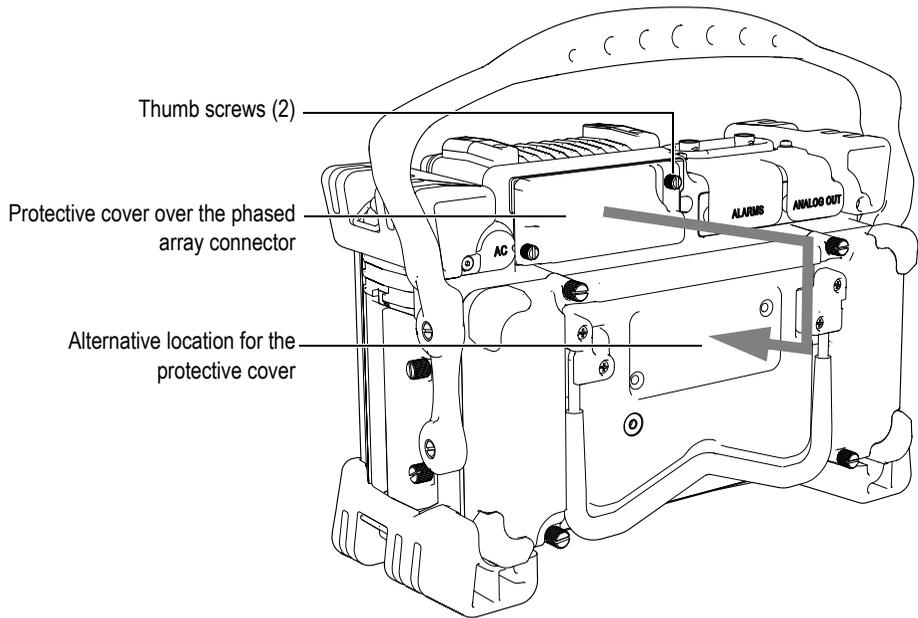
Figure 1-9 Phased array connection cover

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 32). A rubber cover protects each connector. The connectors provide analog outputs, digital alarm outputs, a digital input, and encoder outputs. Refer to section 19.3 on page 316 for the complete specifications of the supported I/O signals.
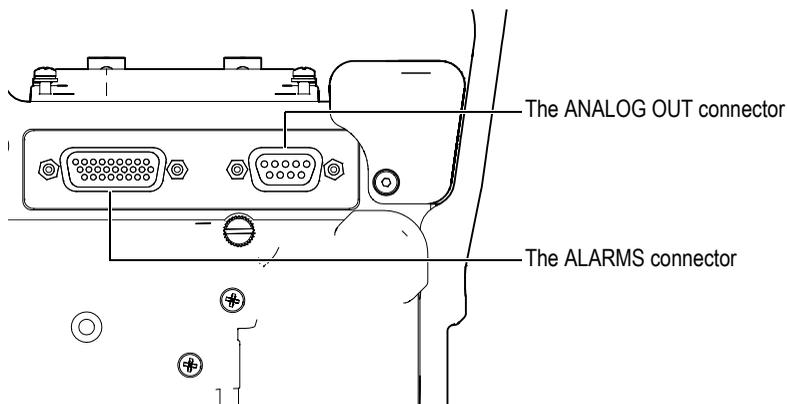
Figure 1-10 The ALARMS and ANALOG OUT connectors

![CAUTION]

⚠ CAUTION

Do not expose the instrument to harsh and wet environments while the ALARMS or the ANALOG OUT connectors are not protected by their rubber covers. To prevent connector corrosion and damage to the instrument, keep the rubber protective covers on the connectors when no cable is connected.

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.
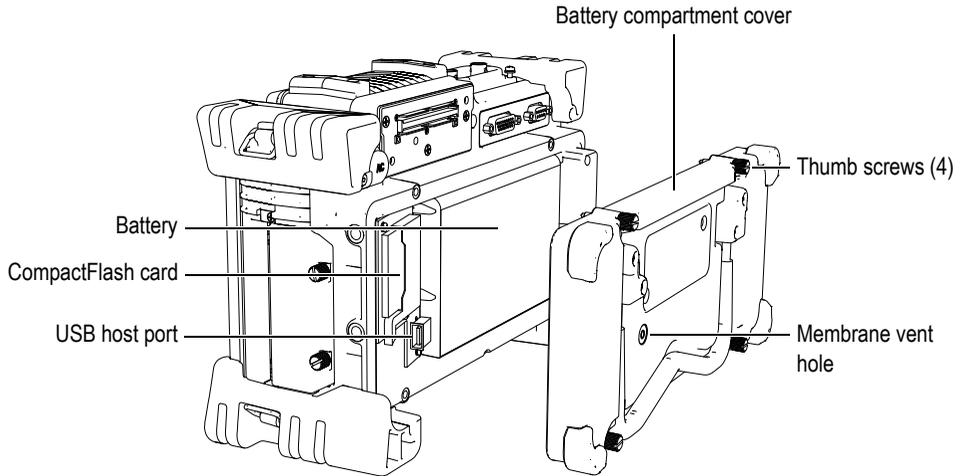
Figure 1-11 Battery compartment cover

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).

Also inside the battery compartment is an auxiliary USB host port and a CompactFlash card port. The EPOCH 1000 Series comes standard with a 2 GB capacity Compact Flash 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, a door covers the instruments' computer connection compartment (see Figure 1-12 on page 34). This door has an integral membrane seal to keep liquids away from the unsealed connections behind the door.

Table 5 on page 34 describes connectors available in the computer connection compartment.
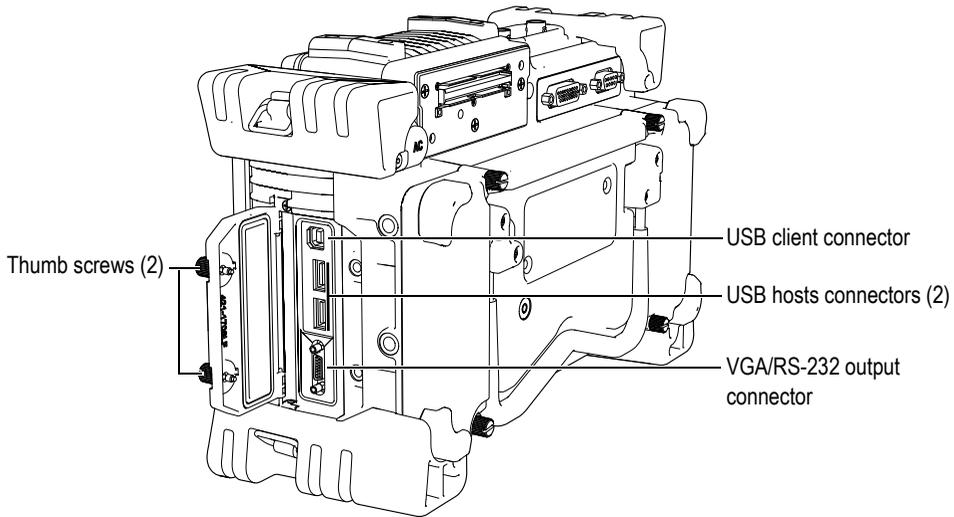
Figure 1-12 The connectors behind the computer connection compartment door

Table 5 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 section 3.5 on page 86 and section 8.5.1 on page 131).
USB hosts	2	Used to connect USB peripherals such as a printer, a keyboard, a mouse or a storage device (see section 8.5.2 on page 131).
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 section 8.1 on page 127). Used to establish an RS-232 communication link (see section 8.4 on page 131).

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 pipe stands for variable viewing angles (see Figure 1-13 on page 36). 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 pipe stand is located underneath the front of the instrument. This is a smaller pipe stand and allows for shallow viewing angles.

16°   Tilted on the bottom stand

47°   Tilted on the rear stand
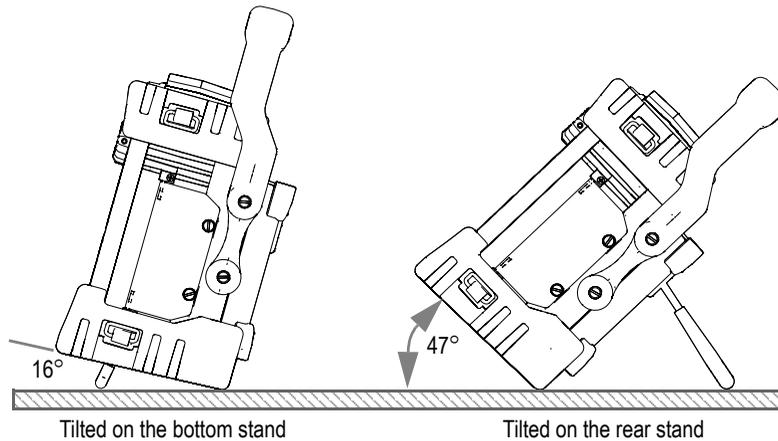
Figure 1-13 Tilting angles using the bottom and rear stands

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 24 on page 312.

2. Powering the EPOCH 1000 Series

This chapter describes how to operate the EPOCH 1000 Series using different power supply options. The topics are as follows:

- Starting the EPOCH 1000 Series
- Using the AC Line Power
- Using Battery Power
- Charging the Battery
- Replacing the Battery

2.1 Starting the EPOCH 1000 Series

Figure 2-1 on page 40 shows the location of the power key and of the power indicator.
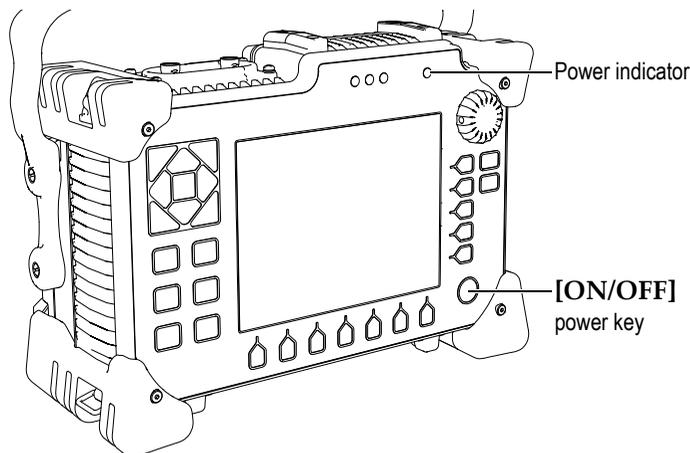
Figure 2-1 Location of the EPOCH 1000 power key and indicator

Pressing the **[ON/OFF]** power key causes an initial beep. The instrument's startup screen appears. The instrument then goes through a series of self-tests for 45 to 60 seconds and then starts up. The power indicator and the battery indicator provide basic feedback regarding the operating/charging status of the instrument (see Table 6 on page 40).

Table 6 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%

When a phased array probe is connected to the EPOCH 1000 Series, the instrument automatically detects it and completes the startup process by opening the **Beam** setup page, allowing you to validate probe parameters (see Figure 2-2 on page 41). Refer to section 12.2 on page 240 for details on the **Beam** setup page. Press **[ESCAPE]** to save and close the **Beam** setup page.

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

2.2   Using the AC Line Power

AC line power is supplied to the EPOCH 1000 Series instrument via the charger/adaptor (PN: EP-MCA). The EP-MCA has a universal AC power input, so it operates with any line voltage from 100–120 VAC or 200–240 VAC and with 50 Hz to 60 Hz line frequency. The charger/adaptor output connects to the AC adaptor plug of the EPOCH 1000 Series instrument (see Figure 2-3 on page 42).
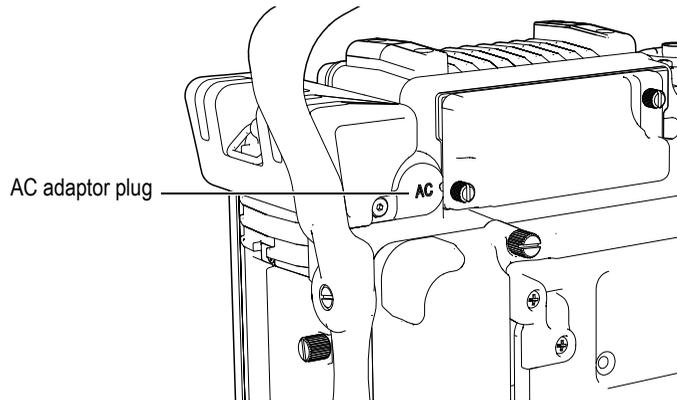
Figure 2-3 The AC adaptor plug

To use AC line power

1. Connect the power cord to the charger/adaptor unit and to an appropriate line power source.

![CAUTION symbol] **CAUTION**

Use only the AC power cord supplied with the EPOCH 1000 Series instrument. Do not use this AC power cord with other products.

---

2. Remove the rubber seal over the AC adaptor port on the back of the EPOCH 1000 Series instrument.
3. Connect the DC output power cable from the charger/adaptor to the AC adaptor input jack (see Figure 2-3 on page 42).
4. Turn on the EPOCH 1000 Series by pressing the front panel power key (see Figure 2-1 on page 40).

   The front panel power indicator activates (see Figure 2-1 on page 40).

2.3 Using Battery Power

The EPOCH 1000 Series operates with its standard rechargeable lithium-ion (Li-ion) battery (PN: EPXT-BAT-L).

<div align="center">⚠️</div>

WARNING

Only use the Olympus rechargeable Li-ion battery pack (PN: EPXT-BAT-L) 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.

A battery charge indicator is always present near the top right of the active instrument display (see Figure 2-4 on page 43). 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.

Battery charge indicator
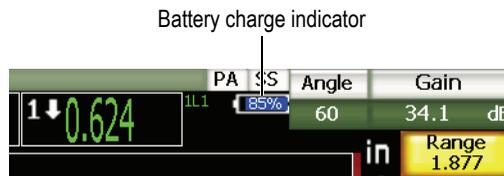
Figure 2-4 The battery charge indicator

Battery Operating Time

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.

2.4 Charging the Battery

> ⚠️ **WARNING**
>
> Only use the Olympus rechargeable Li-ion battery pack (PN: EPXT-BAT-L) 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.

The EPOCH 1000 Series battery can be charged internally using the EP-MCA charger/adaptor or externally using the optional standalone battery charger (PN: 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**
>
> • 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.

When the EPOCH 1000 Series is connected to AC power and powered ON, the battery indicator displays a lightning bolt symbol instead of the standard level indicator with percentage showing remaining battery life.

To charge the battery internally

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 charges when the instrument is On or Off, but the rate of charge is slower when the instrument is On. Refer to Table 6 on page 40 for power indicator meanings.

Battery Usage Instructions

By nature, unused batteries slowly discharge. A fully discharged battery will not recharge. Follow the instructions 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 (2) months.
- Never place partially discharged batteries in storage without a full recharge.

2.5   Replacing the Battery

The battery is located in a compartment that is accessible from the back of the EPOCH 1000 Series (see Figure 2-5 on page 46).
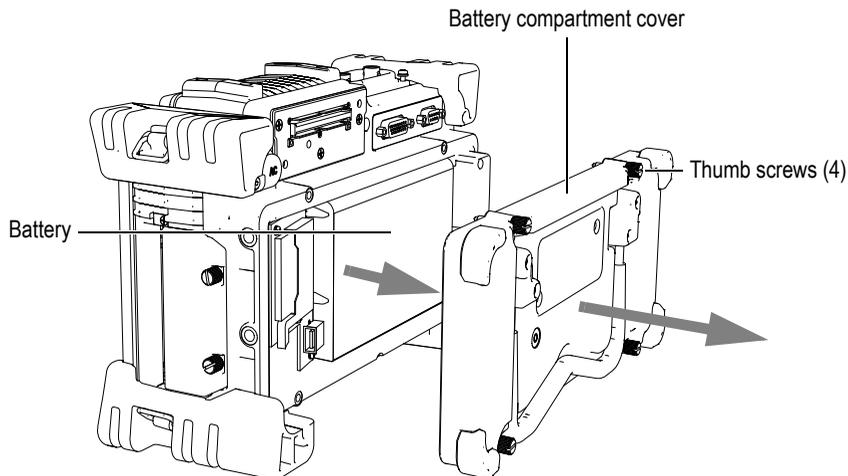
Figure 2-5 Opening the battery compartment

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 46).
3. Remove the battery compartment cover.
4. Remove the battery (EPXT-BAR-L).

![Warning triangle icon] **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 as the result of the explosion while charging the battery.

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. Topics are as follows:

- Software Main Display
- Menu Contents
- About Setup Pages
- Basic Procedures
- Managing Data with GageView Pro Interface Program

3.1 Software Main Display

The EPOCH 1000 Series software main display elements are exploded in Figure 3-1 on page 50. The following sections describe each of the main display elements.
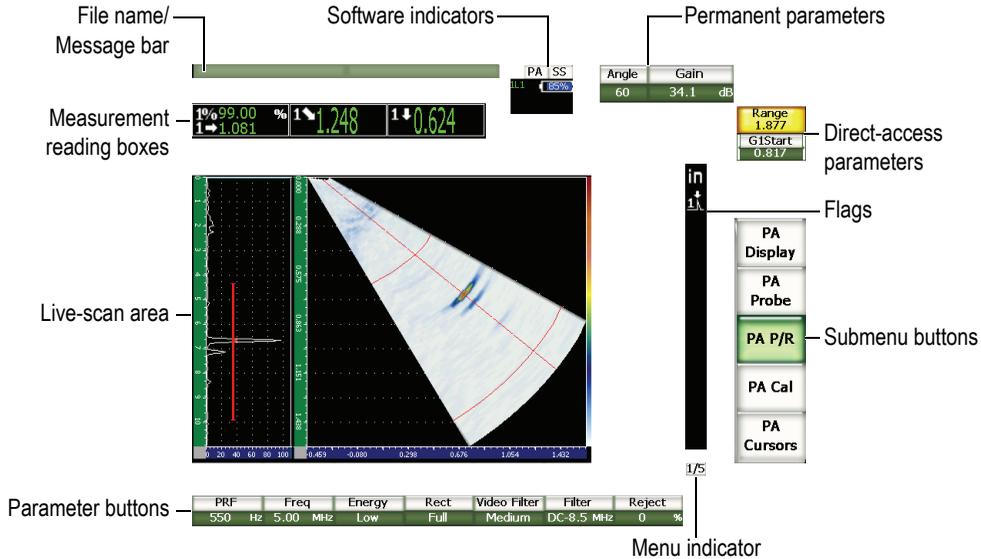
Figure 3-1 Exploded view of the software main display elements

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 51). 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.
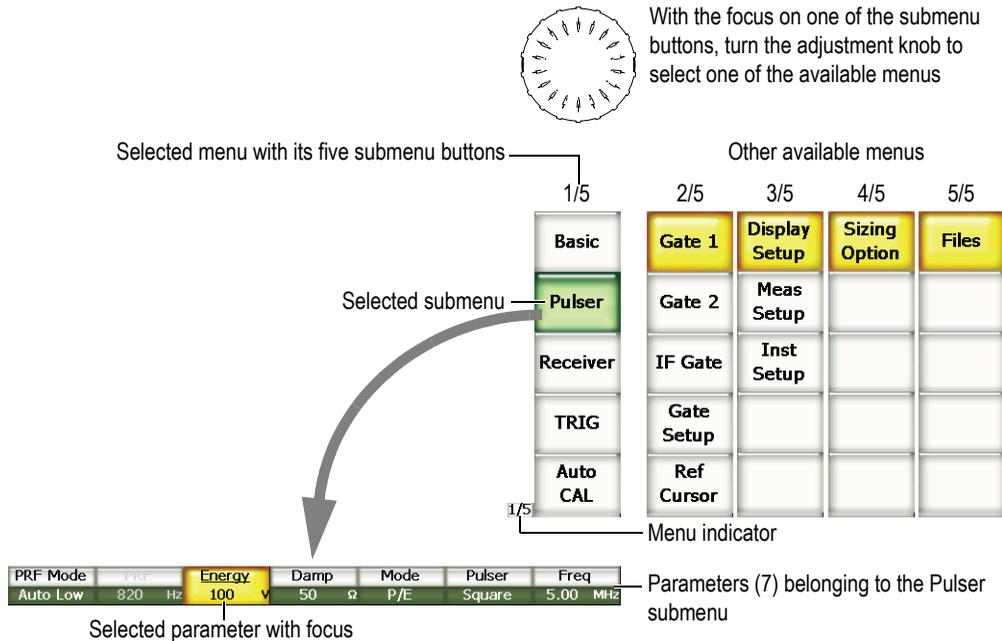
Figure 3-2 Overview of the menu system in UT operation mode

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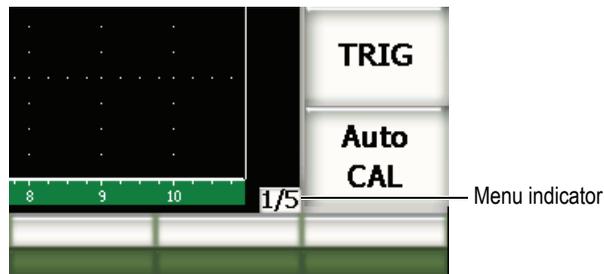
Figure 3-3 The menu indicator (1/5)

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 3.2 on page 61 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:

Menu > Submenu > Parameter = value

where:

> *Menu* is replaced by the value of the menu indicator (ex.: **3/5**)

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

> *Parameter* is replaced by the label of the parameter (ex.: **Unit**)

> *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 53 is used.
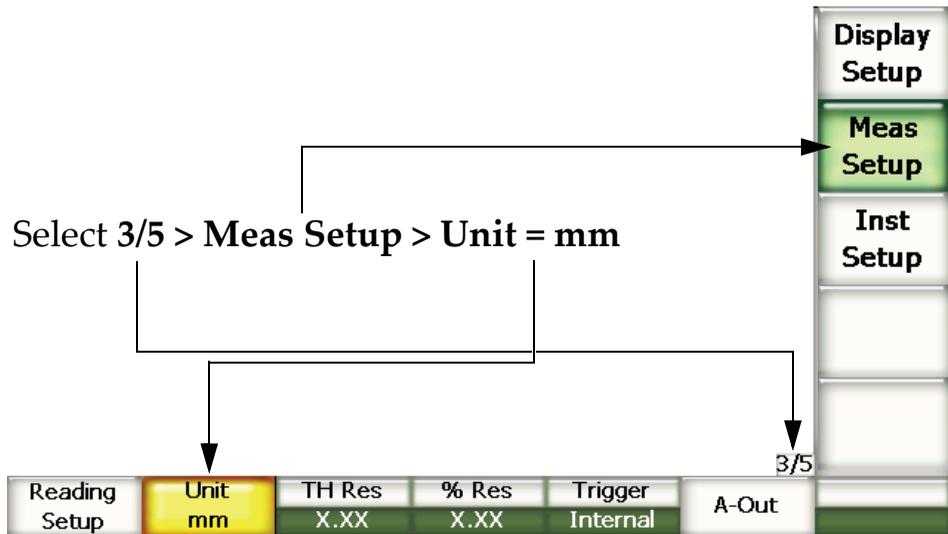
Figure 3-4 Concise convention to identify menu elements

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

Choose **2/5 > Gate 1 > Width**.

NOTE

Activating an optional feature that introduces another menu increases the total number of menus shown by the menu indicator (Ex.: **1/5** becomes **1/6**).

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 54).
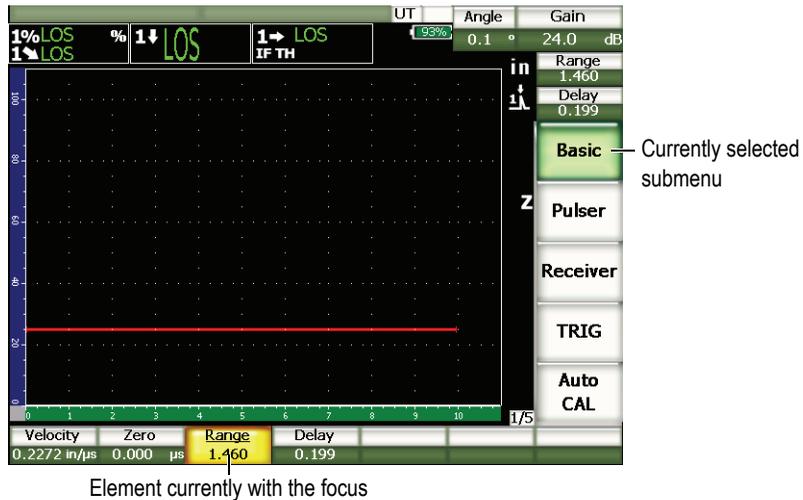
Figure 3-5 The focus is on the element appearing yellow

3.1.4   About Button Types

Table 7 on page 54 presents the various types of buttons found in the EPOCH 1000 Series interface.

Table 7 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.

Table 7 Button types *(continued)*

Type	Example	Description
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.
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 opened data file, together with its current identifier (ID) [see example in Figure 3-6 on page 55].

File name ———┐   ┌——— Current identifier

Th_data2   V202-RM1

Figure 3-6 Message bar with a file name example

The EPOCH 1000 Series text messages also appear in the bar as needed, following your actions (see example in Figure 3-7 on page 55).

Please Wait...

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 56). Table 8 on page 56 describes the various indicators that appear or may appear in the area.

Operation mode indicator ——┐   ┌—— Scan type indicator
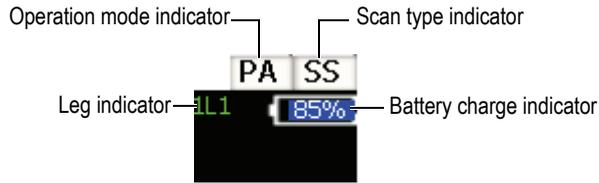
Figure 3-8 Example of software indicators

Table 8 Software indicators

Indicator	Icon	Description
Operation mode	PA	Instrument in phased array mode
	UT	Instrument in conventional UT mode
Scan type	SS	S-scan sector scan
Battery charge	85%	Indication (%) of the remaining battery charge
Leg indicator	1L1	Indicates leg of gated signal for gates 1, 2 and/or IF gate in the format <gate>L<leg #>

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 2-5 on page 46). 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.
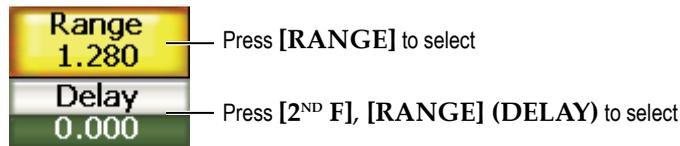
Figure 3-10 Example of the Range and Delay direct-access parameters

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). Refer to section 3.3.3 on page 71 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). In PA operation mode, different views are available (refer to
section 14.1 on page 253 for details).
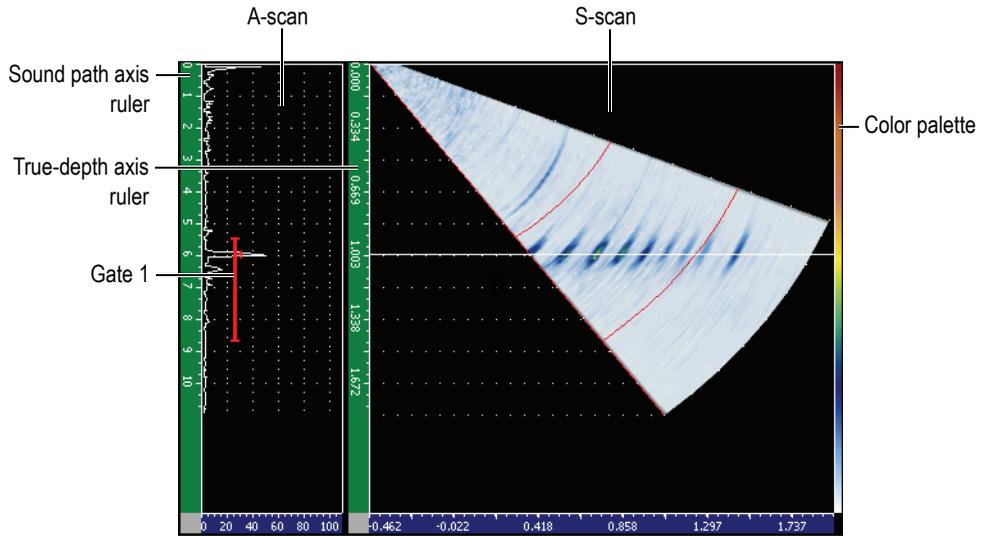
Figure 3-12 Example the live-scan area in A/S Vert mode

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 (see Figure 3-13 on page 59). Table 9 on page 59 provides a description of the possible flags.

Figure 3-13 The area displaying flags

Table 9 Flag description

Flag	Description
in	Length units are inches
mm	Length units are millimeters

Table 9 Flag description *(continued)*

Flag	Description
⬆	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.
1	Gate 1 is in edge (or flank) measurement mode.
2	Gate 2 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.
A A¹₂ 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.
AVG	AVG is active.
AWS	AWS D1.1/D1.5 is active.
CAL	Calibration is active.
CAL (locked)	Access to **Gain**, **Auto CAL**, **PA Cal**, **CAL Zero**, **Velocity**, **Angle**, **Pulser**, **Receiver**, and **PA P/R** is locked (see section 3.3.4 on page 76).
CSC	Curved surface correction (CSC) is active.
DAC	DAC/TVG is active.

Table 9 Flag description *(continued)*

Flag	Description
DGS	DGS is active.
E—E	Echo-to-echo measurement is active (see section 6.6 on page 116).
F	Display **[FREEZE]** is active.
OS	Overshoot
P	**[PEAK MEM]** is active.
P_H	**[2ND F]**, **[PEAK MEM] (PK HOLD)** reference echo is active.
R	The recall freeze is active. Press **[MEAS/RESET]** to deactivate.
RZ	The recall zoom is active.
Z	The zoom is active.
[⚡]	Indicates that the instrument is connected to the AC line power.
🔒	Access to all instrument function keys except **[ON/OFF]** is locked (see section 3.3.4 on page 76).

3.2   Menu Contents

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

3.2.1 Conventional UT Mode Menus

The EPOCH 1000 Series conventional UT mode includes five standard menus shown in Table 10 on page 62.

Table 10 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		
	Receiver	IF Gate	Inst Setup		
	TRIG	Gate Setup			
	Auto CAL	Ref Cursor			

Table 11 on page 62 to Table 15 on page 63 provide a quick reference of available submenu and parameter buttons for each conventional UT mode menu.

Table 11 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 12 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				
Ref Cursor	Cursor A	Cursor A	Cursor B	Cursor B			

Table 13 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				

Table 14 Content of the 4/5 standard menu in UT mode

Submenu	Parameters						
Sizing Option	DAC/TVG	DGS	AWS D1.1				

Table 15 Content of the 5/5 standard menu in UT mode

Submenu	Parameters						
Files	Open	Create	Reset	Page Setup	First ID	Last ID	Id:

3.2.2   Phased Array Mode Menus

The EPOCH 1000 Series phased array mode includes five standard menus shown in
Table 16 on page 64. Many of these menus are identical to their corresponding
conventional UT mode menus.

Table 16 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		
	PA P/R	IF Gate	Inst Setup		
	PA Cal	Gate Setup			
	PA Cursors	Ref Cursor			

Table 17 on page 65 to Table 21 on page 66 provide a quick reference of available
submenu and parameter buttons for each PA mode menu.

Table 17 Content of the 1/5 standard menu in PA mode

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

Table 18 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
IF Gate	Zoom	Start	Width	Level	Alarm	Alarm	Status
Gate Setup	Setup	G1 Tracks	G2 Tracks				
Ref Cursor	Cursor A	Cursor A	Cursor B	Cursor B			

Table 19 Content of the 3/5 standard menu in PA mode

Submenu	Parameters						
Display Setup	Color Setup	A-Scan Setup	VGA	Image Overlay			
Meas Setup	Reading Setup	Unit	TH Res	% Res	Trigger	A-Out	
Inst Setup	General	Owner Info	Status				

Table 20 Content of the 4/5 standard menu in PA mode

Submenu	Parameters						
Sizing Option	AWS D1.1						

Table 21 Content of the 5/5 standard menu in PA mode

Submenu	Parameters						
Files	Open	Create	Reset	Page Setup	First ID	Last ID	Id:

3.3   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 PA operation mode, choose **1/5 > PA Probe > Beam** to access the **Beam** setup page shown in Figure 3-14 on page 67.
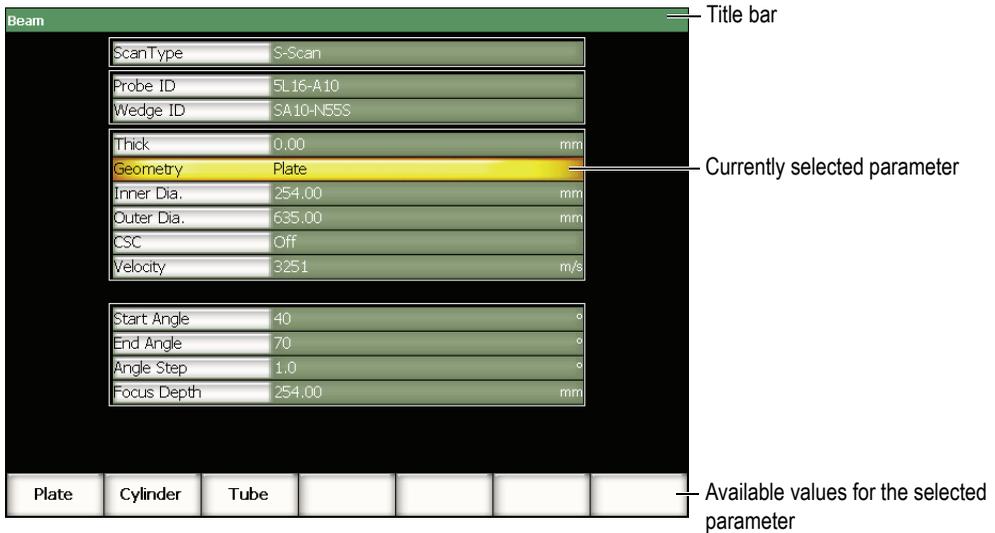
Figure 3-14 The Beam setup page and its elements

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. With a USB keyboard connected to the EPOCH 1000 Series, pressing the ESCAPE key also allows you to leave a setup page.

The following sections describe the available setup pages.

3.3.1   Color Setup Page

The **Color** setup page, shown in Figure 3-15 on page 68, is accessible by choosing **3/5 > Display Setup > Color Setup**.
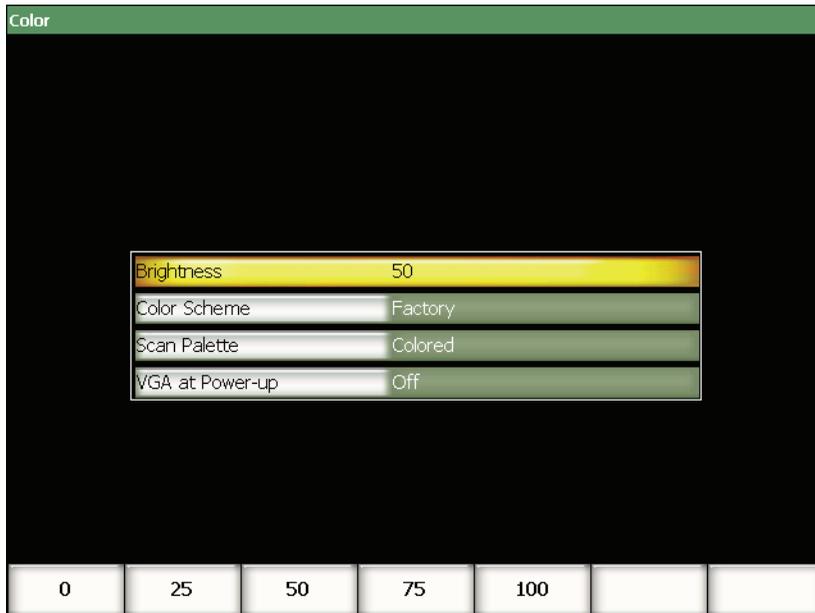
Figure 3-15 The Color setup page

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

Scan Palette

Used to set the color palette for phased array image scans:

Grey Scale

Colored (default value)

VGA at Power-Up

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

3.3.2   A-Scan Setup Page

The **A-Scan** setup page, shown in Figure 3-16 on page 69, is accessible by choosing **3/5 > Display Setup > A-Scan Setup**.
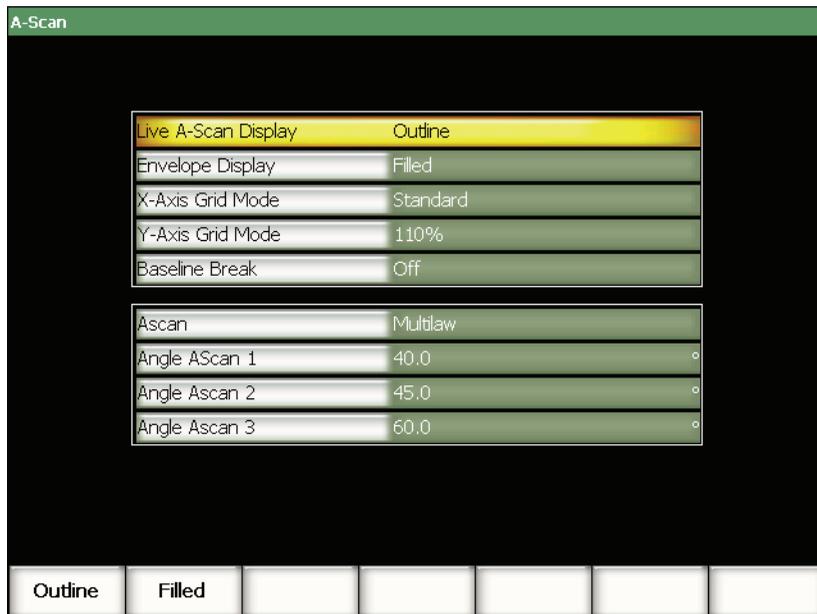
Figure 3-16 A-Scan setup page

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.

Ascan

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

Angle AScan 1, **2**, or **3**

>   Used to set the angle for three A-scans in **MultiLaw** mode.

3.3.3 Meas Setup Page

The **Meas** setup page, shown in Figure 3-17 on page 71, is accessible by choosing **3/5 > Meas Setup > Reading Setup**. This page allows you to select which measurement appears in the measurement reading boxes at the top of the software main display (see section 3.1.9 on page 57).

Figure 3-17 The Meas 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 select 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 3-17 on page 71). Table 22 on page 72 presents the available measurement readings.

Figure 3-18 Example of measurement reading boxes with icons

Table 22 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**.
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**.

Table 22 Available measurement readings *(continued)*

Icon	Measurement readings	Description
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.
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.

Table 22 Available measurement readings *(continued)*

Icon	Measurement readings	Description
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.
FBH	**Flat-Bottom Hole (FBH) Size**	Flat-bottom hole (FBH) size (equivalent reflector size) for DGS/AVG evaluation.
OS	**Overshoot (OS)**	Overshoot value in dB comparing echo height to DGS/AVG curve.
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

Table 22 Available measurement readings *(continued)*

Icon	Measurement readings	Description
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
X₂-X₁	**Cursor X2 - Cursor X1**	Difference between the position of cursor X2 and the position of cursor X1 in frozen sector scan sizing mode.
Y₂-Y₁	**Cursor Y2 - Cursor Y1**	Difference between the position of cursor Y2 and the position of cursor Y1 in frozen S-scan sizing mode.
X·Y%	**Cursor X1, Cursor Y1 Intersect Amplitude**	Value of the signal amplitude at the intersection of cursor X1 and cursor Y1 in frozen S-scan sizing mode.
X·Y↕	**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.

3.3.4   General Setup Page

The **General** setup page, shown in Figure 3-19 on page 76, is accessible by choosing **3/5 > Inst Setup > General** and allows you to configure general parameters such as the user interface language and the instrument date and time.

Figure 3-19 The General setup page

The available parameters are:

Language

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

Year

Used to set the year for the instrument internal clock.

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.

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.

3.3.5   Owner Info (Inst Setup Group)

The **Owner Info** setup page, shown in Figure 3-20 on page 78, is accessible by choosing **3/5 > Inst Setup > Owner Info**. The page allows you to input up to five lines of text displayed during start up, at the end of the start-up screens. This text is typically used to show owner or company information, including address and phone number.

Figure 3-20 The Owner Info setup page

3.3.6   Status Setup Page

The **Status** setup page, shown in Figure 3-21 on page 79, is accessible by choosing **3/5 > Inst Setup > Status**. The page provides information about the current status of the instrument such as the internal temperature, battery state as well as instrument hardware/software identification data.
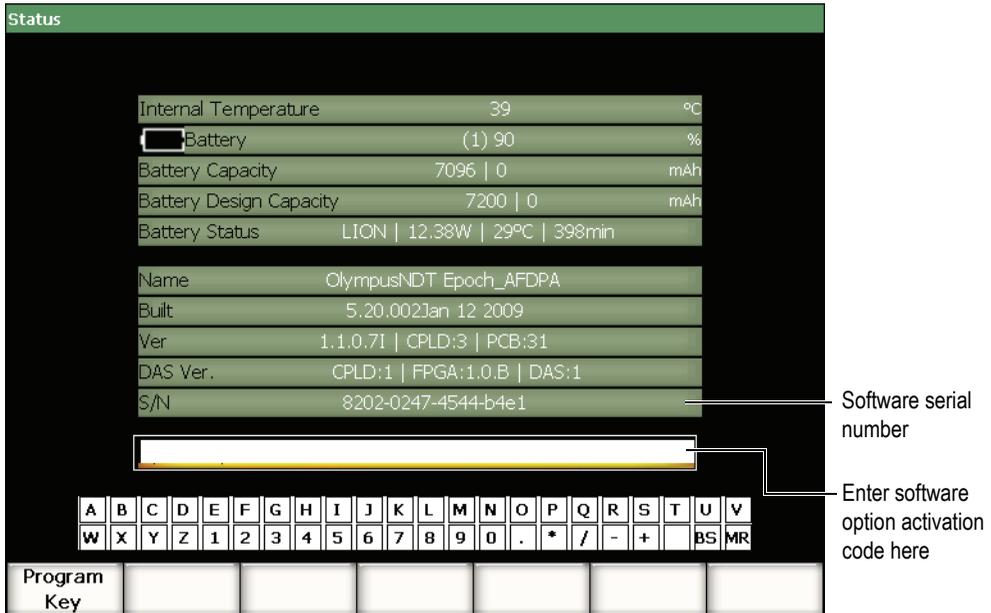
Figure 3-21 The Status setup page

The **Status** page allows you to enter a activate code to allow access to a software option not included with the standard package of instrument features. This is provided by an Olympus representative after the purchase of a particular software option. Refer to section 11.1 on page 195 for details on software option activation.

3.3.7   Display Setup Page (Phased Array Mode Only)

The **Display** setup page, shown in Figure 3-22 on page 80, is accessible by choosing **3/5 > Display Setup > Image Overlay**. The page allows you to activate overlays to the S-scan view.

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 **1/5 > 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, as the beam index point (BIP) in phased array mode varies depending on the selected focal law.

3.4   Basic Procedures

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

3.4.1   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. Ensure that the focus is on one of the submenu buttons using one of the following methods (see section 3.1.3 on page 54 for details on the focus concept):
    a) Press one of the **[F**<*n*>**]** function key.
    b) 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.
    c) With a USB mouse connected to the instrument, click a submenu button.
    d) 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:
    a) Slowly turn the adjustment knob until the desired submenus appear on the right side of the software main display.
    b) Press the **[RIGHT]** or the **[LEFT]** arrow keys until the desired submenus appear on the right side of the software main display.
    c) 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.
    d) 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 section 3.1.1 on page 50 for details on the menu structure).
3. Select the desired submenu using one of the following methods:
    a) Press the **[F**<*n*>**]** function key corresponding to the desired submenu button.

  b) Press the **[UP]** or the **[DOWN]** arrow keys until the desired submenu has the focus.

  c) With a USB mouse connected to the instrument, click the desired submenu.

  d) 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:

  a) Press **[CHECK]** to move the focus to the parameter level, and then press the **[P<*n*>]** parameter key corresponding to the desired parameter button.

  b) Press the **[RIGHT]** or the **[LEFT]** arrow keys until the desired parameter has the focus.

  c) With a USB mouse connected to the instrument, click the desired parameter.

  d) 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.

3.4.2   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 **1/5 > PA Probe > Beam**).

2. Select the desired parameter using one of the following methods:

  a) Press the **[UP]** or the **[DOWN]** arrow key until the desired parameter has the focus.

  b) With a USB mouse connected to the EPOCH 1000 Series, click the desired parameter.

  c) With a USB keyboard connected to the EPOCH 1000 Series, press the **[UP]** or the **[DOWN]** arrow keys until the desired parameter is selected.

3. Change the value using one of the following methods:

  a) Turn the adjustment knob.

  b) Press the **[RIGHT]** or the **[LEFT]** arrow key.

    c)   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.

    d)   With a USB mouse connected to the EPOCH 1000 Series, rotate the wheel of the mouse.

    e)   With a USB keyboard connected to the EPOCH 1000 Series, press the RIGHT or the LEFT arrow key.

4.   Leave the setup page using one of the following methods:

    a)   Press **[ESCAPE]**.

    b)   With a USB keyboard connected to the EPOCH 1000 Series, press the ESCAPE key.

The edited values are effective immediately. It is not possible to cancel the changes.

3.4.3   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 section 3.4.1 on page 81 for details).

The button background of the selected parameter turns to yellow, showing that it now has the focus (see section 3.1.3 on page 54 for details on the focus concept).

2.   Use one of the following methods to change the parameter value:

    a)   Turn the adjustment knob until the desired value appears in the button below the label.

    b)   Press the **[UP]** or the **[DOWN]** arrow key until the desired value appears in the button below the label.

    c)   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.

    d)   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 section 3.4.1 on page 81 for details).

   The button background of the selected parameter turns to yellow, showing that it now has the focus (see section 3.1.3 on page 54 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:

   a) Press **[CHECK]**.

   b) With a USB keyboard connected to the instrument, press ENTER.

   The increase/decrease value mode is coarse when the button label is underlined and is fine when not underlined.

3. Use one of the following methods to change the parameter value:

   a) Turn the adjustment knob until the desired value appears in the button below the label.

   b) Press **[UP]** or the **[DOWN]** arrow key until the desired value appears in the button below the label.

   c) 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.

   d) 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.

3.4.4 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, choose **3/5 > Inst Setup > Owner Info** to access the **Owner Info** setup page shown in Figure 3-23 on page 85.
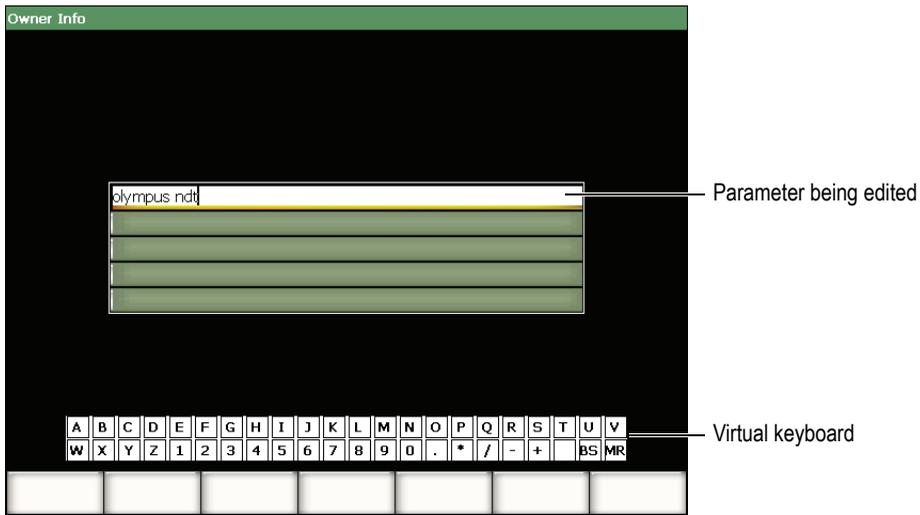
Figure 3-23 The Owner Info setup page with its virtual keyboard

2. Select the parameter that you want to edit using the **[UP]** or the **[DOWN]** arrow key.

3. To enter a character from the virtual keyboard use one of the following methods:

   a) Turn the adjustment knob until the desired character is selected, and then press **[CHECK]** to add the character to the parameter.

   OR

   b) With a USB mouse connected to the EPOCH 1000 Series, 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]**.

3.4.5   Interacting With a Dialog Box

The EPOCH 1000 Series software presents dialog boxes, for example during calibration, to allow you to edit the value of a parameter. 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 3-24 on page 86, press **[LEFT]** or **[RIGHT]** to position the cursor over the digit that you need to modify in the parameter value.
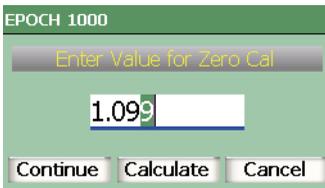
Figure 3-24 Dialog box example

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.

3.5   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.

Refer to the GageView Pro User's Manual.

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

This chapter describes how to adjust the EPOCH 1000 Series pulser/receiver in conventional ultrasound mode. The topics are as follows:

- Adjusting the System Sensitivity (Gain)
- Using the AUTO-XX% Feature
- Setting Reference Gain and Scanning Gain
- Pulser Adjustments
- Receiver Adjustments
- Custom Filter Sets

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. Use one of the two adjustment methods below to adjust the gain setting:
   a) **[UP]** and **[DOWN]** arrow keys
   b) Adjustment knob - clockwise and counterclockwise

| NOTE |

The total system sensitivity is 110 dB.

4.2   Using the AUTO-XX% Feature

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

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 section 4.3 on page 91 for further information).

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.

4.3   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 select 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.

---

3. Use the **[UP]** and **[DOWN]** arrow keys or the adjustment knob to vary the scanning gain.

While using the reference gain and scanning gain, the following parameters appear in the **1/5 > 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.

4.4   Pulser Adjustments

The pulser settings in the EPOCH 1000 Series conventional ultrasound mode are available from the **1/5 > 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.

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

◆ Choose **1/5 > 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. Choose **1/5 > Pulser > PRF Mode = Manual**.

2. Choose **1/5 > Pulser > PRF**, and then vary the setting.
   When needed, press **[CHECK]** to toggle between coarse and fine adjustment.

NOTE

The EPOCH 1000 Series is a *single-shot* instrument. This means that the instrument acquires, measures, and draws 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 from 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

◆ Choose **1/5 > 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

◆   Choose **1/5 > 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 in order to 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 **1/5 > 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

◆ Choose **1/5 > 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 **1/5 > Pulser > Pulser** parameter:

Spike

   Used to mimic a traditional 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     |
+-------------+
```

The EPOCH 1000 Series uses the PerfectSquare technology to achieve optimum 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

◆ Choose **1/5 > Pulser > Pulser**, and then vary the setting.

4.4.6   Pulser Frequency Selection (Pulse Width)

The pulser frequency selection sets the pulse width when **1/5 > 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

◆   Choose **1/5 > 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 Adjustments

The receiver settings in the EPOCH 1000 Series conventional ultrasound mode are accessed from the **1/5 > 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. Total bandwidth 0.2 MHz to 26.5 MHz. Each filter is compliant with the EN12668-1 (see section 4.5.2.1 on page 97).

Advanced

Thirty (30) digital filter sets. Total bandwidth allows all frequencies to be received. Filters not tested to EN12668-1 (see section 4.5.2.2 on page 98).

AxleInspFR

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

To adjust the filter group

◆ Choose **1/5 > Receiver > Filter Group**, and then vary the setting.

4.5.2   Digital Receiver Filters

The EPOCH 1000 Series has a total instrument bandwidth of 26.5 MHz at –3 dB. The instrument offers several broadband and narrow-band digital filters. 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 **Standard** filter set also allows the instrument to provide 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. Due to the shifting of frequency spectrum in most materials, it might 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 section 4.5.1 on page 96).

To adjust the Filter

◆ Choose **1/5 > 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 instrument's 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 set. This allows you to easily identify if the filter being used complies or not with EN12668-1.

4.5.3   Waveform Rectification

The EPOCH 1000 Series can operate in one of four different rectification modes that you can select using the **1/5 > 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

◆ Choose **1/5 > Receiver > Rect**, and then vary the rectification setting.

4.6 Custom Filter Sets

The EPOCH 1000 Series is capable of storing custom filter sets that are developed at a customer's request by Olympus. The **AxleInspFR** filter selection is an example of this custom filter design 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. The topics are as follows:

- Reject
- Peak Memory
- Peak Hold
- Freeze
- Grid Modes

5.1 Reject

The **1/5 > Receiver > Reject** parameter allows eliminating 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 **1/5 > Receiver > Rect = RF** mode.

The reject level is displayed as an horizontal line on the instrument display (see Figure 5-1 on page 102) or two lines in the case of the **1/5 > Receiver > Rect = RF** mode.
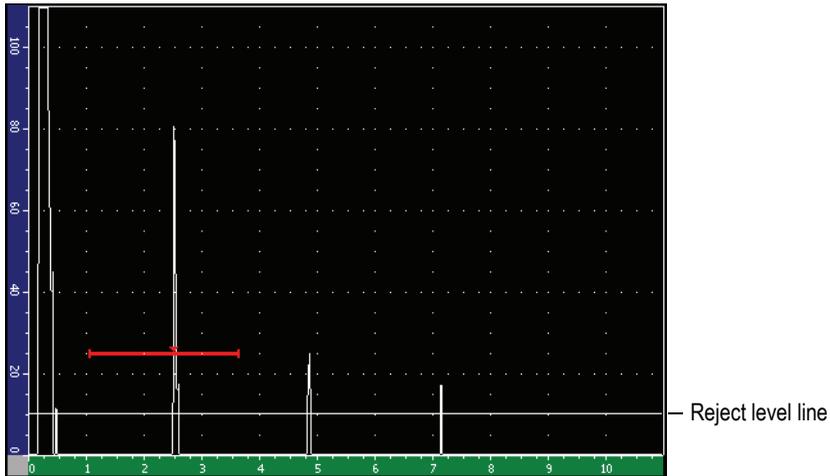
— Reject level line

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 103). In addition, the current, live waveform is displayed at the appropriate place within the signal envelope.
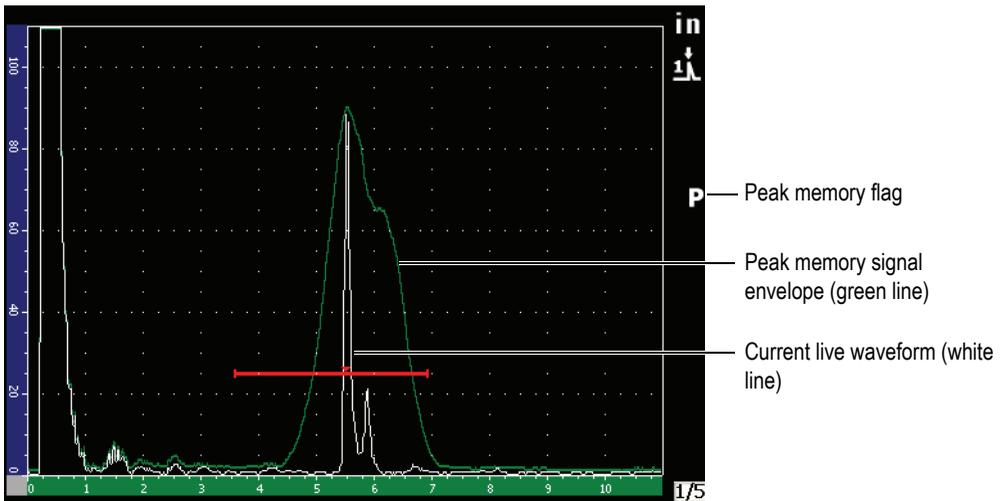
Figure 5-2 Peak memory signal envelope example

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 **1/5 > 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 ▉ 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 becomes inactive and does not acquire any further data. A ▉ 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

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

To adjust the grid modes

1. Choose **3/5 > Display Setup > A-Scan Setup** to open the **A-Scan** setup page.
2. Move the focus to the **X-Axis grid Mode** parameter using the **[UP]** and **[DOWN]** arrow keys (see Figure 5-3 on page 106).
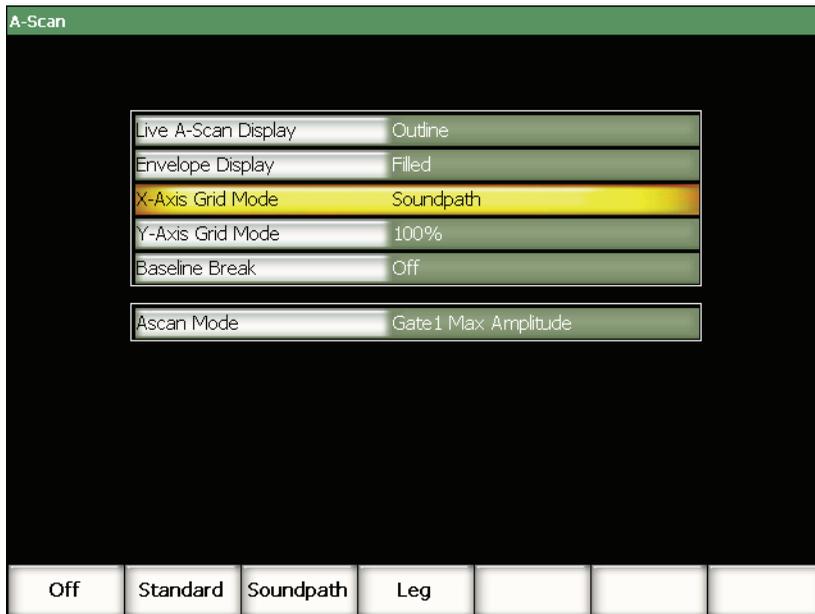
Figure 5-3 Selecting the x-axis grid mode

3. Choose the desired x-axis grid mode using the **[RIGHT]** and **[LEFT]** arrow keys, or using the corresponding direct-access **[P<*n*>]** key (see Figure 5-4 on page 107).
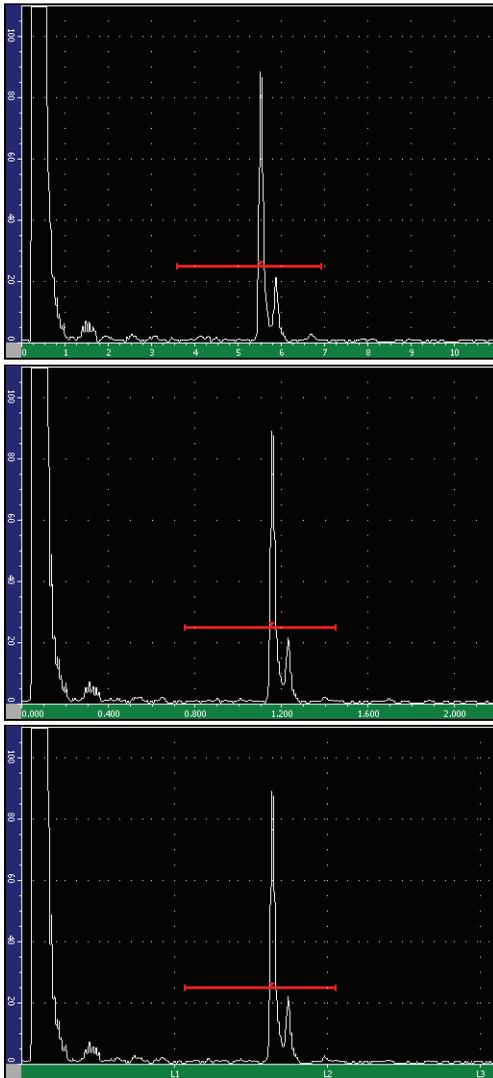
Standard grid: traditional flaw detector view with 10 divisions equally spaced across the screen range, and the numbers 1 - 10 appearing below each division.

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 **1/5 > Basic > Range**, **1/5 > Basic > Delay**, and **3/5 > 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 **1/5 > Basic > Range**, **1/5 > Basic > Delay**, and **1/5 > 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 using the **[RIGHT]** and **[LEFT]** arrow keys, or using the corresponding direct-access **[P<n>]** key (see Figure 5-5 on page 108).
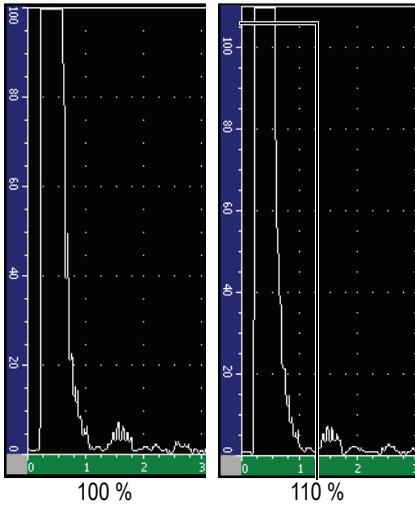
100% or **110%** grid: maximum amplitude height displayed on the vertical Y-Axis.

Figure 5-5 The y-axis grid modes

6.   Gates (Conventional UT Mode)

This chapter describes how to use the gates in the conventional ultrasound mode of the EPOCH 1000 Series. The topics covered are as follows:

- Measurement Gates 1 and 2
- Quickly Adjusting Basic Gate Parameters
- Interface Gate (Optional)
- Gate Measurement Modes
- Viewing Measurement Readings
- Gate Tracking and Echo-to-Echo Measurements
- Operating in Time-of-Flight Mode
- Using the Zoom
- Gate Alarms

6.1   Measurement Gates 1 and 2

The EPOCH 1000 Series has 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. In the EPOCH 1000 Series, gate 1 appears as a red line while gate 2 appears as a blue line.

Gate 1 (red)
Gate 2 (blue)
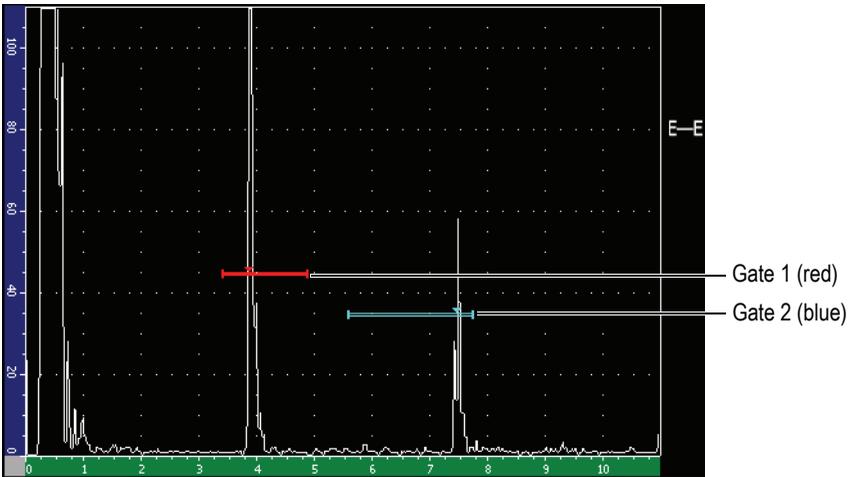
Figure 6-1 Gate 1 and gate 2

Both gates can be used to take thickness measurements with straight-beam transducers, sound path measurements with angle beam transducers, measure signal amplitude, measure 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 section 6.6 on page 116).

You can control the gates using the parameters in the **2/5 > Gate 1** and **2/5 > Gate 2** submenus (see Figure 6-2 on page 111).
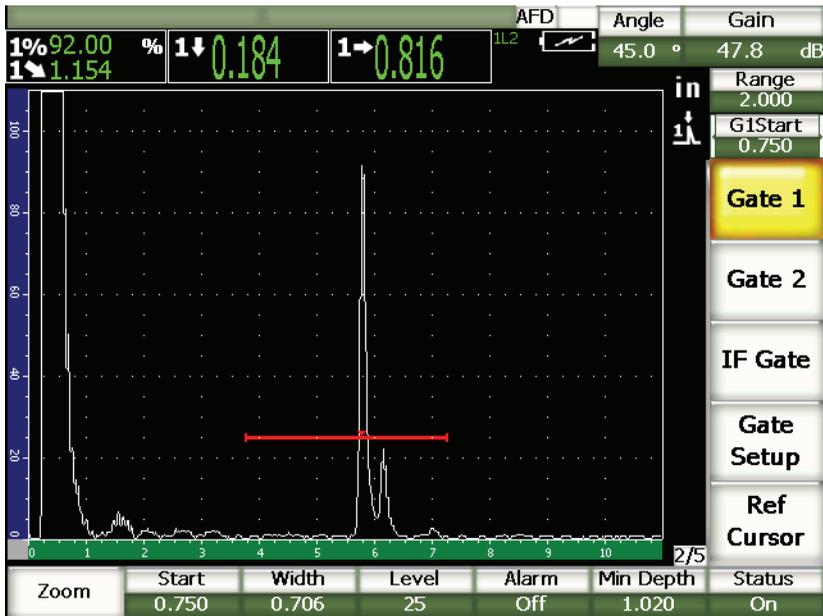
Figure 6-2 The Gate 1 submenu

The available gate parameters are:

Zoom

Used to zoom the display on the width of the gate (refer to section 6.8 on page 119 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 (refer to section 6.9 on page 120 for details).

Min Depth

Used to adjust the minimum depth value which 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 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 112).
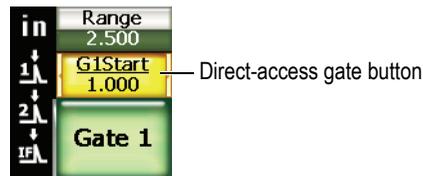
Figure 6-3 The direct-access gate button

2. Edit the value using the adjustment knob or the **[UP]** and **[DOWN]** arrow keys. When needed, press **[CHECK]** to toggle between the coarse and fine mode.

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 which are currently active. To activate a gate, select **2/5 > Gate<*n*> > Status = On**.

---

4. Use the **[RIGHT]** or **[LEFT]** arrow keys to scroll between 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)

The EPOCH 1000 Series features an optional interface gate, providing a third measurement gate. The interface gate positioning is controlled using the same two methods as described in 6.1 on page 110 and 6.2 on page 112 for measurement gates 1 and 2.

For further information about special interface gate functions, see section 11.5 on page 234.

6.4   Gate Measurement Modes

The EPOCH 1000 Series' 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 114) accessible by choosing **2/5 > Gate Setup > Setup**.
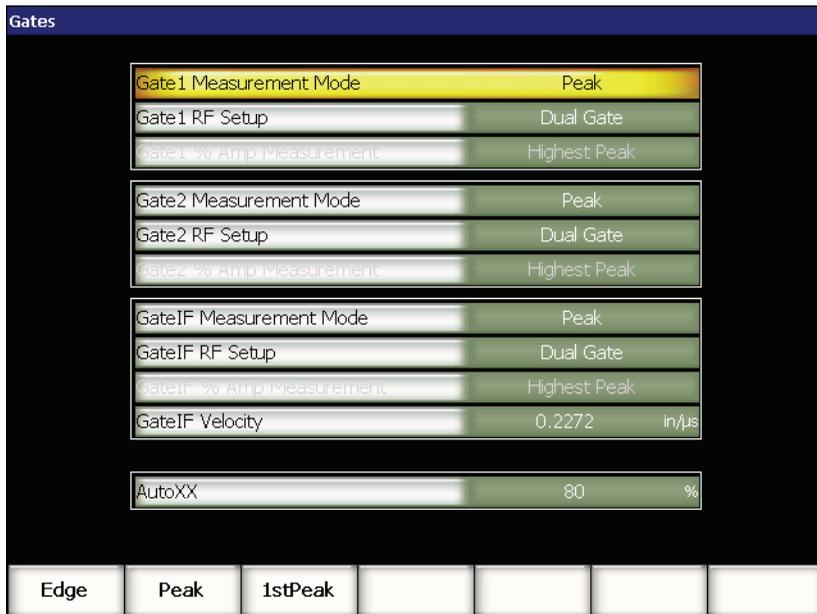
Figure 6-4 The Gates setup page

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 115).
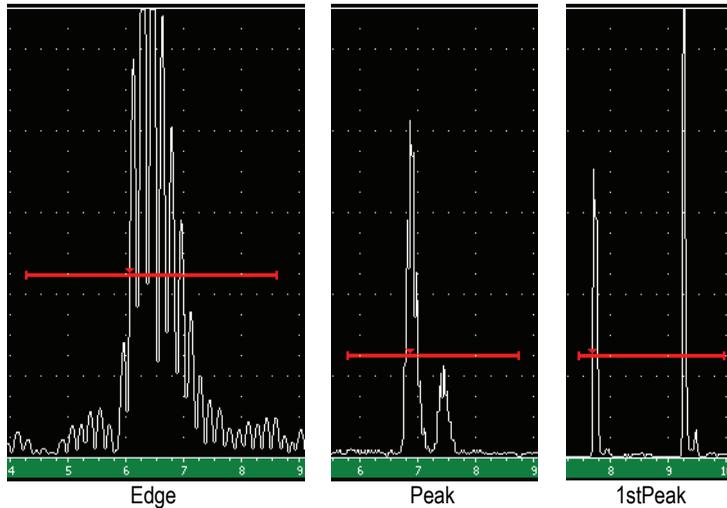
Edge   Peak   1stPeak

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

Gate RF Setup

In unrectified (RF) mode, 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:

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
```

The EPOCH 1000 Series does 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

The EPOCH 1000 Series provides 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 section 3.3.3 on page 71.

6.6   Gate Tracking and Echo-to-Echo Measurements

The gate tracking feature of the EPOCH 1000 Series 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 **2/5 > Gate 1 > Status = On** and **2/5 > Gate 2 > Status = On**.

2. As shown in the example of Figure 6-6 on page 117, position gate 1 over the first echo to detect, and then position gate 2 over the second echo to detect.
   The **2/5 > Gate 2 > Start** position defines the separation between the position of the indication in gate 1 and the start of gate 2.
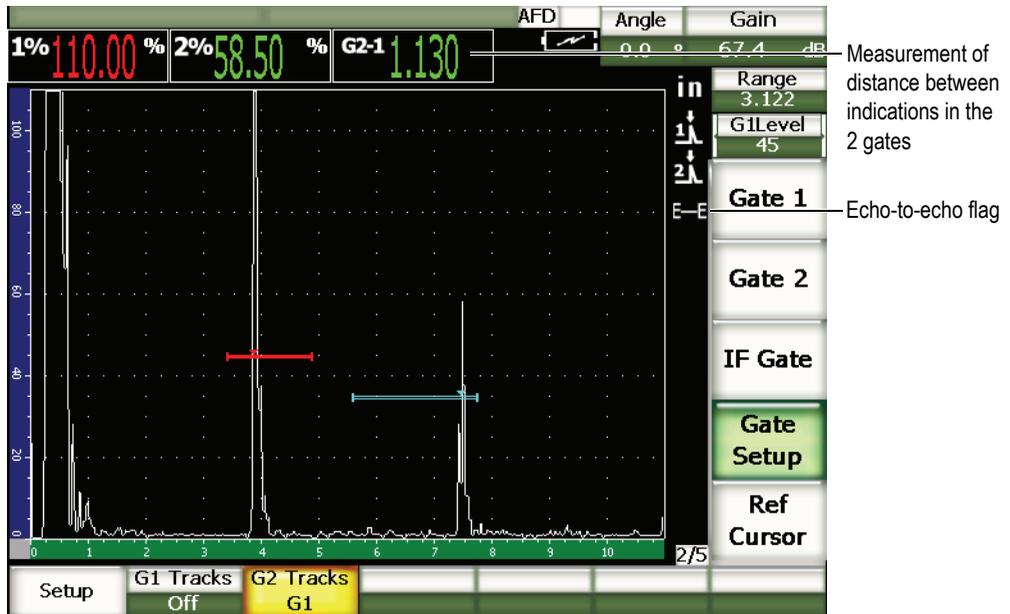
Figure 6-6 Echo-to-echo measurement example

3. Set gate 2 as the tracking gate by selecting **2/5 > 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 section 3.3.3 on page 71 for details).

6.7   Operating in Time-of-Flight Mode

The EPOCH 1000 Series is 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.

As a reminder, when taking thickness measurements, the EPOCH 1000 Series 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 unit would display twice the actual thickness because the sound energy would pass through the part twice.

NOTE

When the instrument is set up to display distances in time-of-flight mode, the **1/5 > 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 **3/5 > 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

The EPOCH 1000 Series allows you to quickly zoom the screen range to provide fine resolution of a particular inspection zone. Using 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 **2/5 > Gate 1 > Status = On** to activate gate 1.
2. Position gate 1 to the desired position.
3. Choose **2/5 > Gate 1 > Zoom**.

6.8.2   Zoom Applications

Zooming is especially useful in certain flaw detection applications. For example, when detecting branches of cracking such as intergranular stress-corrosion cracking (IGSCC), the inspector's job 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 EPOCH 1000 Series' display so that each individual signal can be more easily identified.

When evaluating a crack signal, the inspector's 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. 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 when 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

The EPOCH 1000 Series features 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, the EPOCH 1000 Series emits an audible beep. The instrument also illuminates the red indicator, above the display window, corresponding to the gate with which the alarm has been triggered. To toggle the audible alarm on and off, see section 3.3.4 on page 76.

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 121).
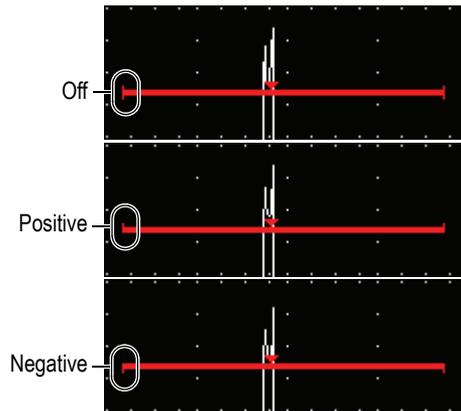
Figure 6-7 Gate tick marks indicating alarm threshold type

To set a threshold alarm

1. Activate the gate by selecting **2/5 > Gate<*n*> > Status = On**.
2. Position the gate to cover the desired area.
3. Choose **2/5 > Gate<*n*> > Alarm**, and then select either the **Positive** or **Negative** threshold alarm condition.

6.9.2   Minimum Depth Alarm

The EPOCH 1000 Series is equipped with a minimum depth alarm that is triggered whenever the current thickness measurement reading falls below an operator-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.

Minimum depth alarm marker
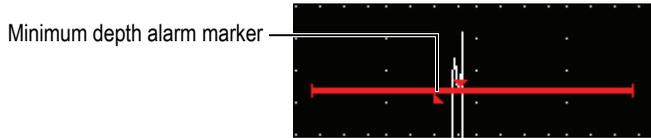
Figure 6-8 Minimum depth alarm marker

To set a minimum depth alarm

1. Activate the gate by selecting **2/5 > Gate<*n*> > Status = On**.
2. Position the gate to cover the desired area.
3. Select **2/5 > Gate<*n*> > Alarm = MinDep**.
4. Choose **2/5 > 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

The EPOCH 1000 Series 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 section 6.9.3 on page 121.

7.   Reference Cursors

This chapter describes how to use the A-scan reference cursors on the EPOCH 1000 Series. The topics covered are as follows:

• Cursors A and B
• Activating and Positioning Cursors
• Cursor Measurements

7.1   Cursors A and B

The EPOCH 1000 Series provides two visual and measurement reference cursors that can be displayed on the instrument's A-scan view. These cursors are controlled with parameters from the **2/5 > Ref Cursor** submenu.
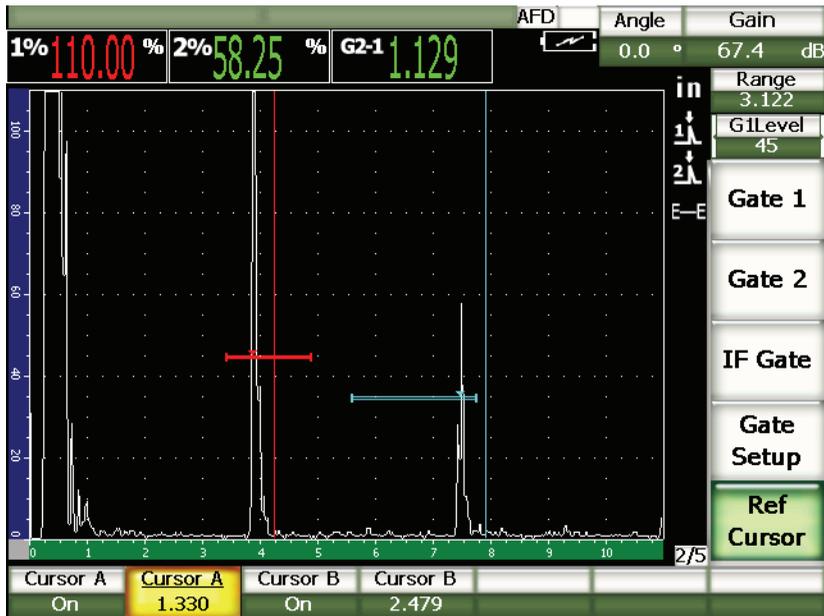
Figure 7-1 A-scan with active reference cursors

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 **2/5 > Ref Cursor > Cursor A =On**.

    Cursor A (red line) appears on the screen.

2. To move cursor A along the screen range, choose **2/5 > Ref Cursor > Cursor A**, and then use the **[UP]** and **[DOWN]** arrows or the adjustment knob to adjust the position.

3. Select **2/5 > 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, choose **2/5 > Ref Cursor > Cursor B**, and then use the **[UP]** and **[DOWN]** arrows or the adjustment knob to 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 choosing **3/5 > Meas Setup > Reading Setup** (see section 3.3.3 on page 71 for details). You can select the following cursor measurements (refer to table 22 on page 72 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 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. The topics covered are as follows:

- VGA Output
- Analog Outputs
- Trigger Input and Output
- Serial Communication (RS-232)
- USB Communication
- Serial/USB Command Protocol

8.1 VGA Output

The EPOCH 1000 Series comes 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 screen on any device that accepts VGA input.

To use the VGA output

1. Turn off the EPOCH 1000 Series and the VGA device.
2. Connect the EPXT-C-VGA-6 cable (optional item) to the VGA/RS-232 output connector of the EPOCH 1000 Series (see Figure 8-1 on page 128), and then to the VGA device.

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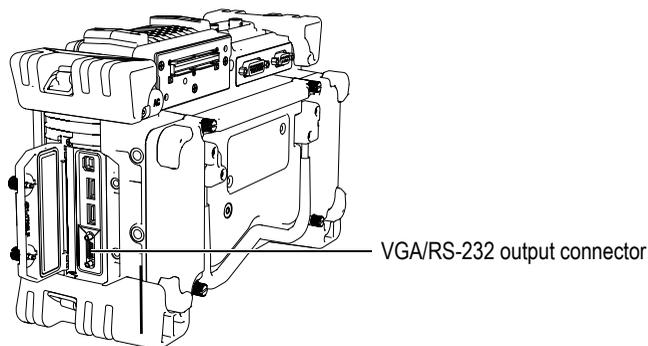
Figure 8-1 The VGA/RS-232 output connector

3. Turn on the EPOCH 1000 Series and the VGA device.

4. Activate the VGA output of the EPOCH 1000 Series by selecting **3/5 > 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 first starts up. To set the VGA output to be active whenever the instrument first starts up:

    a) Choose **3/5 > 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

The EPOCH 1000 Series offers four programmable analog outputs. These analog outputs allow the EPOCH 1000 Series 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 section 1.4.3 on page 31). Refer to Table 33 on page 317 for the ANALOG OUT connector pinout. Each scaled voltage can be output at full PRF rate (up to 6 kHz), or can be compressed to a 60 Hz output, depending on the acquisition rate required by the connected data acquisition device.

The analog output setup parameters are located in the **A-Out** setup page accessible by choosing **3/5 > Meas Setup > A-Out** (see Figure 8-2 on page 129).
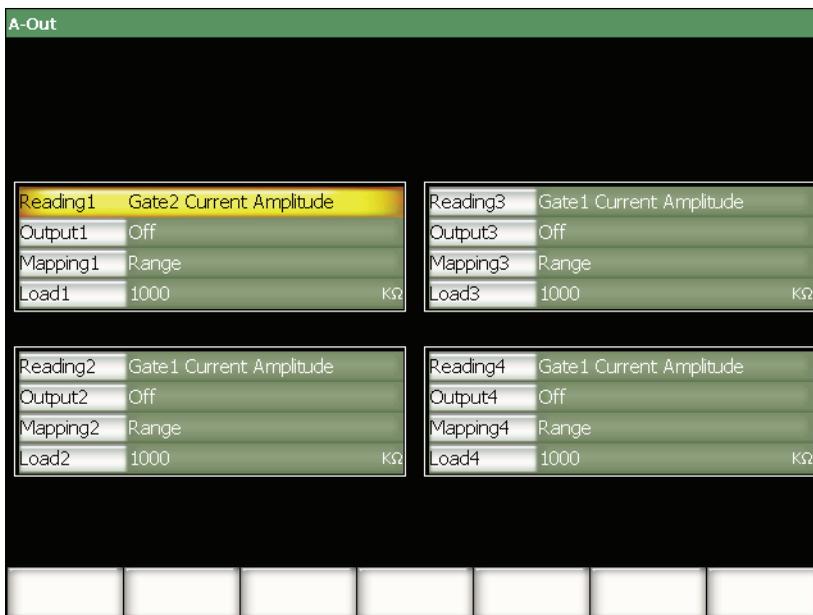
Figure 8-2 The A-Out setup page

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 unit (**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 with the impedance of the input to the peripheral device allows the EPOCH 1000 Series to properly offset the analog output to produce predictable output voltages based on screen measurements. For example, a measurement on the EPOCH 1000 Series 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

The EPOCH 1000 Series offers trigger syncing capabilities to 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 selected 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 section 1.4.3 on page 31). Refer to Table 32 on page 316 for the ALARMS connector pinout.

The trigger input and output mode is set using the **3/5 > Meas Setup** > **Trigger** parameter that offers three selections:

Internal

Standard operational mode internally controlling the pulse timing and frequency. The EPOCH 1000 Series is not affected by the external trigger input but outputs a synchronization pulse, allowing to trigger 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 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)

The EPOCH 1000 Series comes 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 to a computer for communication with the EPOCH 1000 Series' computer interface program, GageView Pro.

Serial communication also allows remote command of the EPOCH 1000 Series. For more information, please see section 8.6 on page 132.

8.5   USB Communication

The EPOCH 1000 Series comes 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, but does not allow the EPOCH 1000 Series 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 to pass commands to peripheral USB devices. The EPOCH 1000 Series has 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 section 10.4 on page 188.

8.6   Serial/USB Command Protocol

The EPOCH 1000 Series 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 access to all functions of the instrument. Contact Olympus for further information.

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

This chapter describes how to calibrate the EPOCH 1000 Series in conventional ultrasound mode. Calibration is the process of adjusting the unit 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 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 unit 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 **1/5 > Auto CAL** submenu), which provides for a fast and easy calibration process. The following section details the procedure to calibrate the EPOCH 1000 Series 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 is in the following modes: Microsecond (time-of-flight), DAC, or TVG.

Calibration is explained in detail in the following sections:

- Getting Started
- Calibration Modes
- Calibrating with a Straight Beam Transducer

- Calibrating with a Delay Line Transducer
- Calibrating with a Dual Element Transducer
- Calibrating in Echo-to-Echo Mode
- Calibrating to Known Sound Path Values with an Angle Beam Transducer
- Calibrating to Known Depth Values with an Angle Beam Transducer
- Curved Surface Correction
- Common Angle Beam Calibration Block Diagrams

9.1 Getting Started

Until you are completely comfortable operating the EPOCH 1000 Series, 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. Choose **1/5 > Basic** > **Velocity**, and then enter an approximate velocity for the test material. Refer to Appendix A on page 321 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 **3/5 > Meas Setup** > **Unit = mm** or **in** to enable the **Velocity** parameter.

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3. Choose **1/5 > Basic** > **Zero**, and then adjust the zero offset of the instrument to 0.000 µs.

4. Choose **1/5 > Basic** > **Range**, and then set the range based on the sound path range within the selected calibration block.

<div style="border:1px solid black; display:inline-block; padding:2px 40px">TIP</div>

Use more range than necessary to ensure all calibration echoes appear on the
screen.

5. Choose **1/5 > Basic** > **Delay**, and then set the screen delay to 0.000 in. or 0.00 mm.
6. Choose **1/5 > 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. Choose **1/5 > TRIG** > **Thick**, and then set the material thickness to 0.00 in. or 0.00 mm.
8. Choose **1/5 > Receiver** > **Reject**, and then set the reject level to 0 %.
9. Select **2/5 > 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 section 4.4 on page 92 and section 4.5 on page 96.

<div style="border:1px solid black; display:inline-block; padding:2px 40px">TIP</div>

Use the auto measurement reading selection feature so that the EPOCH 1000
Series automatically displays relevant thickness/sound path measurements
during calibration based on the instrument settings. For more information, see
section 3.3.3 on page 71.

9.2 Calibration Modes

The EPOCH 1000 Series features 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 **1/5 > 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. This means that you must only calibrate for the material velocity of the inspection to acquire accurate echo-to-echo measurements. You can perform echo-to-echo measurements using the following pairs of gates: **G2 - G1**, **G2 - IF**, or **G1 - IF** (see section 6.6 on page 116).

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 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. (13 mm).

The calibration 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 this example, Olympus standard 5-step steel test block (part number 2214E) is used. The steps measure 0.100 in., 0.200 in., 0.300 in., 0.400 in., and 0.500 in.

NOTE

If the EPOCH 1000 Series 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 9.1 on page 134.
2. Connect the transducer to an appropriate cable and then connect the cable to either of the conventional transducer connectors at the top of the instrument.
3. Select **1/5 > 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. step.

NOTE

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

---

5. Use the **[GATE]** key to position gate 1 so that the first back-wall echo from the known thickness step exceeds the gate threshold.
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 138).
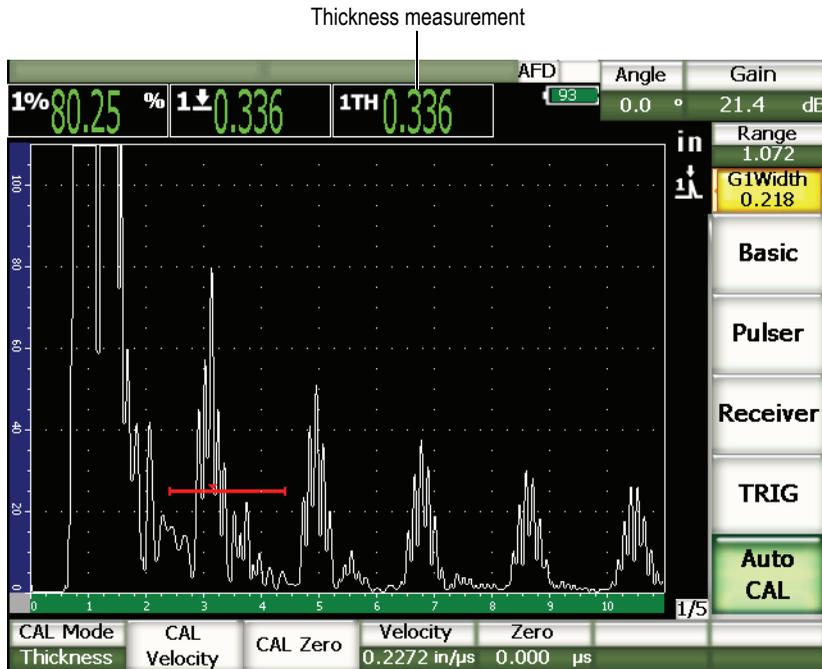
Figure 9-1 Example of a gated calibration signal

7. Once a steady reading is achieved, choose **1/5 > Auto CAL > CAL Zero**.

The screen freezes and the **Enter Value for Zero Cal** dialog box appears (see Figure 9-2 on page 138).
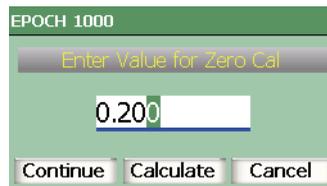
Figure 9-2 The Enter Value for Zero Cal dialog box

8. Adjust the value to match the known thickness of the gated indication (0.200 in. in this example), and then choose **Continue** to continue to the second calibration step (see Figure 9-3 on page 139).

NOTE

If for any reason you need to exit without acquiring calibration data, use the **[RIGHT]** and **[LEFT]** arrow keys to highlight **Cancel**, and then press **[CHECK]**.

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. 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. 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.
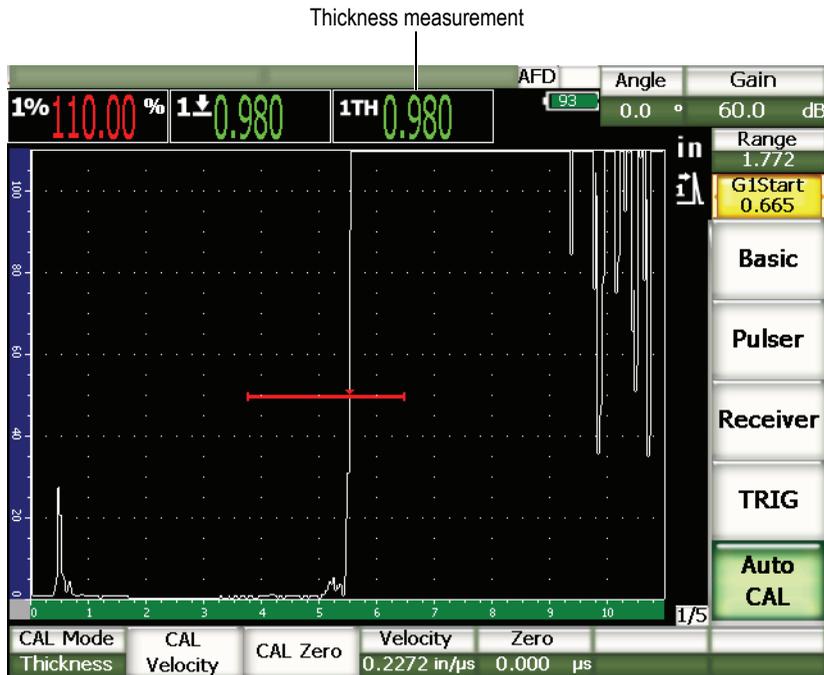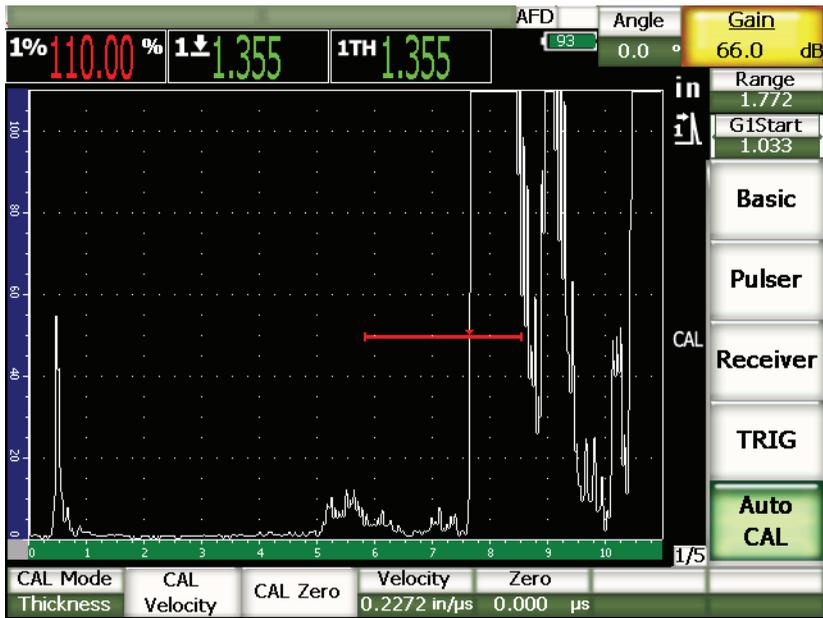
12. Once a steady reading is achieved, choose **1/5 > Auto CAL > CAL Velocity**.

    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 (0.500 in. in this example), and then choose **Calculate** to 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 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, 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., 0.200 in., 0.300 in., 0.400 in., and 0.500 in.

NOTE

If the EPOCH 1000 Series 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 9.1 on page 134.
2. Connect the transducer to an appropriate cable and then connect the cable 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. Choose **1/5 > 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. Choose **1/5 > 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 **1/5 > 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. 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 142).

Thickness measurement
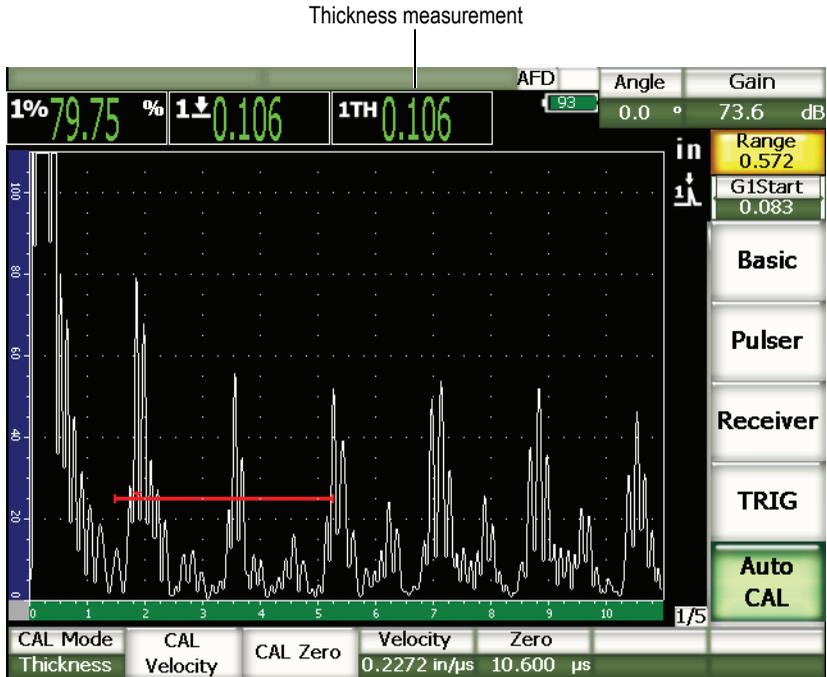
Figure 9-4 Example of a gated calibration signal

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. Once a steady reading is achieved, choose **1/5 > Auto CAL > CAL Zero**.

   The screen freezes and the **Enter Value for Zero Cal** dialog box appears (see Figure 9-2 on page 138).
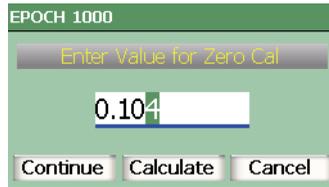
Figure 9-5 The Enter Value for Zero Cal dialog box

11. Adjust the value to match the known thickness of the gated indication (0.100 in. in this example), and then choose **Continue** to continue to the second calibration step (see Figure 9-6 on page 144).

NOTE

If for any reason you need to exit without acquiring calibration data, use the **[RIGHT]** and **[LEFT]** arrow keys to highlight **Cancel**, and then press **[CHECK]**.

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. 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.

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. Once a steady reading is achieved, choose **1/5 > 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 (0.500 in. in this example), and then choose **Calculate** to 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. multiple 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 made from the material being 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., 0.200 in., 0.300 in., 0.400 in., and 0.500 in.

NOTE

If the EPOCH 1000 Series 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   │
>   └──────────────┘

Due to 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 9.1 on page 134.
2. Connect the transducer to an appropriate cable, and then connect the cable to the conventional transducer connectors at the top of the instrument.
3. Select **1/5 > 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) Choose **2/5 > Gate Setup > Setup** to open the **Gates** setup page.
   b) In the setup page, highlight **Gate<*n*> Measurement Mode** and set its value to **Edge**.
   c) Press **[ESCAPE]** to exit the setup page.
6. Select **1/5 > 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. 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 the first back-wall echo from the known thickness step exceeds the gate threshold.

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. Once a steady reading is achieved, Choose **1/5 > Auto CAL > CAL Zero**.

    The screen freezes and the **Enter Value for Zero Cal** dialog box appears.
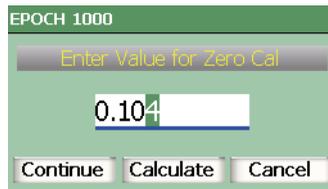
Figure 9-8 The Enter Value for Zero Cal dialog box

11. Adjust the value to match the known thickness of the gated indication (0.100 in. in this example), and then choose **Continue** to continue to the second calibration step.

NOTE

If for any reason you need to exit without acquiring calibration data, press the **[RIGHT]** or **[LEFT]** arrow key to highlight the **Cancel** box, and then press **[CHECK]**.

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. 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. Once a steady reading is achieved, choose **1/5 > 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 (0.500 in. in this example), and then choose **Calculate** to complete the calibration process.

9.6   Calibrating in Echo-to-Echo Mode

The sample echo-to-echo calibration described below is performed using 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, 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, since 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., 0.200 in., 0.300 in., 0.400 in., and 0.500 in.

> **NOTE**
>
> If the EPOCH 1000 Series 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 9.1 on page 134.
2. Connect the transducer to an appropriate cable, and then connect the cable 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. Choose **1/5 > 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. Choose **1/5 > 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 **2/5 > Gate 1 > Status = On** and **2/5 > Gate 2 > Status = On** to use them as measurement gates.

7. Select **2/5 > Gate Setup > G2 Tracks = G1** so that gate 2 tracks gate 1.
    For more information on gate tracking activation, see section 6.6 on page 116.

8. Select **1/5 > 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. 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 so that 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 might be impossible to bring the second indication above 50 % while avoiding saturation of the first signal. If this is true, try using the edge detection mode instead of the peak detection to ensure accurate measurements (see section 6.4 on page 113 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.

Thickness measurement
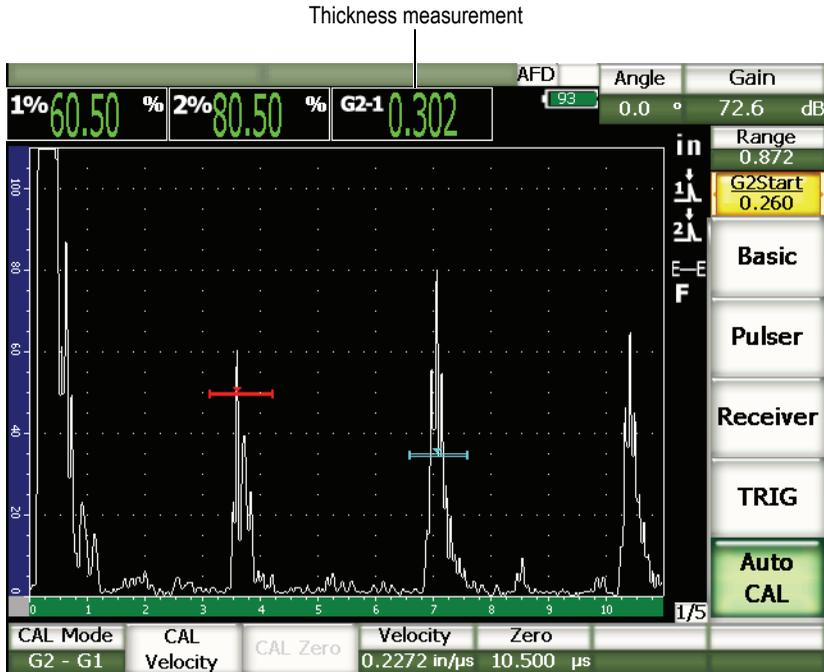
Figure 9-10 Example of a gated calibration signal

13. Once a steady reading is achieved, choose **1/5 > 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 (0.300 in. in
    this example), and then choose **Calculate** to complete the calibration process.

> ┌─────────────┐
> │   NOTE   │
> └─────────────┘
>
> If for any reason you need to exit without acquiring calibration data, use the
> **[RIGHT]** or **[LEFT]** arrow key to highlight **Cancel**, and then press **[CHECK]**.

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. x 0.625 in. 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 9.1 on page 134.
2. Connect the transducer to an appropriate cable, and then connect the cable to either of the conventional transducer connectors at the top of the instrument.
3. Choose **1/5 > TRIG > Angle**, and then enter the correct refracted angle for the transducer/wedge combination (45° for this example).
4. Choose **1/5 > Basic > Velocity**, and then enter the approximate shear-wave velocity of the material being inspected (0.1280 in./μs or 3.251 mm/μs if working in metric units for this example using carbon steel).
5. Choose **1/5 > Basic > Range**, and then enter an appropriate range for the test block being used (12.000 in. or 304.80 mm if working in metric units for this example).

Review the following procedures:

- "Locating the Beam Index Point" on page 154
- "Verifying the Refracted Angle" on page 155
- "Calibrating for Distance" on page 157
- "Calibrating for Sensitivity" on page 160

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 probe/wedge.

To locate the BIP

1. Couple the probe to the test block at the 0 mark.
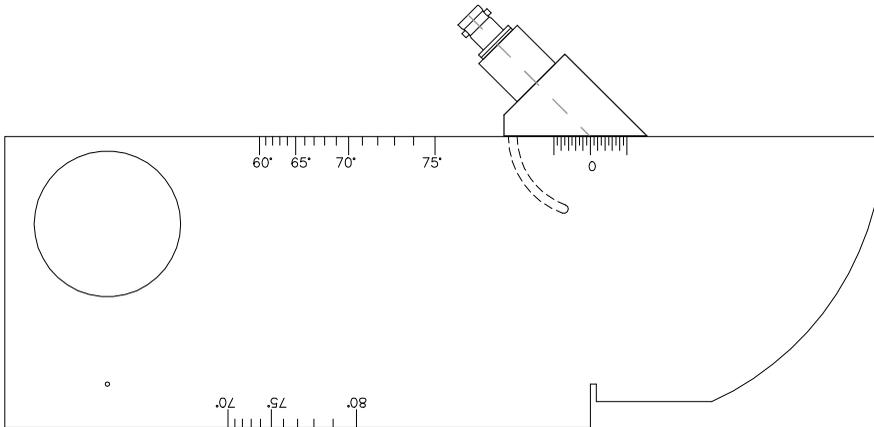
Figure 9-12 IIW block with probe at 0 mark

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. (100 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 155). 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.
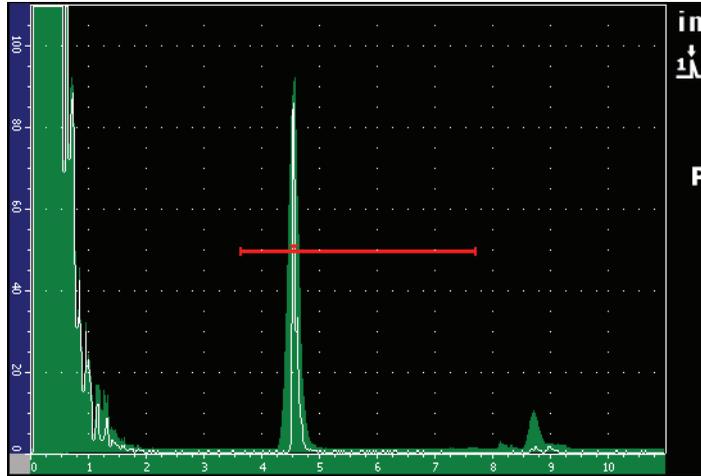
Figure 9-13 Using the peak memory to find the BIP

5. Hold the probe stationary once the signal is peaked up and mark the side of the transducer 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 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 sound path calculations are accurate.

To verify the refracted angle

1. Position the probe over the appropriate angle mark on the block (45° in this example).
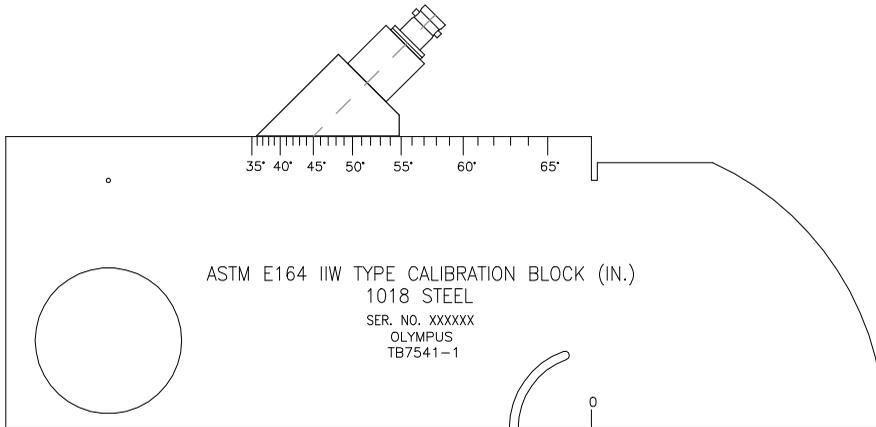
Figure 9-14 The IIW block with probe at the 45° mark

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 once the signal amplitude reaches a maximum' 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 9.7.1 on page 154.

   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. (100 mm) and 9 in. (225 mm) on the screen, which 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 section 9.10 on page 168.

NOTE

If the EPOCH 1000 Series 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. Choose **1/5 > Basic > Range**, and then set the value to 12.00 in. (300 mm).
   This should ensure that the echoes from the block are visible on screen.
2. Select **1/5 > 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 the first reflection from the arc of the block is exceeding the gate threshold.
   This reflection should be close to 4 in. (100 mm).
5. Press **[GAIN]**, and then 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.

Thickness measurement
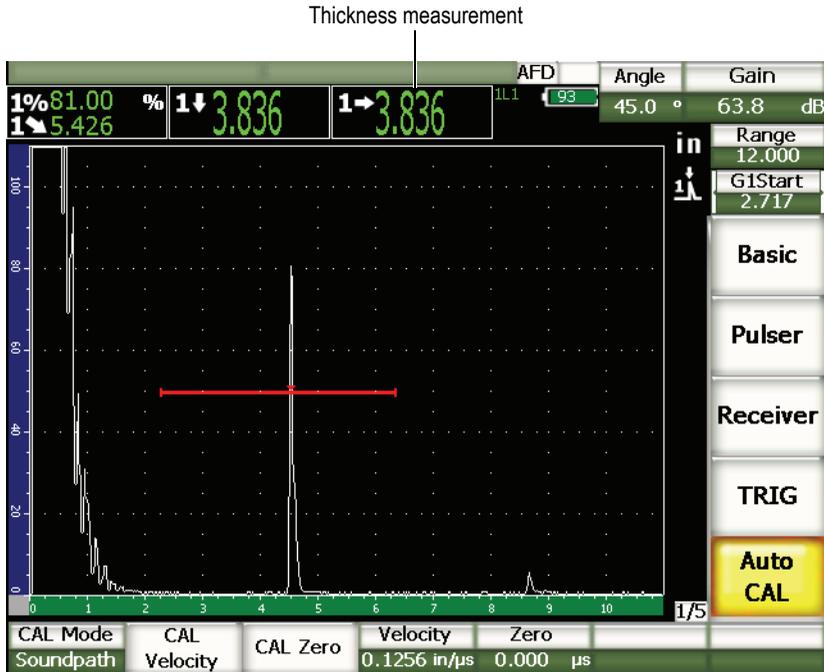
Figure 9-15 Example of a gated calibration signal

6. Once a steady reading is achieved, choose **1/5 > 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 (4.000 in. in
    this example), and then choose **Continue** to continue to the second calibration
    step.

> **NOTE**
>
> If for any reason you need to exit without acquiring calibration data, use the
> **[RIGHT]** or **[LEFT]** arrow key to highlight **Cancel**, and then press **[CHECK]**.

---

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).
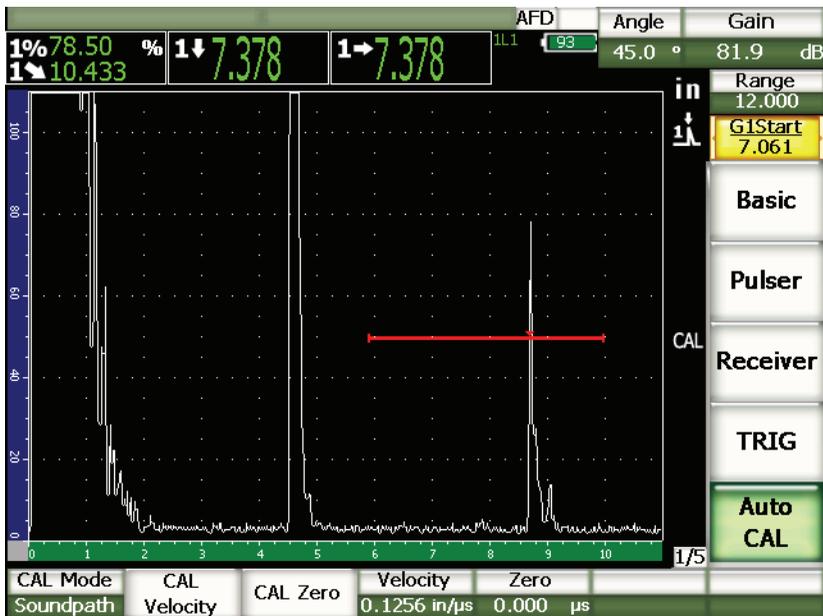
Figure 9-17 The second gated calibration signal

> **NOTE**
>
> Another echo might be present on the screen at approximately the 8 in. (200 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.

Calibrating the EPOCH 1000 Series (Conventional UT Mode)   159

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. Once a steady reading is achieved, choose **1/5 > Auto CAL > CAL Velocity**.

    The screen freezes and the **Enter Value for Velocity Cal** dialog box appears.
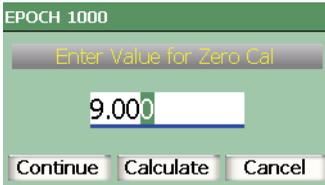
Figure 9-18 The Enter Value for Velocity Cal dialog box

11. Adjust the value to match the known thickness of the gated indication (9.000 in. in this example), and then choose **Calculate** to 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 probe 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.
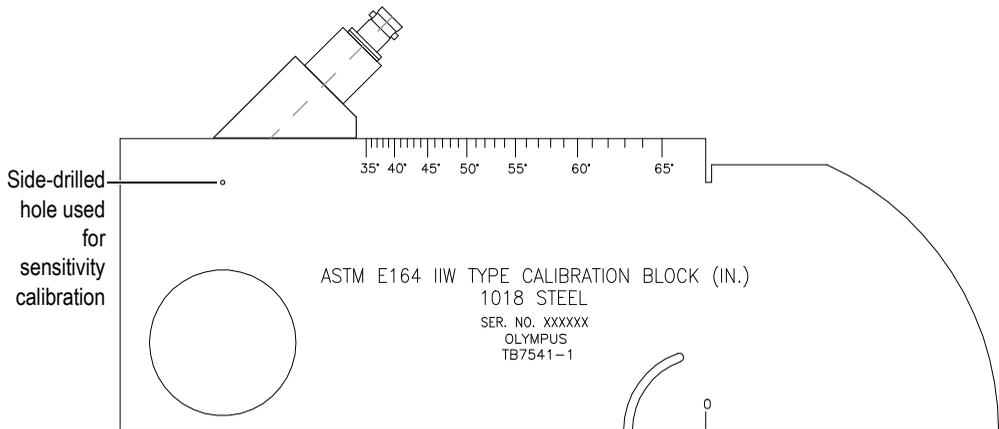
Figure 9-19 The IIW block with probe facing sensitivity hole

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 **1/5 > 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, please see section 4.3 on page 91.
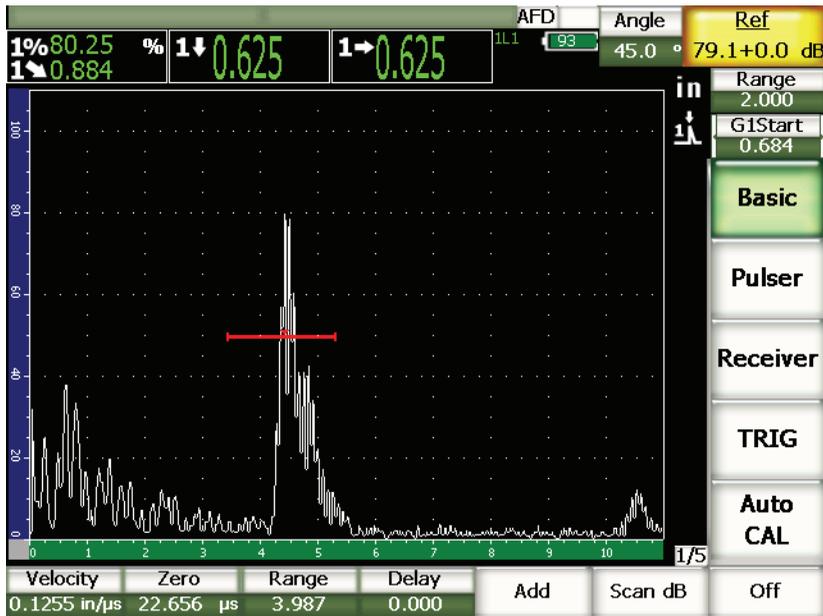
Figure 9-20 The Ref gain with indication

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 9.7 on page 153. 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. x 0.625 in. 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 172), produces echoes at various depths on the screen in 0.25 in. (6.35 mm) increments, which are used for depth 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 depth 0.5 in. and 1.5 in. (12.5 mm and 38 mm) are used.

For information on distance calibration with other standard calibration blocks, see section 9.10 on page 168.

```
        NOTE
```
If the EPOCH 1000 Series 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 depth distance

1. Choose **1/5 > Basic > Range**, and then set the value to 4 in. (100 mm). This ensures that the echoes from the block are visible on screen.
2. Select **1/5 > 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 the reflection from the first side-drilled hole is exceeding the gate threshold. This reflection should be close to 0.5 in. (12.5 mm).
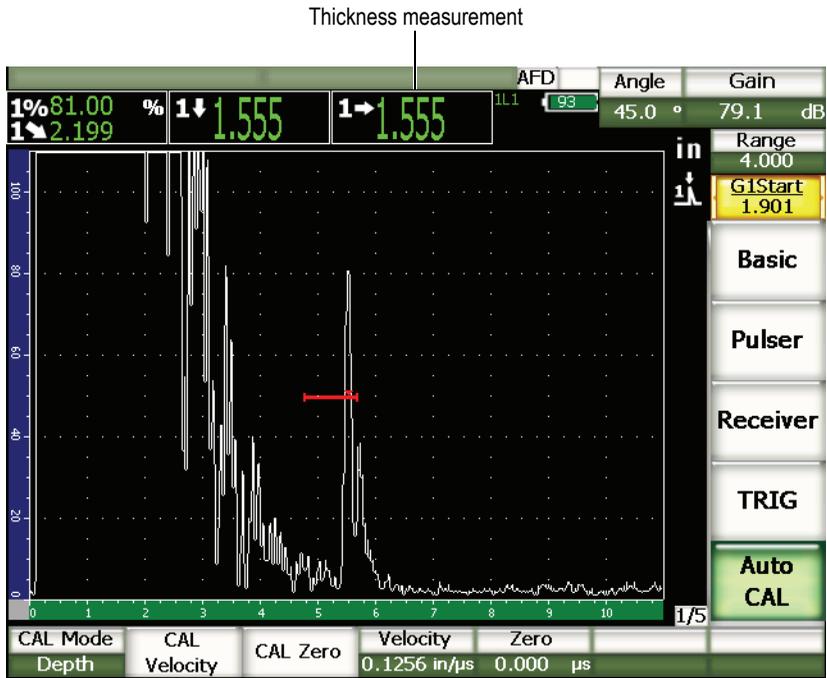
Figure 9-21 Example of a gated calibration signal

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. Once a steady reading is achieved, choose **1/5 > Auto CAL > CAL Zero**.

    The screen freezes and the **Enter Value for Zero Cal** dialog box appears.
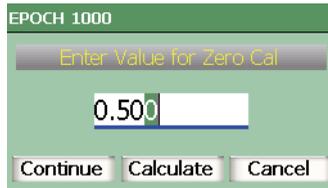
Figure 9-22 The Enter Value for Zero Cal dialog box

7. Adjust the value to match the known thickness of the gated indication (0.500 in. in this example), and then choose **Continue** to continue to the second calibration step.

```
         NOTE
```

If for any reason you need to exit without acquiring calibration data, use the **[RIGHT]** or **[LEFT]** arrow keys to highlight the **Cancel** box, and then press **[CHECK]**.

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. Once a steady reading is achieved, choose **1/5 > Auto CAL > CAL Velocity**.
    The screen freezes and the **Enter Value for Velocity Cal** dialog box appears.
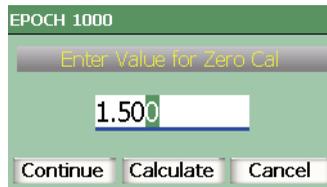
Figure 9-24 The Enter Value for Velocity Cal dialog box

11. Adjust the value to match the known thickness of the gated indication (1.500 in. in this example), and then choose **Calculate** to complete the calibration process.

9.9   Curved Surface Correction

The EPOCH 1000 Series provides for 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. Select **1/5 > TRIG > CSC = On** to activate curved surface correction.

   The CSC symbol appears in the flag area.

2. Choose **1/5 > TRIG > Outer Dia.** or **Inner Dia.**, and then enter the diameter of the inspection piece.

9.10   Common Angle Beam Calibration Block Diagrams

Figure 9-25 on page 168 to Figure 9-31 on page 173 illustrate calibration blocks commonly used with angle beam probes.
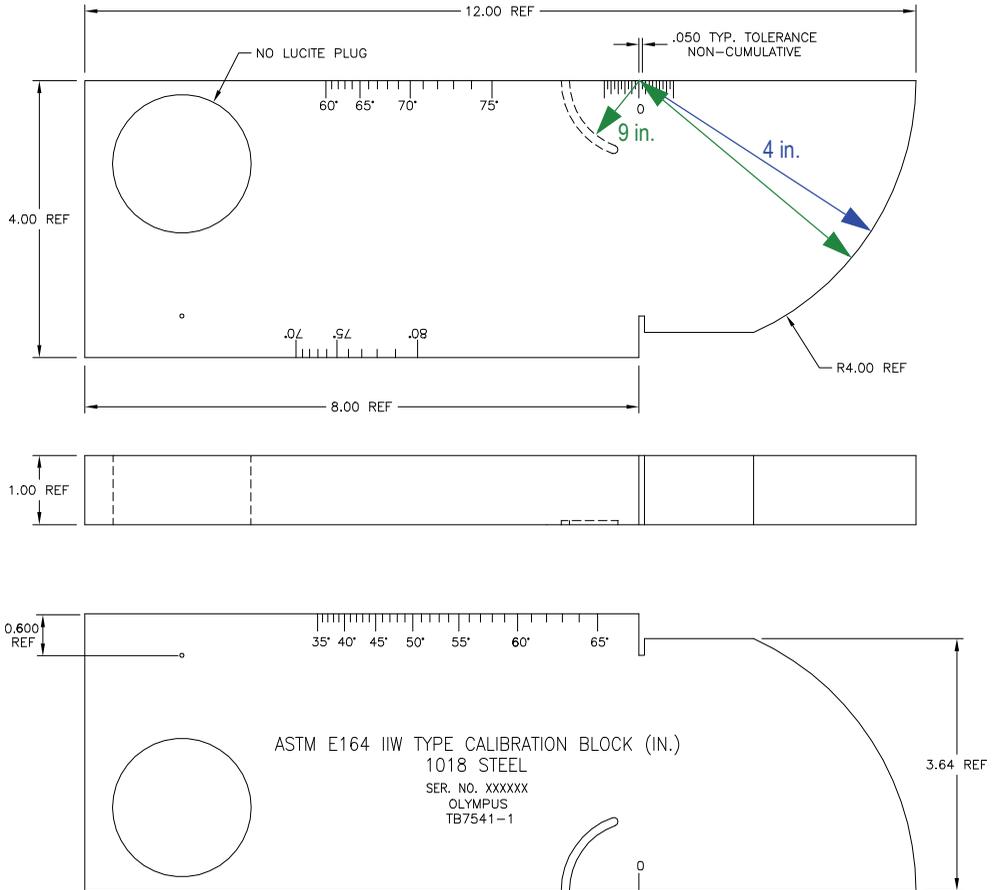
Figure 9-25 The ASTM E164 IIW type calibration block (P/N TB7541-1)
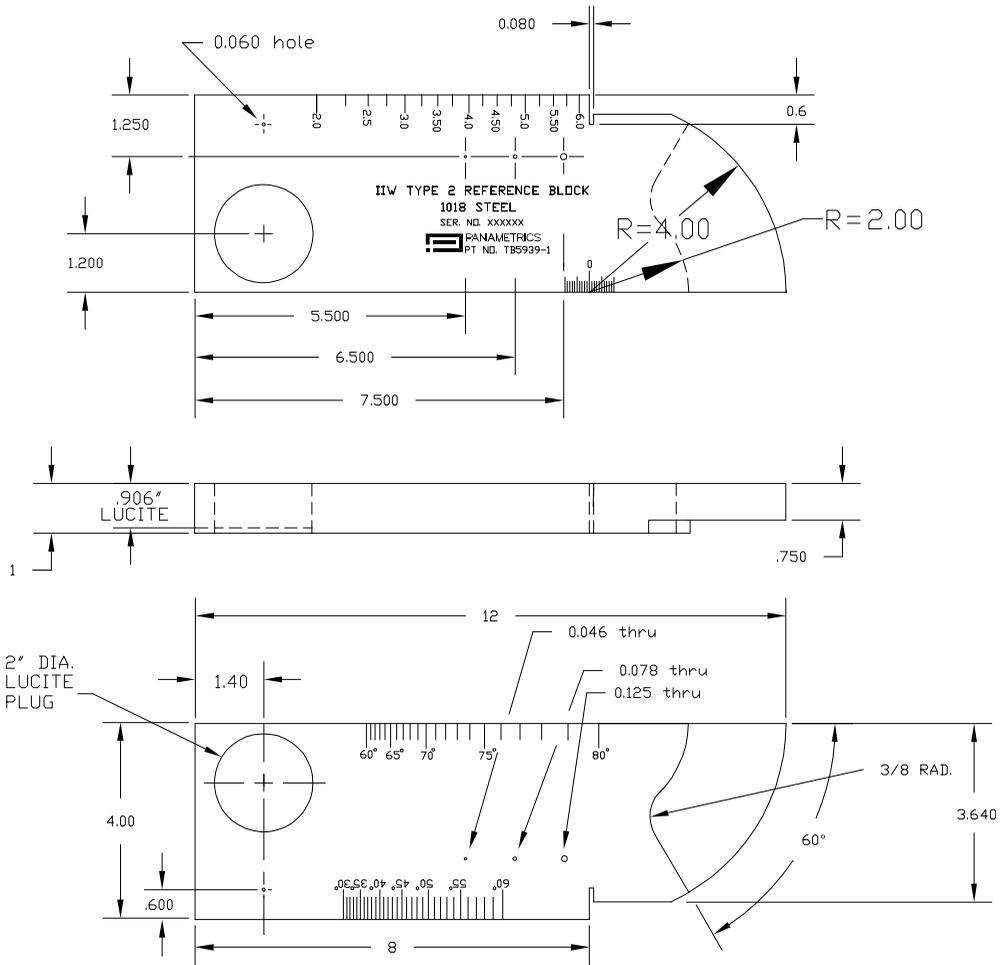
Figure 9-26 The IIW type 2 reference block (P/N TB5939-1)
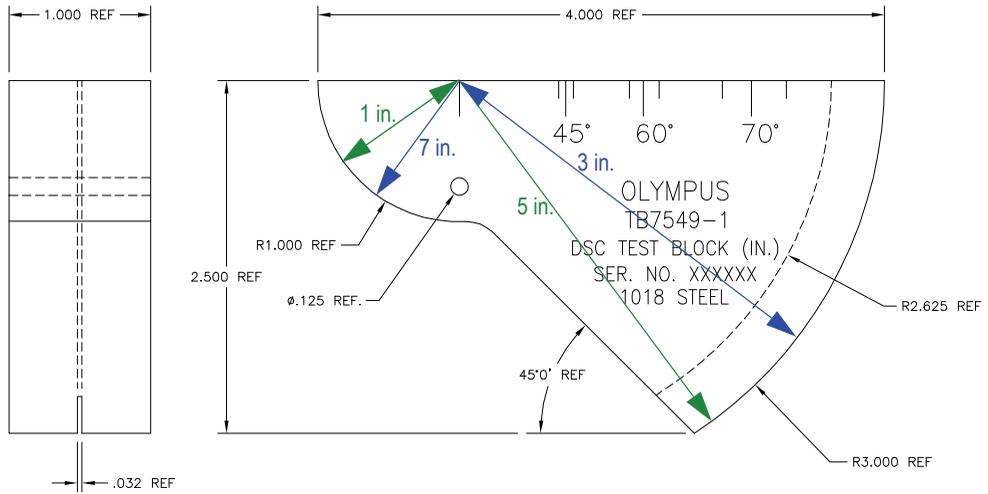
Figure 9-27 The distance and sensitivity calibration (DSC) test block (P/N TB7549-1)
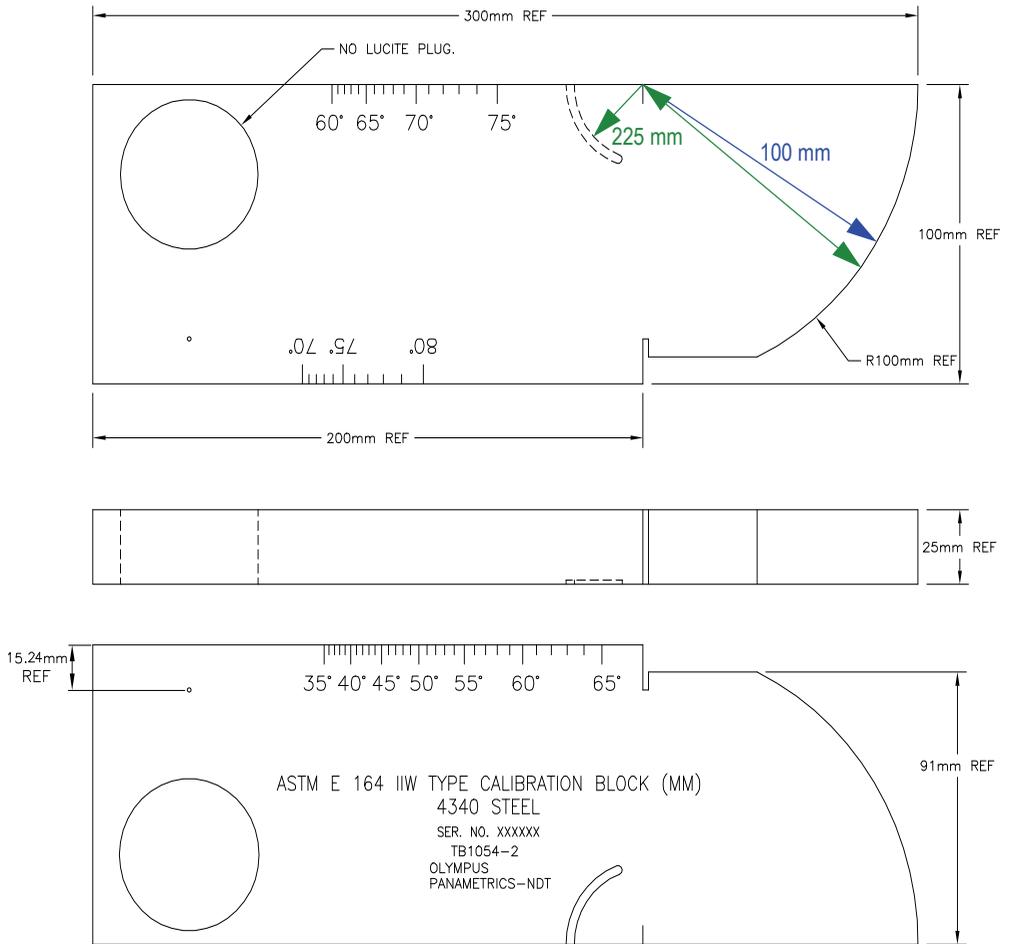
Figure 9-28 The ASTM E164 IIW type metric calibration block (P/N TB1054-2)
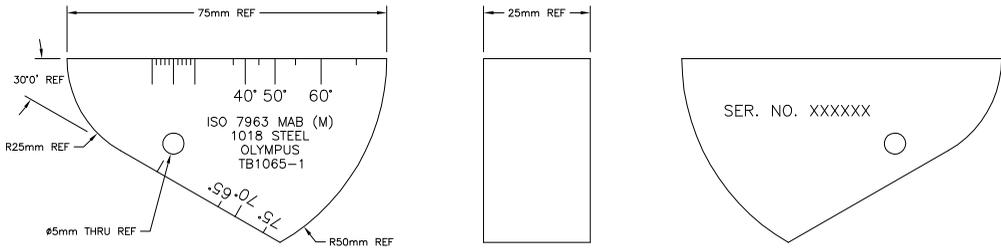
Figure 9-29 The ISO 7963 MAB calibration block (P/N TB1065-1)
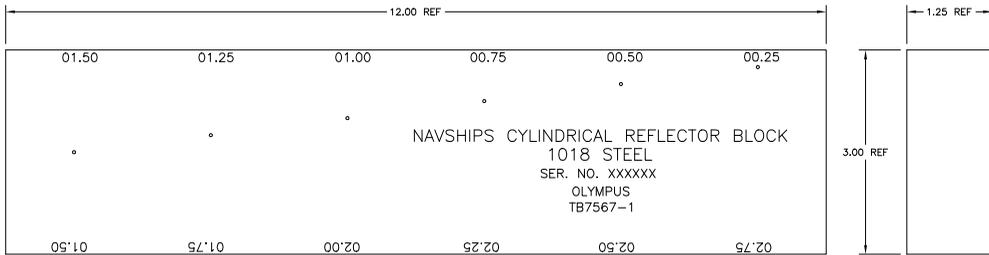
Figure 9-30 The Navships cylindrical reflector block (P/N TB7567-1)
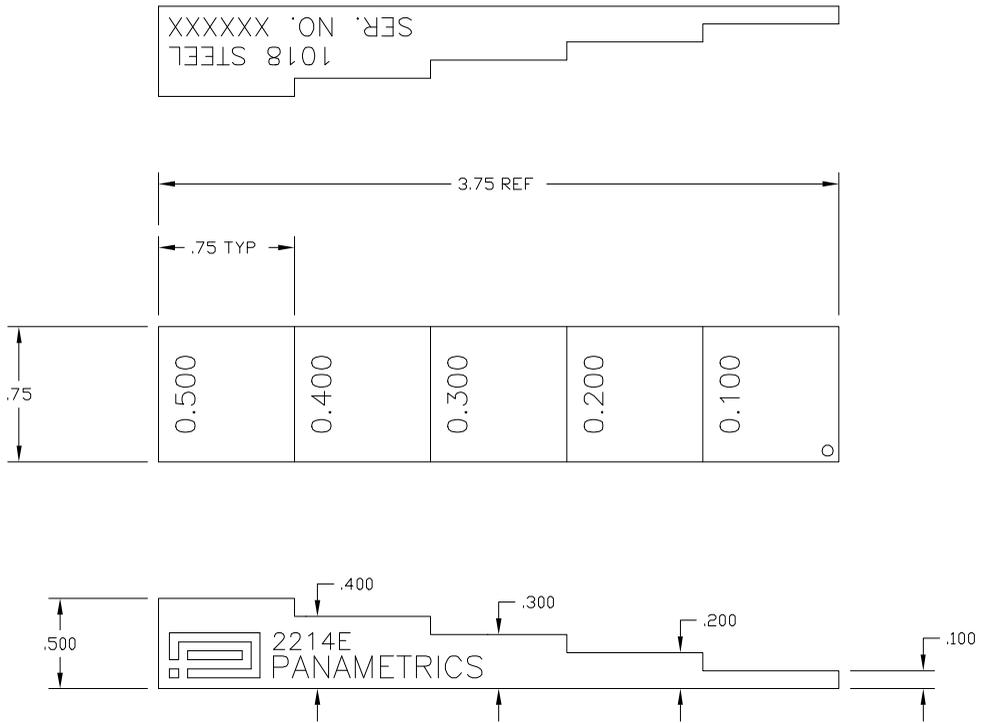
Figure 9-31 The 5-step precision thickness calibration block (P/N 2214E)

10. Managing the Data Logger

This chapter describes how to manage the EPOCH 1000 Series internal data logger. Topics covered include the following:

- Data Logger Overview
- Data Logger Storage Capacity
- Files Submenu
- Setting Up and Printing Reports
- Saving Screen Captures
- Instrument Resets
- Hard Instrument Reset

10.1 Data Logger Overview

Olympus has designed the data logger for ease of use and a wide range of file types and features for flaw detection and corrosion thickness gaging requirements. The data logger includes the following capabilities:

- Data organized by file and identifier (ID) codes
- Alphanumeric filenames and identifier (ID) codes
- File description, inspector ID, and location note field for every file
- File types similar to corrosion thickness gages:
  — Calibration files
  — Incremental 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
- Ability to transfer data between the EPOCH 1000 Series and a computer or printer.
- Ability to store files, images, and exported data on removable memory.

10.2 Data Logger Storage Capacity

The EPOCH 1000 Series stores the following information every time you press **[SAVE]**:

- 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
- S-scan image (phased array 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)

The EPOCH 1000 Series data logger can store over 300,000 IDs with the information listed above. All data is stored for every ID that you choose to save on the 2 GB CompactFlash card provided with each instrument.

10.3 Files Submenu

The EPOCH 1000 Series data logger parameters are accessible by choosing the **5/5 > Files** submenu. The available parameters are:

Open

Used to select a file as the active storage location.

Create

> Used to create a new file.

Reset

> Used to access the instrument and database reset functions.

Page Setup

> Used to access printing functions and removable storage setup items.

First ID

> Used to jump the current file to the first identifier (ID) in the file.

Last ID

> Used to jump the current file to the last identifier (ID) in the file.

Id:

> Indicates which identifier (ID) is currently active for storage

These parameters are covered in detail in the following sections.

10.3.1   Creating Data Files

You must create a data file before any information can be stored to the EPOCH 1000 Series. This file creation can be performed onboard the instrument, or can be created in the GageView Pro computer interface program and uploaded to the instrument.

To create files onboard the instrument

1. Choose **5/5 > Files > Create** to open the **Create** setup page shown in Figure 10-1 on page 178.
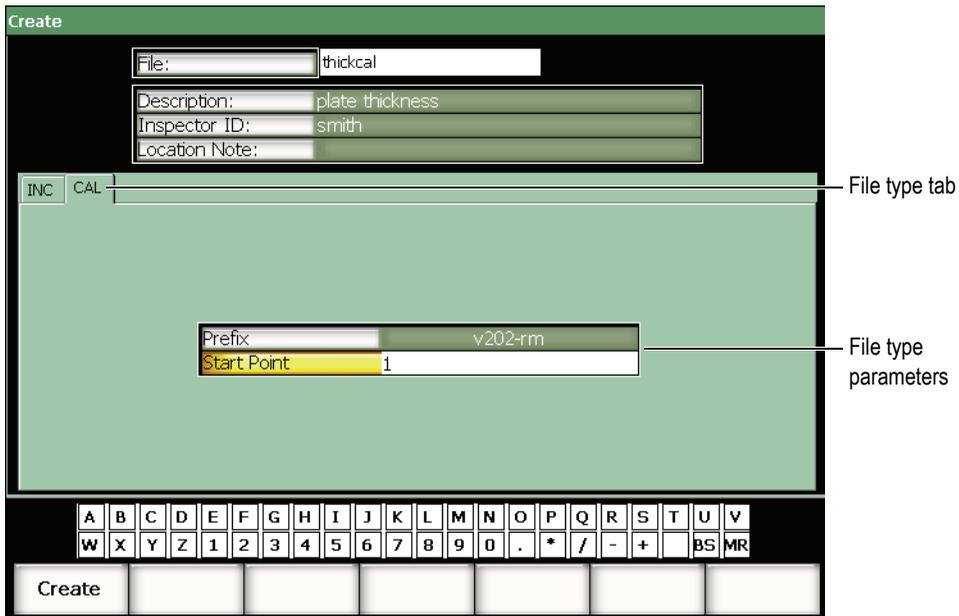
Figure 10-1 The Create setup page

2. In the **Create** setup page, choose **File**, and then enter a file name up to 8 characters long using the virtual keyboard or a USB keyboard.
3. Optionally enter information for the following parameters:
   a) Choose **Description**, and then enter a file description.
   b) Choose **Inspector ID**, and then enter identification information for the inspector.
   c) Choose **Location Note**, and then enter information regarding the inspection location.
4. Choose the desired file type tab (**CAL** in the example shown in Figure 10-1 on page 178). For more information on available file types, see section 10.3.6 on page 185.
5. Complete all required file type parameters.
6. Once you have completed file setup, choose **Create** to exit the setup page and create the desired file.

NOTE

Once a file is created, you must open the file before trying to save information. This is a separate function from **Create**. See section 10.3.2 on page 179 for a complete description of the **Open** function.

10.3.2   Opening Data Files

The EPOCH 1000 Series 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 function 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.

You can then use the **Recall** or **Quick Recall** functions to recall any number of calibration files during the inspection without making those files the active storage location (see section 10.3.5 on page 183). Once a new calibration is recalled, you can return immediately to using the **[SAVE]** key to store inspection data to the inspection file without having to open the inspection file again.

While this structure requires more operations at the beginning of an inspection, it can greatly reduce the number of operations required during an inspection.

To review the list of files currently available on the instrument, choose **5/5 > Files > Open**. This opens the **Open** setup page as shown in Figure 10-2 on page 180.
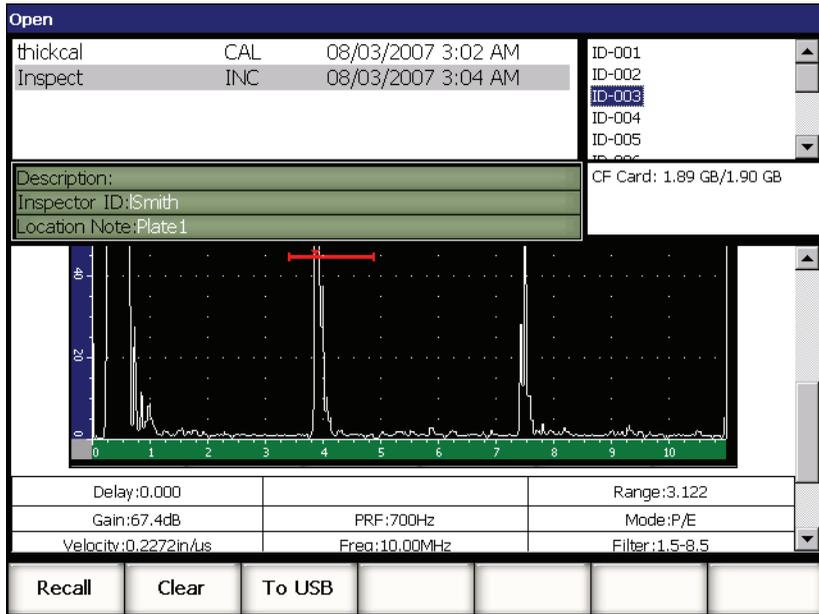
Figure 10-2 The Open setup page

The list of available files appears at the top-left of the setup page. Use the **[UP]** and **[DOWN]** arrow keys to scroll through each file. The IDs stored in each file are listed on the right of the screen when the file is highlighted.

To review a list of saved measurement readings within a particular file, highlight the file and press **[CHECK]**. A list of all IDs with measurement readings appears in the lower-half of the display.
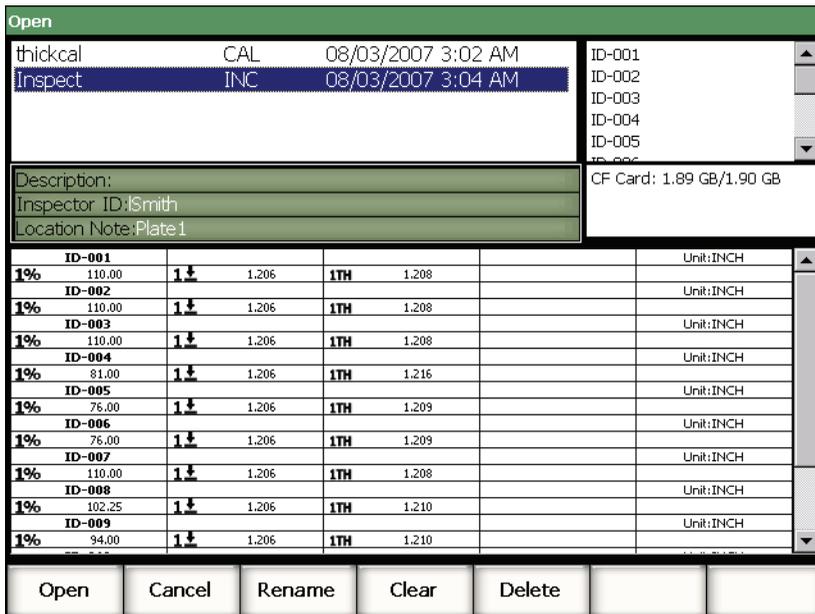
Figure 10-3 The File ID review screen

While the focus is on a file name, five parameter functions are available at the bottom of the setup page:

Open

Used to open the highlighted file as the active storage location.

Cancel

Used to leave the setup page and return to the live screen.

Rename

Used to rename the highlighted file.

Clear

Used to clear all data from the highlighted file but retaining the file structure, the file name and all IDs.

Delete

Used to delete the entire file, clearing the file contents and removing the file name and IDs from the available file list.

When a file ID is highlighted, the following parameters become available at the bottom of the setup page:

Recall

Used to recall all parameter settings within the highlighted ID as the live parameter settings.

Clear

Used to clear the data for the selected ID.

To USB

Used to create an HTML format report on a connected USB storage device for the contents of the highlighted ID.

10.3.3 Saving Data to Files

The EPOCH 1000 Series allows you to save data whenever there is an active file (survey) and an ID has been entered. Files are created by choosing **5/5 > Files > Create** as described in section 10.3.1 on page 177, or in GageView Pro and transferred to the instrument. Pressing **[SAVE]**, saves the data within the active file.

NOTE

If there is no active ID, the instrument displays the error message "No active ID" at the top of the display. You must have an active file (survey) and an ID entered before saving data. For more information, see section 10.3.2 on page 179.

When you press **[SAVE]**, the EPOCH 1000 Series saves the following information:

- Filename
- ID
- Up to 6 measurement readings (operator selected)
- A-scan waveform
- S-scan image (Phased Array Mode only)
- All instrument setup parameters
- Alarm information
- Any display flags
- Gate measurement mode icons

- Leg indicators for both gates
- Any displayed peak memory envelopes or peak hold A-scans
- Software feature/option setups

10.3.4   File Review

The EPOCH 1000 Series allows you to review the full contents of saved information within each file.

To access the full file content review

1. Choose **5/5 > Files > Open** to open the **Open** setup page.
2. Highlight the desired file in the file name list.
3. Press the **[RIGHT]** arrow key to highlight the ID list within the highlighted file name.
4. Use the **[UP]** and **[DOWN]** arrow keys to highlight the desired ID.
5. Press **[CHECK]**.

    The contents of the file for the highlighted ID appears in the lower-half of the screen.

6. Turn the adjustment knob to scroll up and down within the lower-half of the screen to review the entire file content.

10.3.5   Quick Calibration File Recall

The EPOCH 1000 Series allows you to quickly recall a calibration file without entering the file review submenu. The quick calibration recall feature is accessed by pressing **[RECALL SETUP]** on the keypad. A dialog box appears, showing a list of all .CAL files stored on the EPOCH 1000 Series instrument (see Figure 10-4 on page 184).

Figure 10-4 The Quick Recall dialog box

NOTE

Only files created using the CAL file type are displayed in the quick recall setup window.

To quickly recall a file using the recall setup

1. Press **[RECALL SETUP]**.

   The **Quick Recall** dialog box appears.

2. Use the **[UP]** and **[DOWN]** arrow or the adjustment knob to select the desired calibration file.

3. Press **[CHECK]** to select the desired file and recall its settings as the live instrument parameters.

4. Press **[ESCAPE]** to cancel the operation and return to the live screen.

10.3.6   Data File Types

The EPOCH 1000 Series supports two file types. These files allow storage of calibration data or standard inspection data. Each file type appears as a separate tab in the **Create** setup page, accessible by choosing **5/5 > Files > Create**.

Figure 10-5 The Create setup page with the INC file type tab selected

Each file type has a unique set of setup items. Not all items are mandatory to properly set up a file for data storage.

The following sections describe each file type in detail. In each section, a list of mandatory and optional fields is provided to aid in file setup.

10.3.6.1   Calibration File

A CAL file is designed for storage of instrument setups (calibrations). These files can only contain one saved ID at a time. This allows you to rapidly recall an instrument setup, either from the data logger submenu, or by using the **[RECALL SETUP]** button on the instrument keypad.

Mandatory Fields

- **Start Point**

Optional Fields

- **Prefix**

10.3.6.2   Incremental

After entering a starting ID number (up to 11 alphanumeric characters in the ID Prefix and up to 10 alphanumeric characters in the ID number itself), the EPOCH 1000 Series automatically increments the subsequent ID numbers using the following incrementing rules:

- Only that portion of an ID number consisting 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, etc. The 9 to 0 transition is done only after incrementing the character to the left. Letters are cycled A, B, C,..., Z, A, etc. 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 is shown on the display above the function keys. Subsequent saves overwrite measurement readings if you do not manually change the ID number first.

Mandatory Fields

- **Start Point**

Optional Fields

- **Prefix**

<div style="border:1px solid; display:inline-block">**NOTE**</div>

To make the instrument increment through a range of numbers several digits
wide while beginning with a single digit ID number, the maximum number of
digit positions must be entered initially using leading zeroes (see Figure 10-6 on
page 187).

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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

Figure 10-6 Example of an INC file type

10.4   Setting Up and Printing Reports

The EPOCH 1000 Series allows you to create basic reports on the instrument from stored or live data and print them out in the field using the USB host port of the instrument. To print an onboard report, you must be able to set up a **Report Header**, set up the printer output, and have access to a PCL5 compatible printer.

To set up and print a report

1.   Choose **5/5 > Files > Page Setup** to open the **ReportSetup** setup page.

Figure 10-7 The ReportSetup setup page

2.   Using the virtual keyboard or a USB keyboard:

   a)   Enter up to eight lines of text for the **Report Label**.
   These lines appear at the top of the report that is printed from the instrument.

   b)   Enter up to eight lines of text for the **Report Header**.
   These lines also appear at the top of the report that is printed from the instrument.

3. Choose **Printer**, and then select between **PCL Inkjet** or **PCL Laser,** corresponding to the type of printer that you connect to the instrument.

4. Optionally, choose **Draft Mode = On** to print a low-resolution draft of the report.

5. Optionally, choose **Color = On** to print the report in color (**Off** for black and white).

6. Select **Print Function = Report**.

7. Press **[ESCAPE]** to save the report configuration and exit the setup page.

8. Press the **[2ⁿᵈ F], [RECALL SETUP] (PRINT)** keys to print the report to the destination specified in step 6 (see the report example shown in Figure 10-8 on page 189).
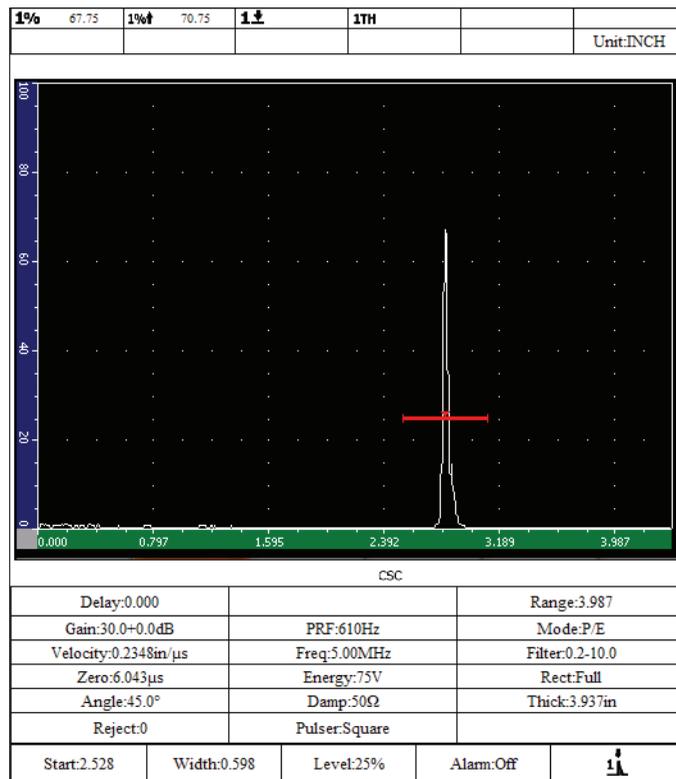
Figure 10-8 Report example

10.5   Saving Screen Captures

You can save screen captures of the EPOCH 1000 Series software either to the CompactFlash card included with the instrument or to a USB storage device connected to the instrument. This allows you to quickly capture live inspection data information for use in reports.

To save a screen capture

1. Choose **5/5 > Files > Page Setup** to open the **ReportSetup** setup page.
2. Choose **Print Function**, and then select the save destination for the screen capture file:

   a) Select **Image->CF** to save screen capture files to the CompactFlash card.

   OR

   b) Choose **Image->USB** to save screen capture files to the USB storage device connected to a USB host port of the EPOCH 1000 Series.
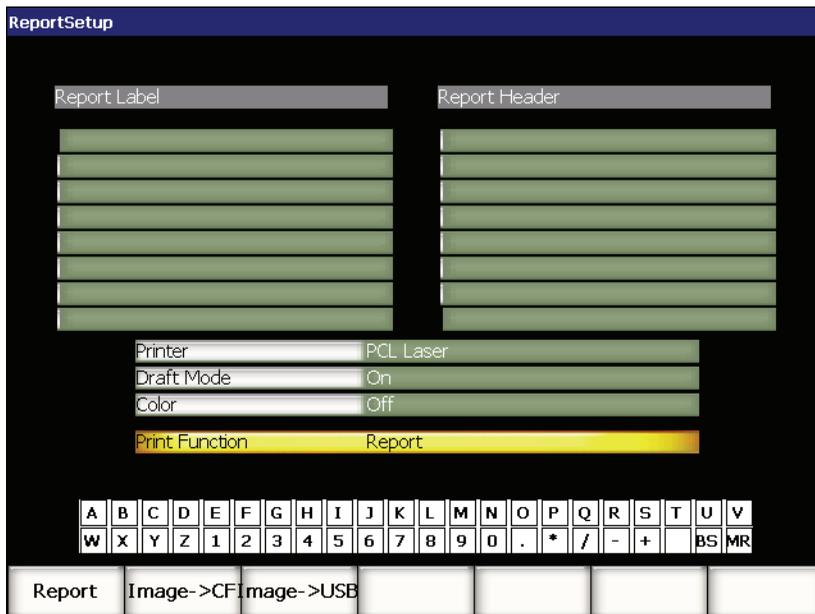
Figure 10-9 The Print Function in the ReportSetup setup page

3. Press **[ESCAPE]** to save the report configuration and exit the setup page.

4. Depending on your selection in step 2:

   a) Ensure that the CompactFlash card is inserted in the CompactFlash port in the battery compartment (see section 1.4.4 on page 32).

   OR

   b) Connect the USB storage device to one of the two USB host ports in the computer connection compartment on the right side of the instrument.

5. Press **[2ⁿᵈ F], [RECALL SETUP] (PRINT)** to save the screen capture file to the destination specified in step 2.

   The PNG format screen capture files that include the entire visible screen are saved under the following path and file name:
   \Olympus-NDT\EPOCH1000\<*instrument_s/n*>\ScreenCapture<#>.png

10.6 Instrument Resets

The EPOCH 1000 Series allows you to reset its current settings to default values, when necessary. The instrument reset parameters are available in the **Resets** setup page accessible by choosing **5/5 > Files > Reset**. Use the **[UP]** and **[DOWN]** arrow keys to highlight the desired data set. There are four data set options:

Master/Database

   Represents the entire data logger and the live parameters.

Parameters

   Represents the live parameters only.

Datalogger

   Represents acquired data only.

Probe Library

   Represents the DGS/AVG probe library data.

Up to five parameter functions are available at the bottom of the setup page to perform actions on the selected data set:

Restore

   Restores a backed up database, loading a back up file located at the root of a USB storage device attached to the instrument, and then turns the instrument off. The restored data set is available when you restart the instrument.

Backup

Backs up the selected data set by creating a backup file at the root of the USB storage device connected to the instrument (BackupDB.sdf file for **Master/Database** and BackupParameters.sdf file for **Parameters**).

Reset

Restores values to factory or user defined default settings (defined using **Create**) for the selected data set, and then turns the instrument off. The reset data set is available when you restart the instrument.

Create

Used to create user defined default settings with the current data set values. These settings are restored when you choose **Reset**.

Factory

Resets values to factory default settings, regardless of user defined default settings, and then turns the instrument off. The factory data set is available when you restart the instrument.

10.7 Hard Instrument Reset

In some situations, standard instrument resets may not correct an error occurring in the EPOCH 1000 Series' software. On rare occasions, the instrument may get stuck while starting up, which does not allow you to access standard instrument resets.

The EPOCH 1000 Series allows you to perform a hard reset on the instrument.

⚠️ **CAUTION**

A hard reset clears the data logger and returns all settings to the factory default values.

To perform a hard instrument reset

1. Create and save an empty text file named RESET.TXT to the root folder of a USB storage device.
2. Plug the USB storage device into the EPOCH 1000 Series.
3. Turn the instrument on while this USB storage device is connected.

The instrument detects the presence of the RESET.TXT file on the USB storage device, performs a hard instrument reset and restarts the instrument.

4. Allow the instrument to complete the startup process.

| NOTE |

For more information on troubleshooting tips, see chapter 18 on page 307.

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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. The topics are as follows:

• Defining Licensed and Unlicensed Software Features
• Dynamic DAC/TVG
• DGS/AVG
• AWS D1.1/D1.5 Weld Rating Software
• Interface Gate
• Floating Gate

11.1 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 conventional flaw detector:

• Dynamic DAC/TVG
• DGS/AVG
• AWS D1.1/D1.5 Weld Rating Software

The EPOCH 1000 Series also has two software options available. These options are not standard inclusions of the base instrument, and must be purchased and added to the unit. These two options, interface gate and floating gate, 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. This allows the software to be activated without having to return the instrument to a service center.

To activate a software option

1. Choose **3/5 > Inst Setup > Status** to open the **Status** setup page shown in Figure 11-1 on page 196.
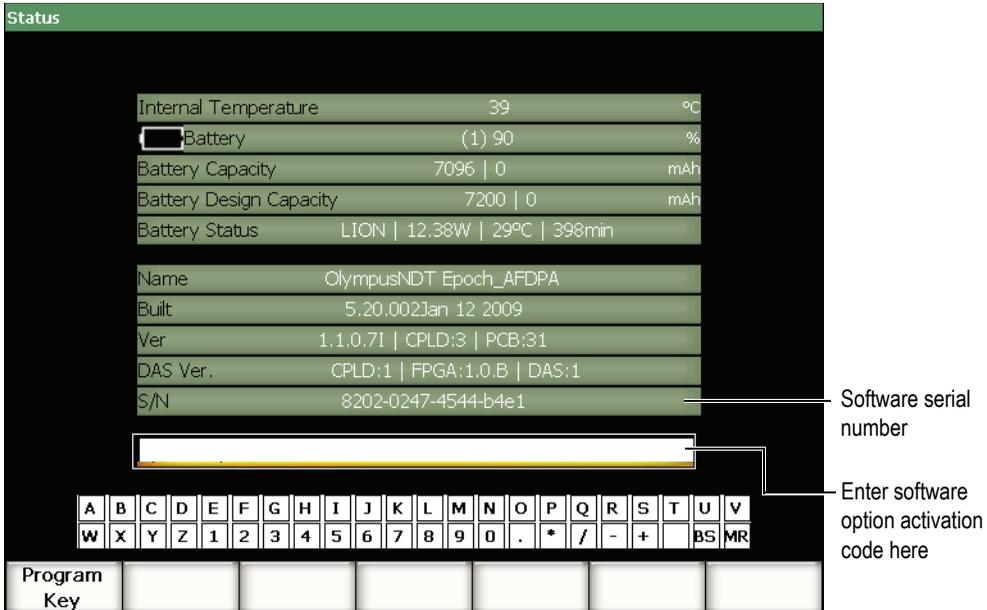
Figure 11-1 The Option key entry dialog box

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 an activation code.
4. Once this remote activation code is provided, open the **Status** setup page.

5. Using the virtual keyboard, enter the activation code in the field above the virtual keyboard (see Figure 11-1 on page 196).

6. When finished entering the activation code, choose **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 plotting a DAC curve, reflectors of the same size as those used for creation of the curve produce echoes that peak along the curve despite 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 the EPOCH 1000 Series, 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 freedom to use both techniques during a single inspection. When you switch from 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 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 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 choosing **4/5 > Sizing Option > DAC/TVG** (see Figure 11-2 on page 198).
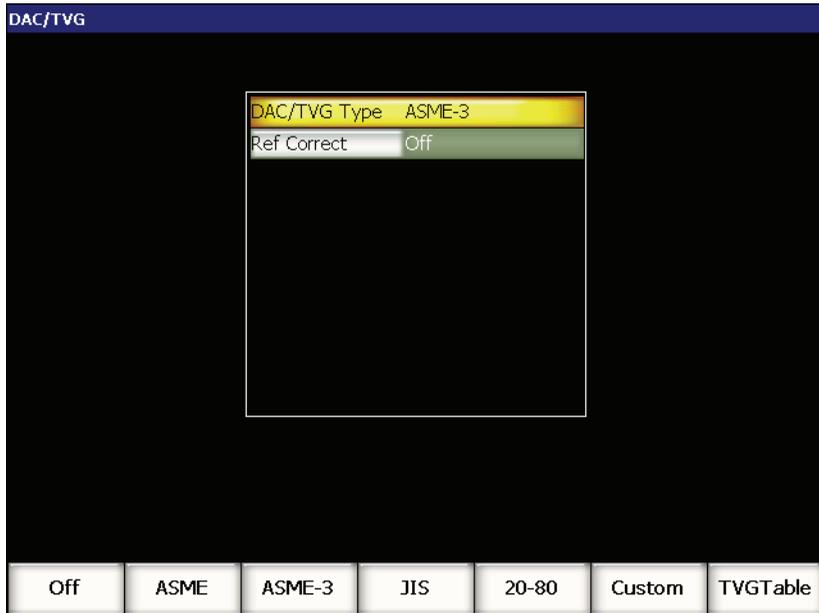
Figure 11-2 The DAC/TVG setup page

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. The reference correction feature, when activated, 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.

Once the proper selection of DAC/TVG has been made (including activation of **Ref Correct** where applicable), use the **[ESCAPE]** key to return to the live A-scan screen and begin DAC/TVG setup.

Once in the live A-scan mode, a new menu appears (**6/6**), dedicated to DAC/TVG features. This menu allows access to several important functions that control DAC/TVG setup and operation.

To deactivate a DAC/TVG feature, return to the **DAC/TVG** setup page and, and then set **DAC/TVG Type = 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

Once you have selected the desired DAC mode, the live A-scan display should appear as shown in Figure 11-3 on page 200.
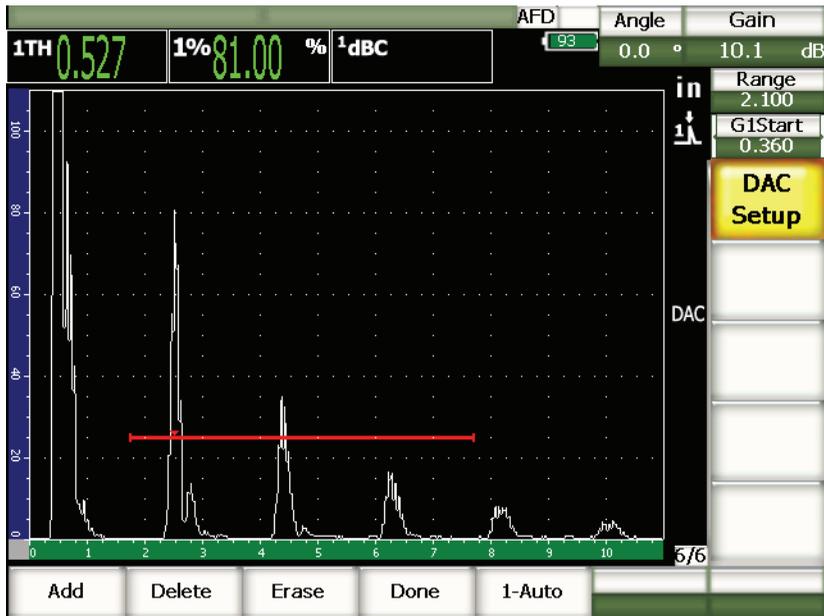
Figure 11-3 First DAC setup step

To capture DAC points, you must move gate 1 to the echo, and then choose **6/6 > DAC Setup > Add**.

TIP

The EPOCH 1000 Series allows 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. Choose **6/6 > DAC Setup > 1-Auto** or **[2nd F], [GATE]** to activate auto-80 % for each indication before capturing the point.

Once a point is captured, the peak amplitude of that point is marked using an "x" symbol. Figure 11-4 on page 201 shows one DAC point captured using **Add**.
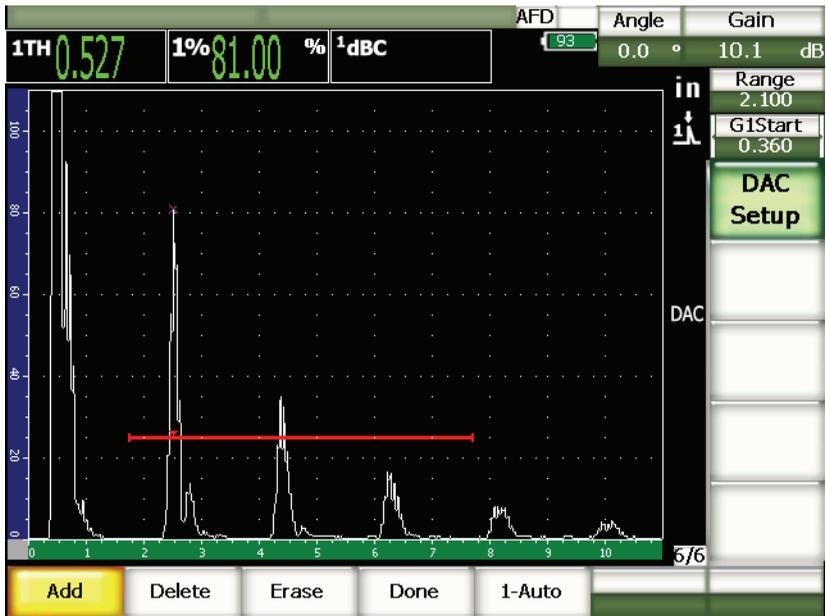
Figure 11-4 DAC Setup one point

Figure 11-5 on page 202 shows the EPOCH 1000 Series display when the second point has been captured.
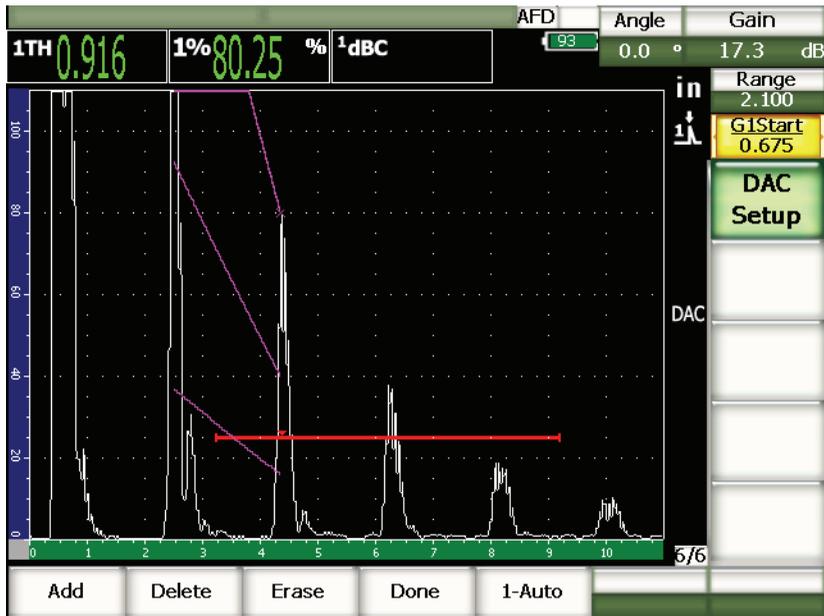
Figure 11-5 DAC setup two points

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 the entire DAC curve acquired.

Erase

Erases only the point(s) within the gated region.

Done

Completes curve acquisition and switches to inspection mode.

Figure 11-6 on page 203 shows a DAC curve after 5 points have been acquired. In this example, every point was automatically adjusted to 80 % FSH prior to capture.
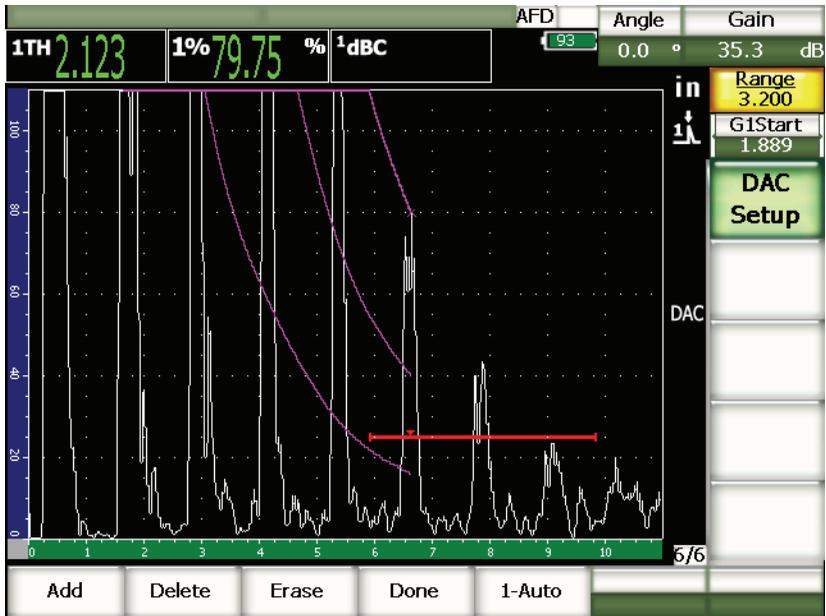
Figure 11-6 DAC Setup five points

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.

Once the correct number of points have been captured, choose **6/6 > DAC Setup > Done** to complete the DAC curve and switch to the DAC inspection mode.
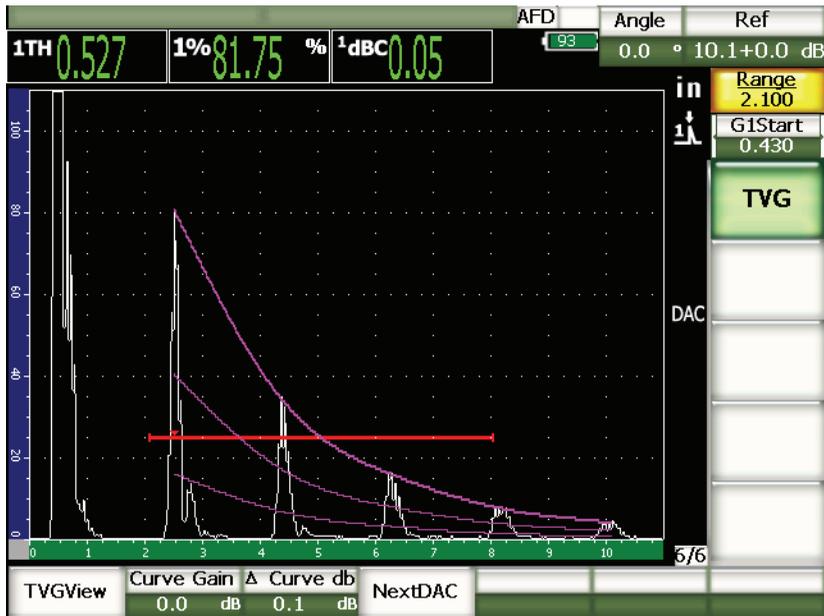
Figure 11-7 The completed DAC curve

Once 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, 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.
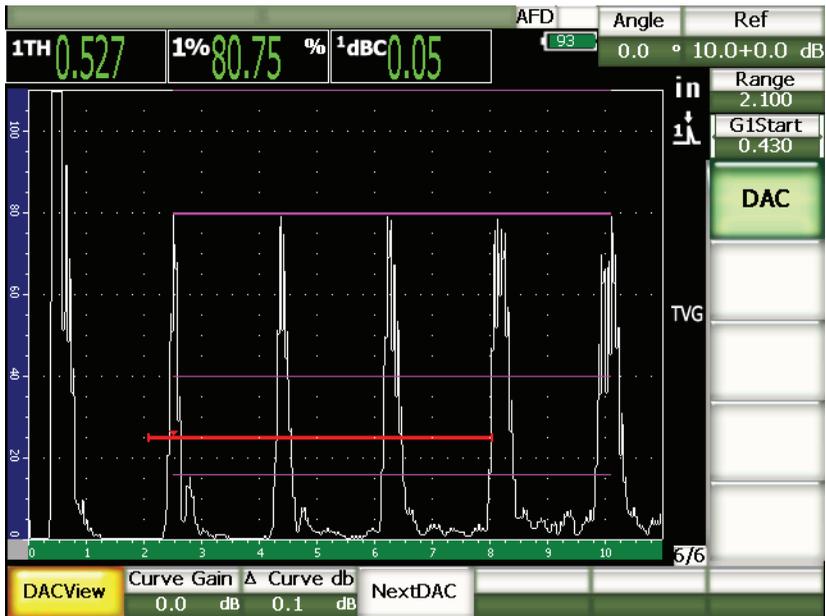
Figure 11-8 Completed DAC curves in DAC view mode

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 11-9 on page 206 shows a reduced range with delay.

Figure 11-9 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

In order to quickly find and identify potential defects, it is commonly required by code to increase the gain (scanning gain) on the EPOCH 1000 Series 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. Use the **[UP]** and **[DOWN]** arrow keys or the adjustment knob to increase or decrease scanning gain.
3. Press **[ESCAPE]** twice to return to the **1/5 > Basic** submenu.
4. Choose **1/5 > Basic > Scan dB** to toggle between the base (reference) gain and the adjusted scanning gain.
5. Choose **1/5 > Basic > Off** to turn scanning gain off completely.

Figure 11-10 on page 207 shows an ASME DAC setup with 3 dB of scanning gain added.

Figure 11-10 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 11-11 on page 208 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 11-11 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

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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. Choose **6/6 > TVG > Δ Curve dB**, and then choose the desired increment of the gain adjustment.
2. Choose **6/6 > TVG > Curve Gain**, and then adjust the curve gain by the selected increment either positive or negative.

Figure 11-12 on page 209 shows a DAC setup with DAC gain in use to provide accurate echo amplitude measurement by placing the echo close to 80 % FSH.
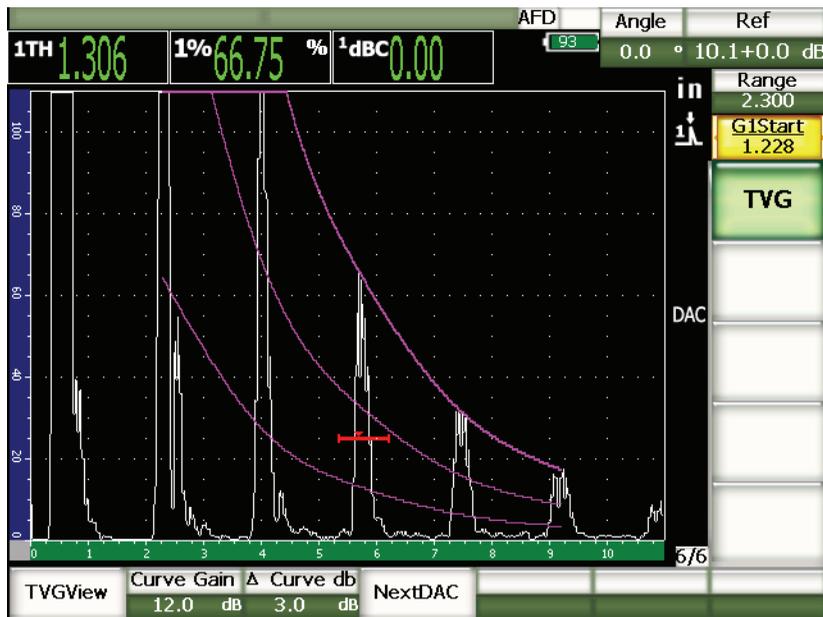
Figure 11-12 DAC curves with adjusted gain

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 between a calibration block and 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. The EPOCH 1000 Series can be easily adjusted 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. Choose **1/5 > Basic**.
2. Press **[GAIN]**.
3. Use the **[UP]** and **[DOWN]** arrow keys or the adjustment knob to bring the scanning gain to the desired level for transfer correction.
4. Once the desired scanning gain is displayed, choose **1/5 > 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 choose **6/6 > 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 choosing **4/6 > Sizing Options > DAC/TVG**.

2. Use the **[RIGHT]** and **[LEFT]** arrow keys, the adjustment knob, or the direct-access **[P]** keys to 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, choose **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 11-13 Custom DAC setup

The custom DAC setup and functionality are the same as the ASME and ASME III discussed earlier in this section. Figure 11-14 on page 212 shows a completed custom DAC setup.
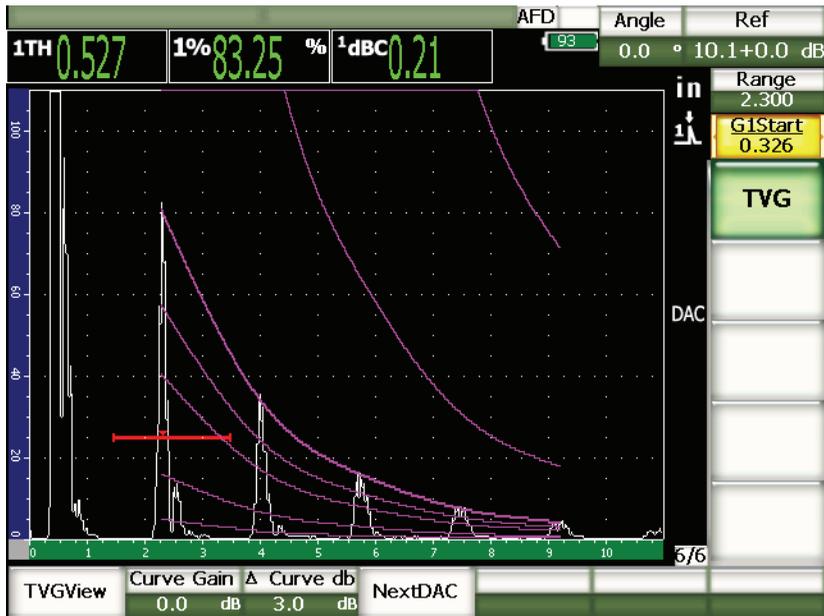
Figure 11-14 Completed custom DAC

Once 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.

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 these 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.
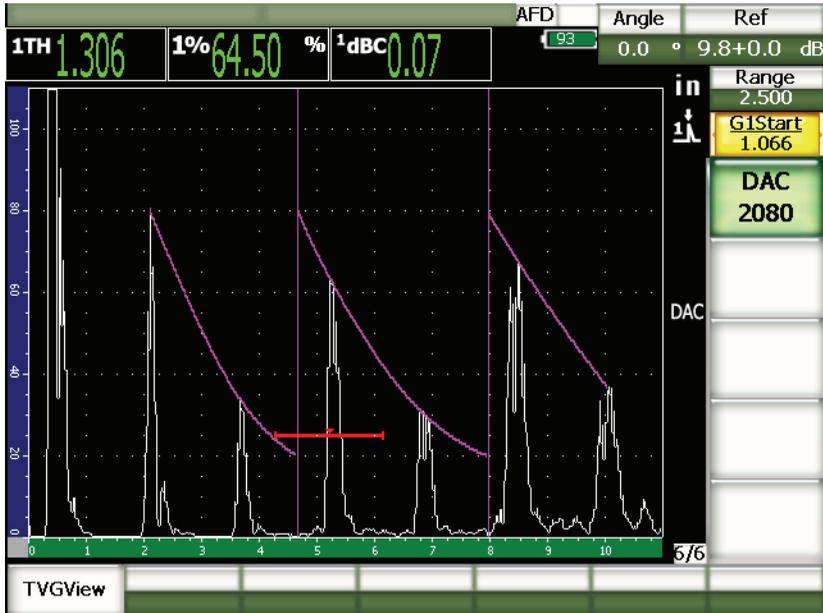
Figure 11-15 Completed 20-80 DAC

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.

Once the **20 %-80 % DAC** curve is completed, you can toggle between DAC and TVG views, manipulate **Range**, **Delay**, **CAL Zero** and **Angle**, and also to 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 in 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 the EPOCH 1000 Series to be used as a true immersion scanning instrument.

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 beginning 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. The TVG curve defined with the TVG table option uses the following parameter functions in the **6/6 > TVG Setup** submenu:

Add

Add 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 **6/6 > TVG Table** parameters.

TVGTable On

Displays the TVG table so you can refer to, or edit, points in the customized TVG setup.

TVGTable Off

Hides the TVG table so you have a larger view of the live A-scan.

Edit

Enters the TVG table to allow point-by-point editing.

Add

> Adds a row to the end of the TVG table for new points.

Insert

> Adds a row before the current highlighted row.

Delete

> Deletes the highlighted row from the TVG table.

Erase

> Erases all points from the TVG table.
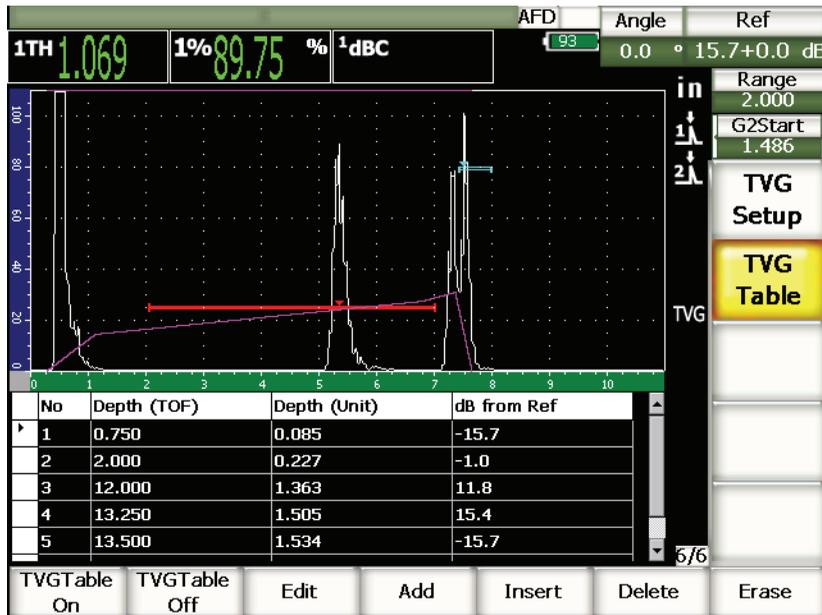
Figure 11-16 Completed TVG table with table view

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 uses these points as a reference and draws a straight line, representing 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 selected units (in., mm, etc), along the screen range where a gain adjustment is defined.

dB from Ref

> The gain value, as compared to base (reference) gain, of the exact point defined along the screen range.

To build a TVG setup with TVG Table

1. Choose **TVGTable On** to view the current TVG table.
2. Choose **Edit** to edit points within the table.
3. Choose **Add** to add a new point to the table.
4. Use the **[RIGHT]** and **[LEFT]** arrow keys to select **Depth** (either TOF or units), and adjust the value of the point depth using the adjustment knob.
5. Use the **[RIGHT]** and **[LEFT]** arrow keys to select the **dB from Ref** column and use the adjustment knob to vary the gain value from base gain.
6. Repeat steps 3 to 5 to continue adding points and adjusting the gain across the screen range using TVG table.
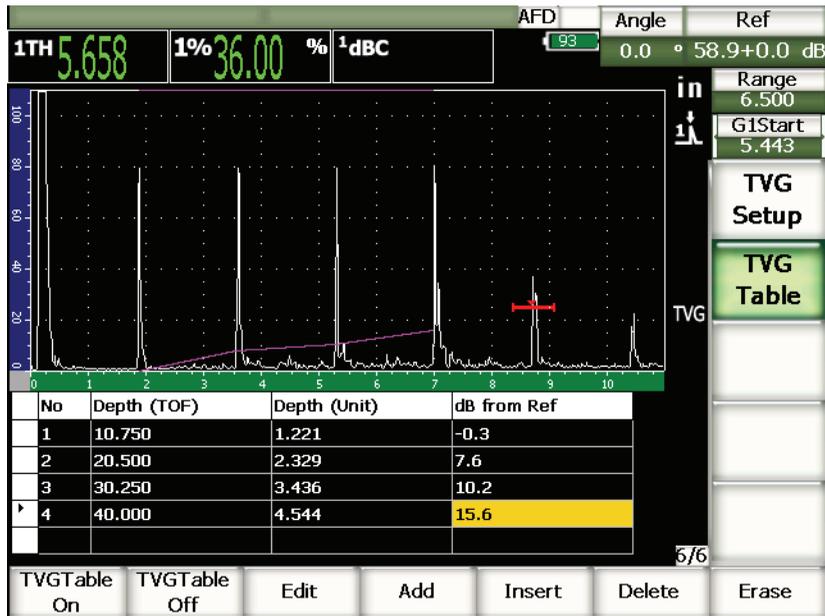
Figure 11-17 TVG table being set up

7. Use the **[UP]** and **[DOWN]** arrow keys to move up and down between rows to edit previously adjusted points.

8. When finished, choose **TVGTable Off** to hide the setup table and inspect using a full-screen A-scan view.
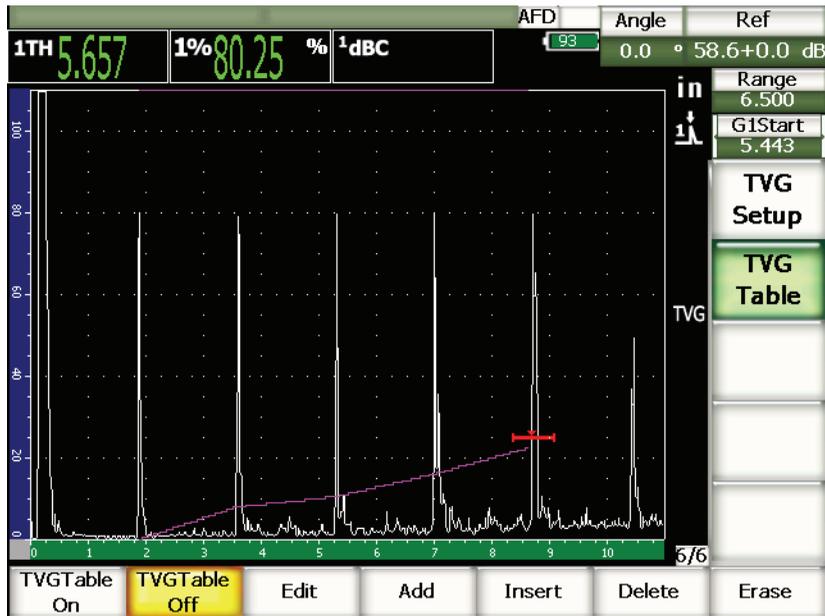
Figure 11-18 A-scan inspection with TVG table (table view off)

11.3   DGS/AVG

The Onboard DGS/AVG option in the EPOCH 1000 Series 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 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.

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. 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 the EN 583-2:2001 requirements. It is extremely important that you be familiar with this specification and others, and be 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   Option 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 221) by choosing **4/5 > Sizing Option > DGS/AVG**.

Figure 11-19 DGS/AVG setup page

This screen allows you to define the exact probe being used for the inspection, and to 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

Selects the type of probe to be used (Straight Beam, Angle Beam, Dual, or Custom).

Probe Name

Selects the actual probe to be used.

Reflector Type

Defines 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)
- • 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 angle beam inspections 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 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.

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 the surface distance measurements.

NOTE

You, as a trained operator, must be aware of 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 later in this manual.

Once 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. Press **[2ᴺᴰ F]**, **[GAIN] (REF dB)** to capture the reference-reflector and build the DGS/AVG curve.
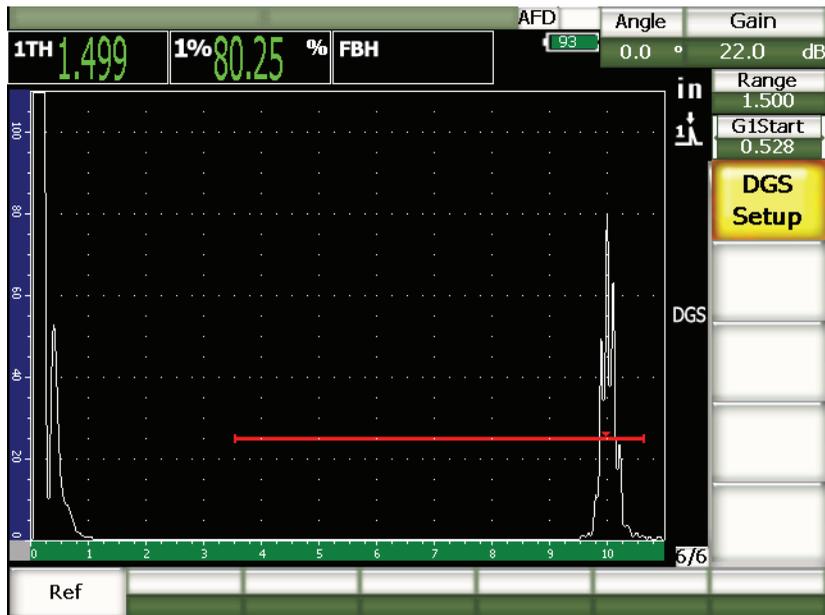
Figure 11-20 Reference-reflector before capture

After capturing the reference-reflector, the EPOCH 1000 Series automatically calculates the DGS/AVG curve(s) and displays them at the correct registration level amplitude on the screen.
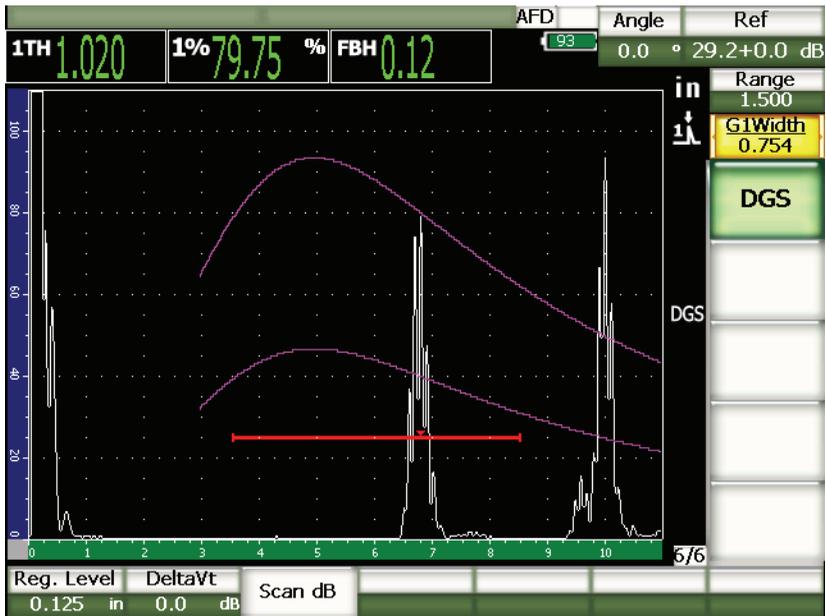
Figure 11-21 DGS/AVG curves on the screen

11.3.2   Curve Adjustment Options

Once a DGS/AVG curve has been calculated on the EPOCH 1000 Series, 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.

11.3.3   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 between a calibration block and 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. The EPOCH 1000 Series allows you to adjust 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

◆ Choose **7/7 > 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.

11.3.4   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 using DGS/AVG curve-adjustment gain.

To adjust the DGS/AVG curve gain

1. Press **[GAIN]**.
2. Use the **[UP]** and **[DOWN]** arrow keys or the adjustment knob to adjust the curve gain. The curve-gain difference is added/subtracted from the instrument base (reference) gain.

> | NOTE |
> | --- |
>
> DGS/AVG curve gain adjustment are applied to both the echo height and curve height to maintain the amplitude ratio and therefore, the sizing comparisons.

Figure 11-22 on page 227 shows a DGS/AVG setup with curve-gain in use to provide accurate echo-amplitude measurement by placing the echo close to 80 % FSH.
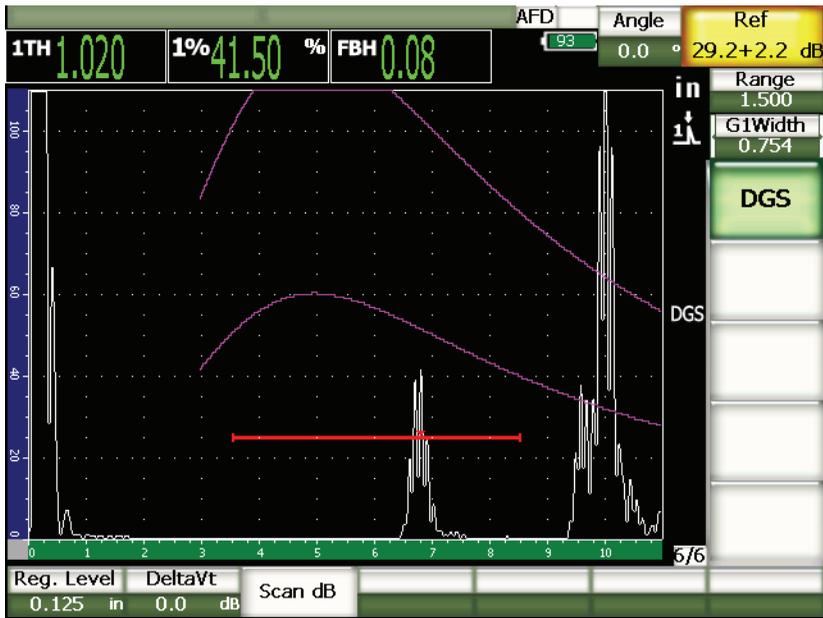
Figure 11-22 Gain curve adjusted DGS

11.3.5   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 the EPOCH 1000 Series 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

◆   Choose **7/7 > DGS > Reg. Level** to adjust the current registration-level value.

11.3.6   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, it might be suitable in many conditions 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.) (dB)

D = Indication rating (dB)

The AWS D1.1 inspector must take the Indication Rating (D) that is calculated based on A, B, and C 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 your 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 perform some required calculations automatically and also by permitting the inspector to document discontinuities in the EPOCH 1000 Series' data logger for reporting purposes.

The EPOCH 1000 Series 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   Option Activation

The first step in operating the EPOCH 1000 Series for AWS D1.1 inspections is to calibrate the instrument 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 **4/6 > 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 80 % full-screen height (FSH). 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 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 80 % FSH.
3.   Choose **6/6 > 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 section 3.3.3 on page 71.
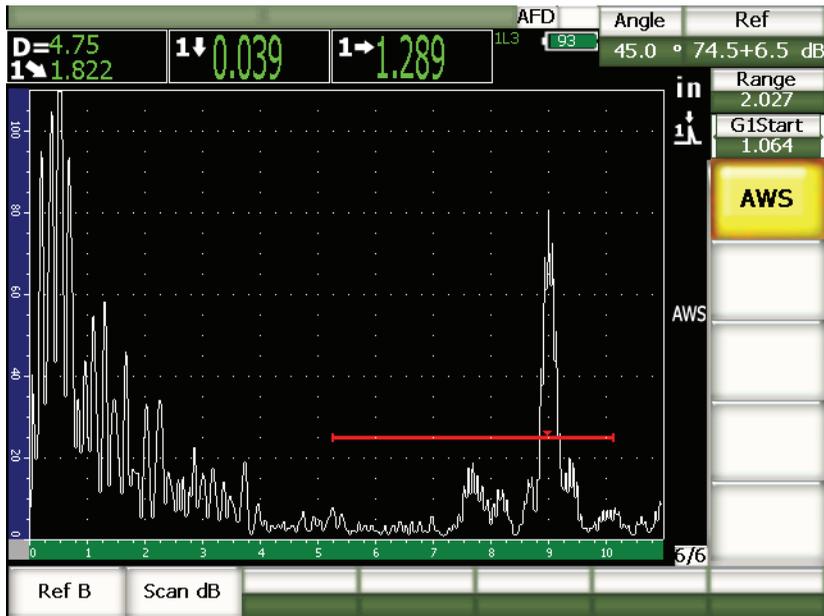
Figure 11-24 Active AWS with D rating

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. Choose **6/6 > 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 automatically calculates the A and C values necessary to provide a D indication rating value. For A, the EPOCH 1000 Series automatically calculates the required dB value to bring the gated echo to 80 % FSH. To calculate C, the EPOCH 1000 Series 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 chapter 10 on page 175.

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 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.

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 **2/6 > IF Gate** submenu becomes available. The interface gate status, positioning and alarm conditions are controlled via the same methods described in chapter 6 on page 109.
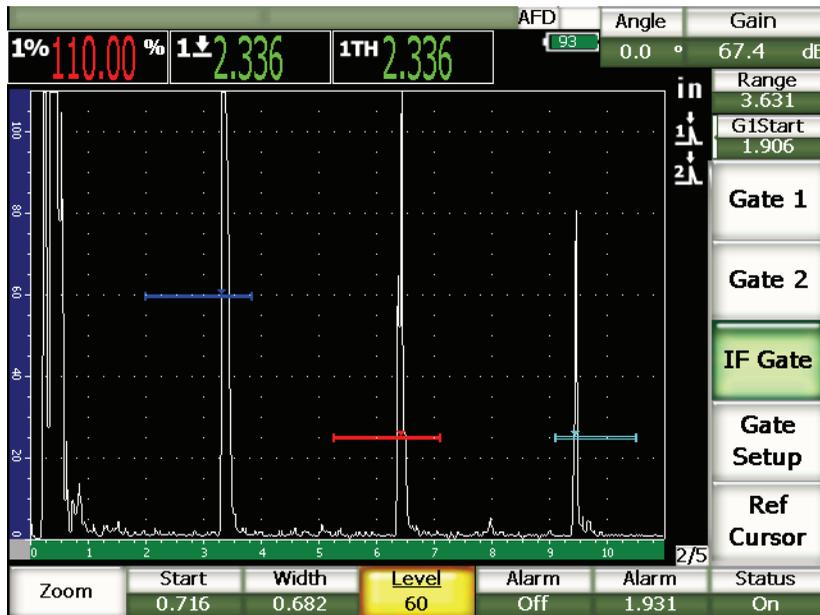
Figure 11-25 Active IF gate with IF Gate submenu

11.5.2   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 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 chapter 6 on page 109.

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, 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 **FGate** setup page by choosing **3/6 > General Option > Floating Gate**. The floating gate setup page allows you to adjust the following parameters:

G1 Float

Activate/Deactivate the floating gate feature for gate 1.

Level

Level (in dB) at which the gate tracks below the peak amplitude of the gated indication (gate 1).

G2 Float

Activate/Deactivate the floating gate feature for gate 2.

Level

Level (in dB) at which the gate tracks below the peak amplitude of the gated indication (gate 2).

IF Float

Activate/Deactivate the floating gate feature for the interface gate (if available).

Level

Level (in dB) at which the gate tracks below the peak amplitude of the gated indication (interface gate).
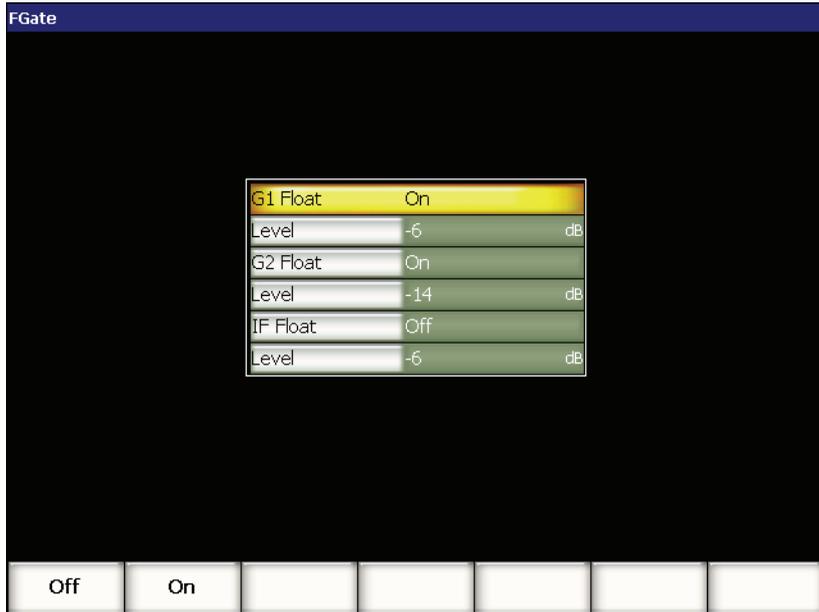
Figure 11-26 Floating gate setup page

Once the desired setup for floating gate is adjusted, press **[ESCAPE]** to return to the live A-scan view and begin the inspection with floating gate features active.

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 11-27 on page 237 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.
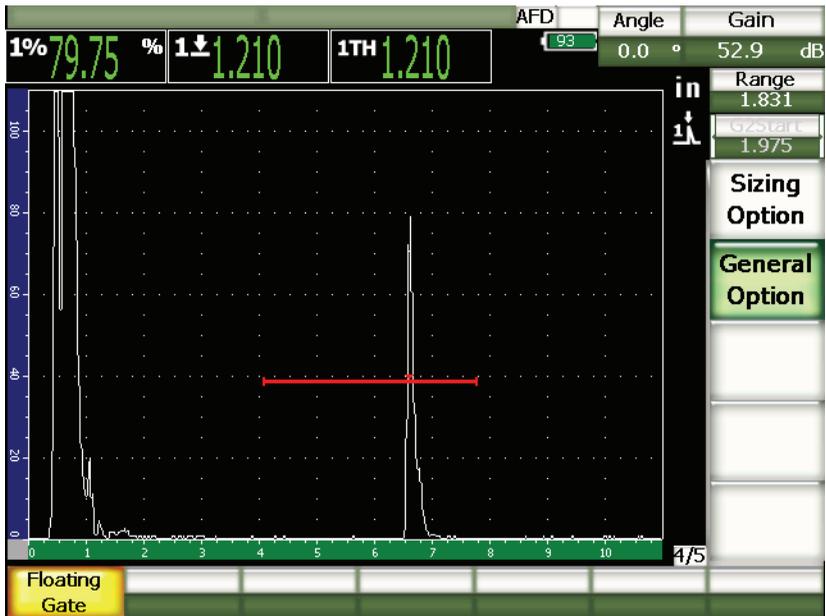
Figure 11-27 Indication using –6 dB floating gate

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 11-28 on page 238 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.
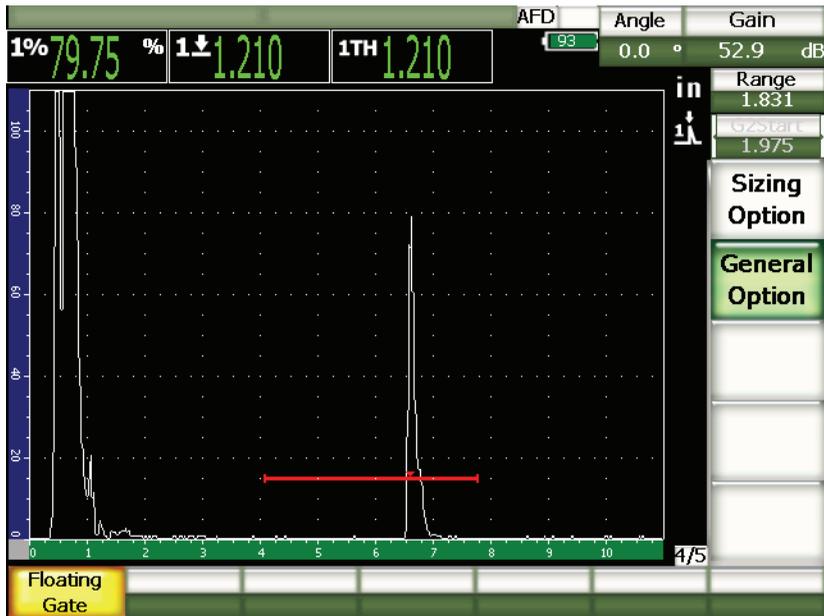
Figure 11-28 Indication using –14 dB floating gate

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 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.

12. Probe and Beam Setup (Phased Array Mode)

This chapter describes how to set up a phased array probe on the EPOCH 1000 Series. The topics are as follows:

- Automatic Probe Identification
- Beam Setup Page
- Edit Probe Setup Page

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, the instrument 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 while the instrument is in conventional UT mode, the instrument provides a prompt which allows 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 12.2 on page 240.

The EPOCH 1000 Series acquires probe information directly from Olympus phased array probe specifications stored on the probe itself. If the probe cannot be identified, it is possible to manually enter probe parameters (see section 12.3 on page 244).

12.2   Beam Setup Page

The **Beam** setup page (shown in Figure 12-1 on page 240) 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 choosing **1/5 > 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., this S-scan would represent all reflections in the test piece from 40° to 70° within a 4 in. sound path of the transducer.
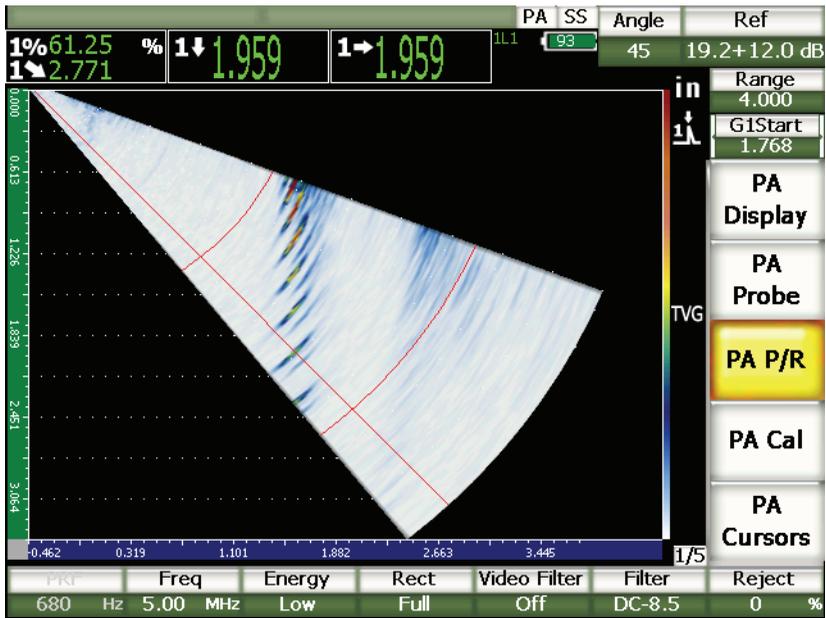
Figure 12-2 S-scan image 40°–70° with 4 in. sound path

The **Beam** setup page has three main sections of items that must be adjusted to ensure proper phased array setup and calibration.

12.2.1   Probe and Wedge Selection

The first main section of items in the **Beam** setup page includes **Probe ID** and **Wedge ID**. These are the two most important items to adjust to ensure proper phased array probe setup.

Probe ID

The name of the phased array probe connected to the instrument. This item 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 items in the **Beam** setup page to common settings based on the type of wedge selected.

The EPOCH 1000 Series recognizes six phased array probes as standard probes. These six probes have been designed to closely match the specifications and frequencies of common conventional transducers used in manual inspections. When one of these six probes is selected, the **Wedge ID** item 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 non standard 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 section 12.3 on page 244.

12.2.2   Inspection Material and Geometry

The second section of items 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 items change to default values. You may then make manual adjustments to fit the needs of the current inspection. These items include:

Thick

Defines 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.

Geometry

Defines the geometry of the test piece. You can select from **Plate**, **Cylinder**, or **Tube**.

Inner Dia.

Allows you to specify the inner diameter of a curved inspection piece. This value is used when curved surface correction is active for circumferential inspections on the inner diameter of a pipe or other curved surface.

Outer Dia.

Allows you to 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.

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.

Velocity

Defines 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 items 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 items default to the most common settings used with the selected probe/wedge combination. These items 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°.

Focus Depth

Defines focus depth of inspection. For general applications, **Max** focus or **Unfocused** are recommended. Focusing optimizes the transducer response for indications at a particular depth.

The EPOCH 1000 Series is limited to 60 focal laws for a given probe setup. To avoid focal law setup errors, use the following formula:

$$\frac{EndAngle - StartAngle}{AngleStep} \leq 60$$

Once all items in the Beam setup page have been reviewed, use the **[ESCAPE]** key to apply these settings and return to the live display.

NOTE

After reviewing the **Beam** setup page, the instrument must recalculate all focal laws based on any changes to the item definitions. This recalculation typically takes less than 15 seconds.

12.3   Edit Probe Setup Page

The EPOCH 1000 Series allows 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.

For custom probe and wedge definitions, use the **Edit Probe** setup page accessible by choosing **1/5 > PA Probe > Probe**.

Figure 12-3 The Edit Probe setup page

13. Adjusting the Pulser Receiver (Phased Array Mode)

This chapter describes how to adjust the EPOCH 1000 Series pulser/receiver in phased array mode. The topics are as follows:

• Setup from Automatic Probe ID
• Manual Pulser Adjustment
• Manual Receiver Adjustments

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 **1/5 > PA P/R** submenu.

For phased array probes that are not automatically recognized, or to allow optimization of the pulser and receiver settings, the EPOCH 1000 Series allows 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 **1/5 > 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 transducer is being pulsed by the electronic circuitry in the EPOCH 1000 Series. 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 reviewed in the **1/5 > PA P/R > PRF** parameter.

NOTE

The EPOCH 1000 Series phased array mode is limited to 1360 Hz.

13.2.2   Pulser Frequency Selection (Pulse Width)

Pulser frequency selection sets the pulse width applied to the phased array transducer. 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 to the center frequency of the transducer being used 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. Choose **1/5 > PA P/R > Freq**.
2. Use the **[UP]** and **[DOWN]** arrow keys or the adjustment knob to vary the **Freq** value. In the **Freq** adjustment, coarse and fine steps are equal.

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 transducer 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 **1/5 > 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. Choose **Rect**.
2. Use the **[UP]** and **[DOWN]** arrow keys or the adjustment knob to vary the **Rect** setting.

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┌─────────────────────┐
│        NOTE         │
└─────────────────────┘
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In **RF** rectification, the S-scan palette changes to allow for positive and negative amplitude values.

13.3.2 Video Filtering

The EPOCH 1000 Series allows video filtering in phased array mode. Video filtering is a digital algorithm that mathematically smoothes 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.

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┌─────────────────────┐
│        NOTE         │
└─────────────────────┘
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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.
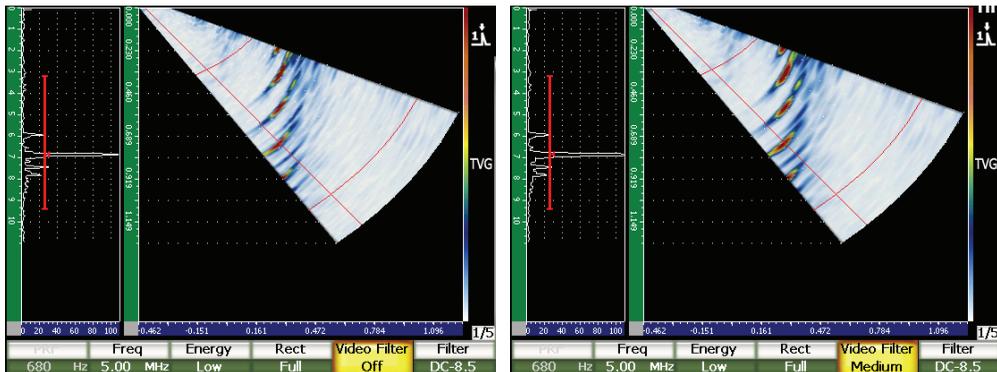
Figure 13-1 A/S Vert view with Video Filter set to Off (left) and to Low (right)

The EPOCH 1000 Series provides 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. Choose **1/5 >PA P/R > Video Filter**.
2. Use the **[UP]** and **[DOWN]** arrow keys or the adjustment knob to 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. Choose **1/5 > PA P/R > Filter**.
2. Use the **[UP]** and **[DOWN]** arrow keys or the adjustment knob to vary the **Filter** setting.

The phased array mode of the EPOCH 1000 Series can access all 37 digital filter settings available on the instrument. For a full description of these available filter sets, see chapter 4 on page 89. 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. Topics are as follows:

- Display View Mode
- Focal Law (Angle) Selection Cursor
- Best Fit Mode
- Image and A-Scan Grid and Rulers
- Peak Memory
- Peak Hold
- Freeze
- Display Grid Modes and Overlays

14.1 Display View Mode

In phased array mode, the EPOCH 1000 Series offers four live inspection views accessible by choosing **1/5 > 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 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.
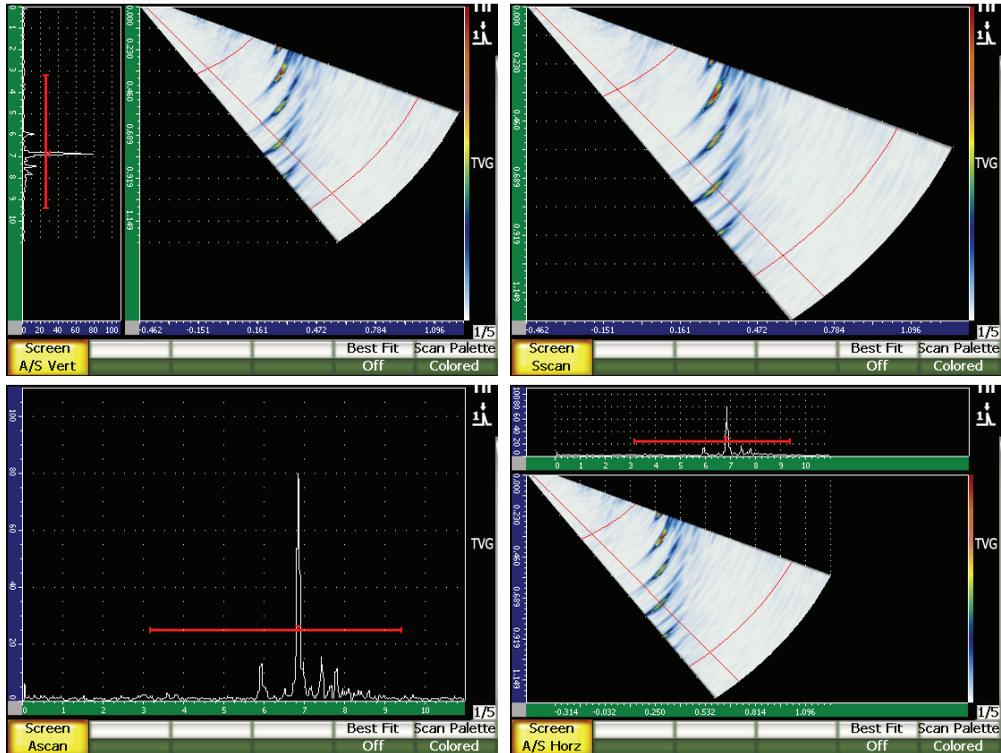
Figure 14-1 The four display view modes

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NOTE
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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 section 14.8 on page 263.

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.   Use the **[UP]** and **[DOWN]** arrow keys or the adjustment knob to change the value of the selected focal law (angle).

Alternatively, you may adjust the focal law (angle) selection cursors by choosing **1/5 > 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.

Currently selected focal law angle

Focal law cursor (red line)
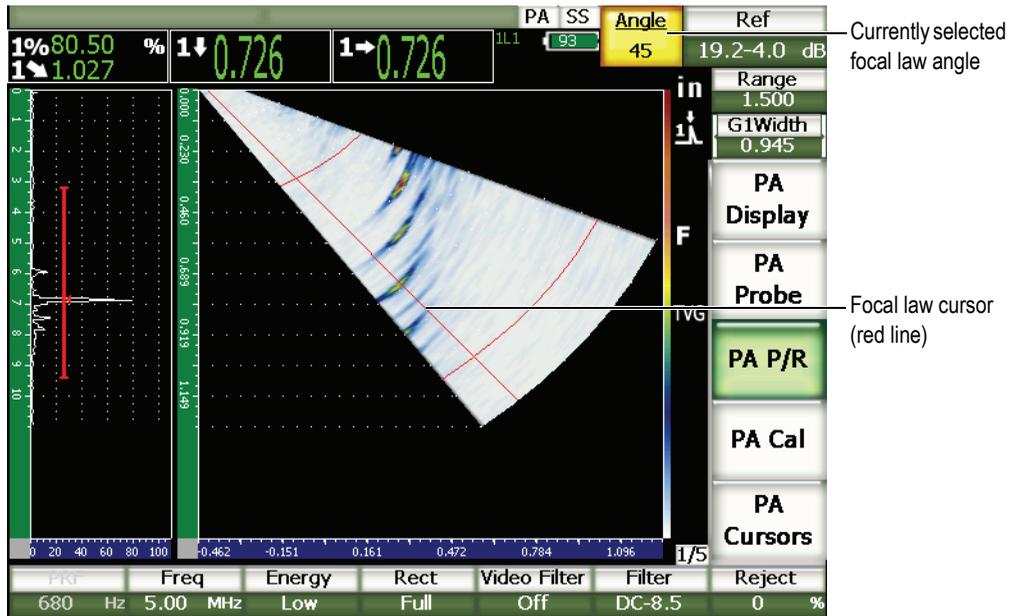
Figure 14-2 A-scan and S-scan with the focal law cursor and the angle parameter box

The EPOCH 1000 Series offers two S-scan color palettes, while operating in phased array mode.

The S-scan palette allows you to identify amplitude variations in the S-scan image. A color gradient is applied to the image, which allows the instrument to 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
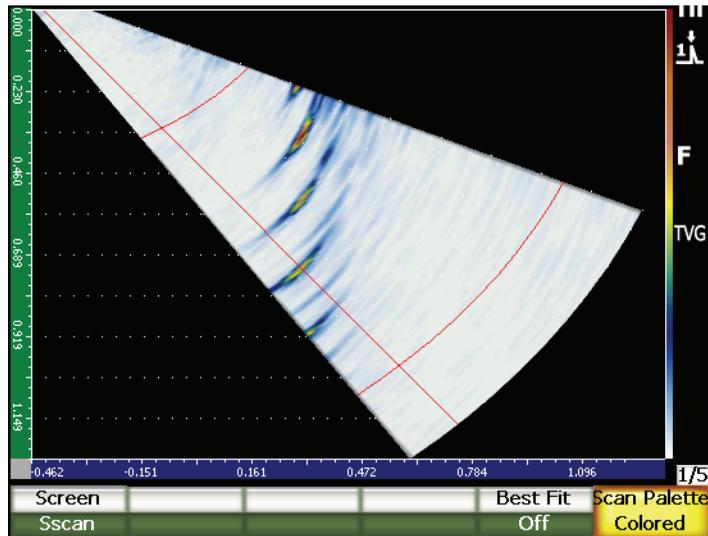
Figure 14-3 S-scan example with the color palette

The available scan palettes in phased array mode are as follows:

Colored

Default setting. Full color palette from white (LOS) to red (high/saturated signal).

Grey Scale

Grey scale palette from black (LOS) to white (high/saturated signal).

To adjust the EPOCH 1000 Series S-scan palette, choose **1/5 > PA Display > Scan Palette**.
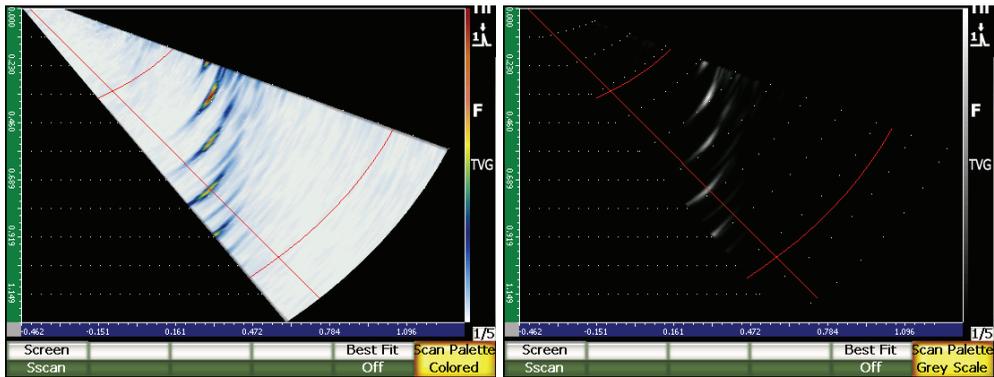
Figure 14-4 The color and the grey scale palettes

14.3   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.
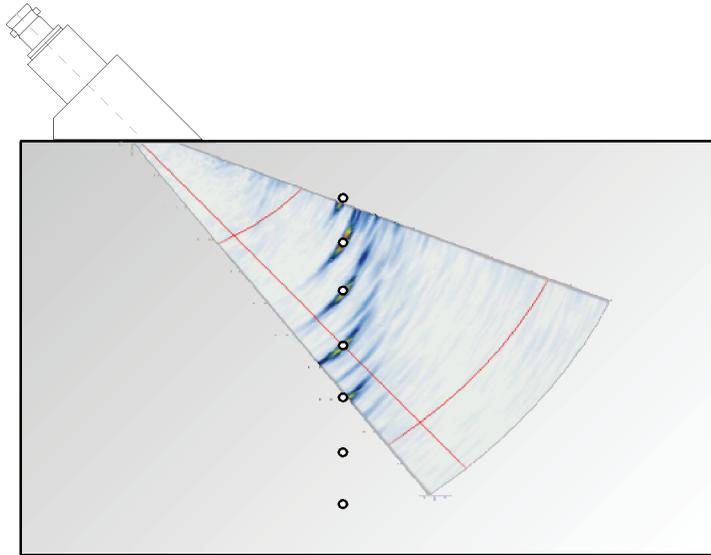
Figure 14-5 S-scan showing the location of visible defects

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.

Best fit off   Best fit on
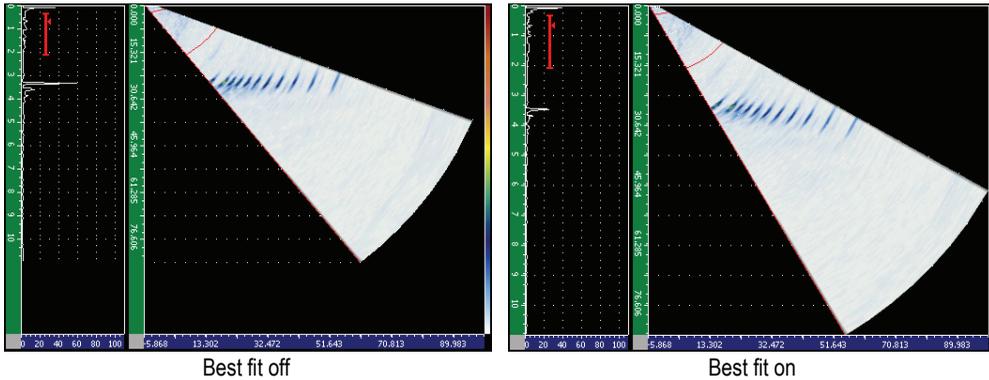
Figure 14-6 Best fit off and on

![warning triangle icon] 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.

14.4   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.

14.4.1   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 accessible by choosing **3/5 > Display Setup > A-Scan Setup**. These include:

Y-Axis Grid Mode

Amplitude height in 100 % or 110 %.

X-Axis Grid Mode

Standard 10 Divisions, Sound Path, Leg, or Off

14.4.2   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 units (in., mm, or μs).

Horizontal

The horizontal ruler displays surface distance measurements per grid division in the currently selected measurement units (in., mm, or μs).

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        NOTE
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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.

14.4.3   Reject

The **1/5 > 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.

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          NOTE
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The reject function can be used in RF display mode.

⚠️
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        IMPORTANT
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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 reject is active.

14.5   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, refer to section 5.2 on page 102.

14.6   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, refer to section 5.3 on page 104.

14.7   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, refer to section 5.4 on page 104.

In phased array mode, once 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 **1/5 > 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.

14.8   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 5.5 on page 105. 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 choosing **3/5 > Display Setup > Image Overlay**.
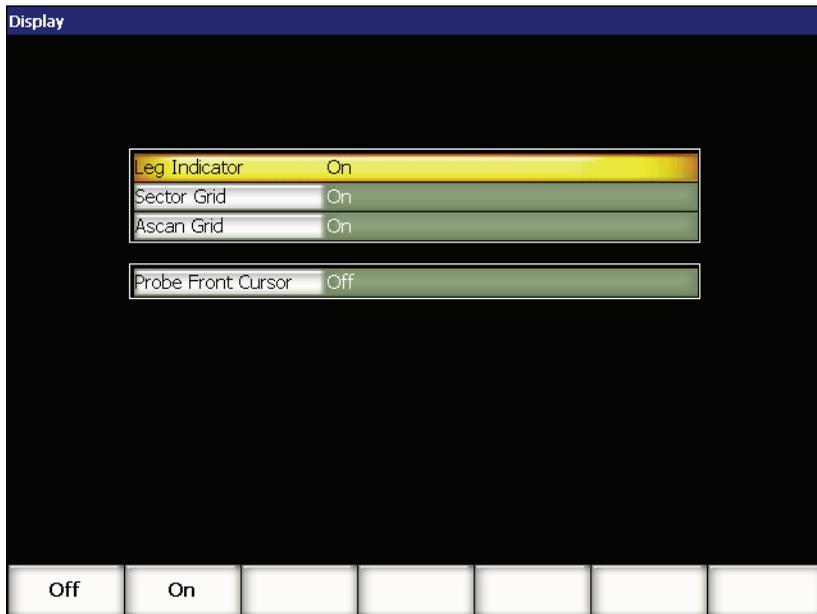
Figure 14-7 Display setup page

14.8.1   Probe Front Cursor

The probe front cursor uses the probe and wedge specifications defined in the initial phased array setup (see chapter 12 on page 239) to determine the horizontal position of the front of the transducer 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. Choose **3/5 > 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 14-8 on page 265).

Probe front cursor (vertical white line)
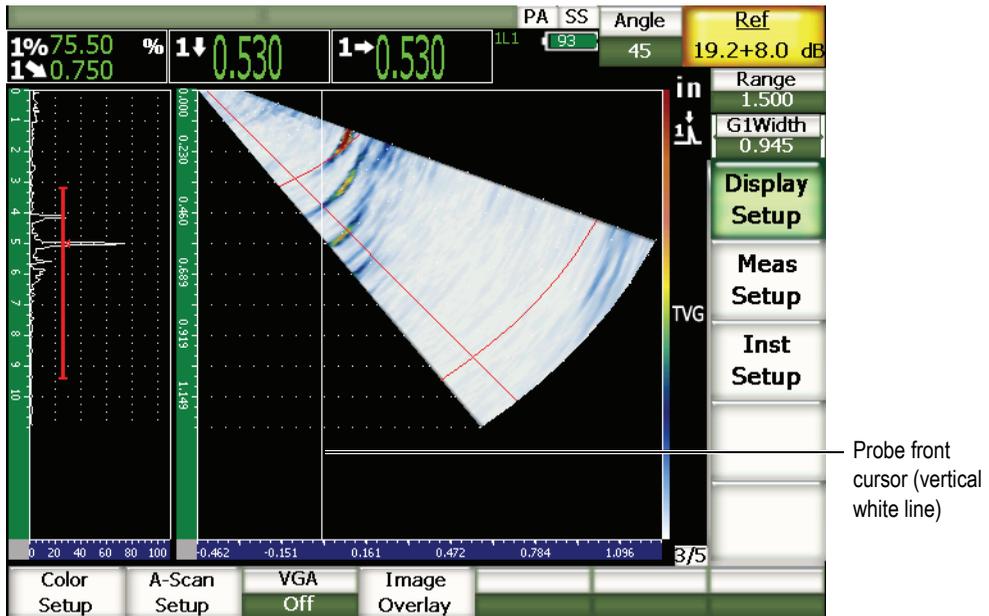
Figure 14-8 S-scan with the probe front cursor active

14.8.2   Leg Indicators

When a part thickness is defined in the **Beam** setup page (see chapter 12 on page 239), the instrument draws (multiple) horizontal line(s), 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.

Leg indicators
(horizontal white lines)

Figure 14-9 S-scan with the leg indicators active

14.8.3   Grid Modes

The **Display** setup page allows you to turn grid views of the A-scan and S-scan on or off independently.

To turn a grid mode on or off

1. To open the **Display** setup page, choose **3/5 > 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 5 on page 101. Available grid modes include: **Off**, **Standard**, **Sound Path**, **Leg**, **100%**, and **110%**. These modes can be activated or deactivated from the **A-scan Setup** setup page accessible by choosing **3/5 > 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.
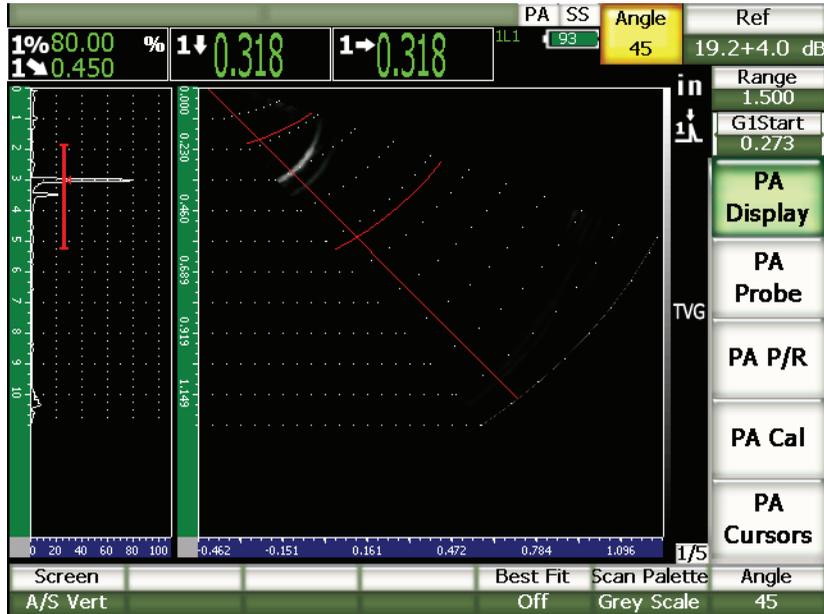
Figure 14-10 A-scan and S-scan in Grey Scale mode with indication

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         NOTE
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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 14-10 on page 267).

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15. Gates (Phased Array Mode)

This chapter describes the operation of measurement gates on the EPOCH 1000 Series in phased array mode. Topics are as follows:

• General Gate Operation
• Gate S-Scan View

15.1 General Gate Operation

The functional operation, including measurement capabilities, of gate 1, gate 2, and the interface gate (optional) in phased array mode is identical to operation in conventional ultrasound mode. Refer to chapter 6 on page 109 for a complete overview of gate functions.

15.2 Gate S-Scan View

The EPOCH 1000 Series displays 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. All gates applied to the S-scan are sound path gates. This means that the start and end position values of the gates are represented in either inches, millimeters or microseconds relative to the sound path of the display range.

NOTE

Other phased array instruments might display true-depth gates, which appear as straight horizontal lines on the S-scan image. 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.

Since gates are represented as sound path values, any displayed gate appears as a curved line 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. This gate end position is defined using the **Gate Width** parameter.

Figure 15-1 A-scan and S-scan with viewable gate

16. Image-Sizing Cursors (Phased Array Mode)

This chapter describes the sizing cursor features on the EPOCH 1000 Series. The topics covered are as follows:

- Cursors X and Y
- Cursors Status
- Cursor Positioning
- Cursor Measurements

16.1 Cursors X and Y

The EPOCH 1000 Series provides two sets of sizing cursors in phased array mode. These cursor sets are only available when freeze is active on the instrument.

These two cursor sets are applied to the S-scan image to allow visual reference and 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 S-scan image provides scaled representations of defects, these cursor sets can provide accurate flaw sizing such as cracks and delamination.

16.2 Cursors Status

To activate the image-sizing cursors

1. Press **[FREEZE]** to activate freeze.
2. Select **1/5 > PA Cursors** > **Cursor X = On** or **Cursor Y = On**.

16.3   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. Press **[FREEZE]** to activate freeze.
2. Select **1/5 > PA Cursors** > **Cursor X = On** and **Cursor Y = On**.
3. Choose **1/5 > PA Cursors** > **Cursor X1**, **Cursor X2**, **Cursor Y1**, and **Cursor Y2** parameters to adjust cursor-position values.
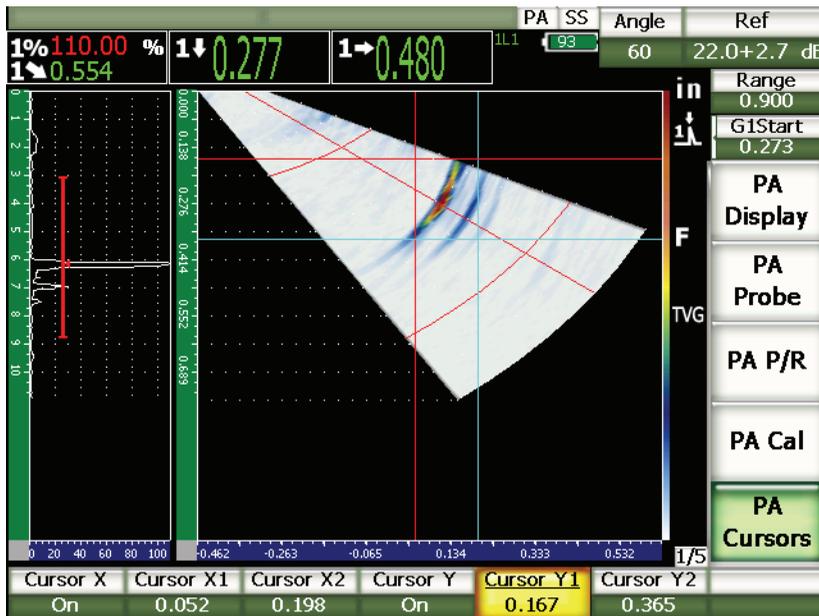
Figure 16-1   Cursors and S-scan during adjustment

The image-sizing cursors cannot be positioned beyond the visible screen range. Also, **Cursor X2** or **Cursor Y2** cannot be positioned before **Cursor X1** or **Cursor Y1**, respectively.

16.4   Cursor Measurements

The EPOCH 1000 Series image-sizing cursors allow four main types of measurements that you can select from the **Reading Setup** setup page accessible by choosing **3/5 > 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.

Figure 16-2   Cursors on S-scan with measurement

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 unit so that it measures accurately on a particular material, using a particular transducer 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 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 for each of the parameters listed above in angle or straight beam (zero degree) mode. The topics covered are as follows:

- Getting Started
- Calibration Types
- Calibrating with a Zero Degree Transducer
- Calibrating With an Angle Beam Transducer
- Gate Adjustment During Calibration
- Calibration On and Off
- Curved Surface Correction

17.1 Getting Started

Until you are completely comfortable operating the EPOCH 1000 Series, 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 choosing **1/5> PA Probe > Beam**. Automatic probe identification or manual probe definition allows to easily set appropriate parameters for the selected phased array transducer, wedge, and inspection type. For more information on using the **Beam** setup page, see section 12.2 on page 240.

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 items.
2. Press **[GAIN]** to select an initial gain value that is appropriate for the calibration and adjust the value by using the **[UP]** and **[DOWN]** arrows or the adjustment knob. 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 transducer 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 inspection 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.

The EPOCH 1000 Series allows 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 angles, high angles sound beam 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.

The EPOCH 1000 Series allows 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

The EPOCH 1000 Series allows 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

The EPOCH 1000 Series allows 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   Calibrating with a Zero Degree Transducer

Use Olympus transducer 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 173 for details).

NOTE

If the EPOCH 1000 Series 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 transducer

1. Follow the initial setup procedure described in section 17.1 on page 275.
2. For the example of the following sections, select the SA10P-0L wedge in the **Beam** setup page accessible by choosing **1/5 > 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 Transducer

To calibrate the velocity with a zero degree transducer

1. Press **[RANGE]**, and then enter an appropriate range for the calibration. For this example, use 1.00 in. (25.4 mm).

2. Select **1/5 > PA CAL > CAL Mode = Velocity**.

3. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 0°.

4. Couple the transducer to the 0.200 in. step of the calibration block.

5. Use the **[GATE]** key to position gate 1 so that the back-wall echo from the 0.200 in. step of the block is exceeding the gate threshold.

6. Adjust the gain so that the echo amplitude is at approximately 80 %.

   A thickness measurement reading appears in large text above the image.
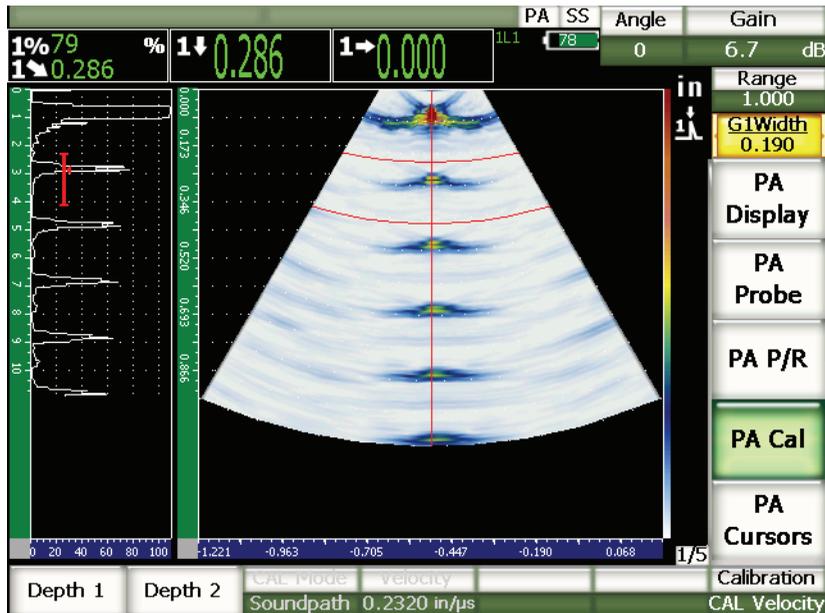
Figure 17-1 Example of gated calibration signal

7. Once a steady reading is achieved, choose **1/5 > 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 (0.200 in. in this example), and then choose **Continue** to continue to the second calibration step.

> | NOTE |
> |------|
>
> If for any reason you need to exit without acquiring calibration data, use the **[LEFT]** or **[RIGHT]** arrow key to highlight **Cancel**, and then press **[CHECK]**.

---

9. Couple the transducer to the 0.500″ 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 %.

    A thickness measurement reading appears in large text above the image.
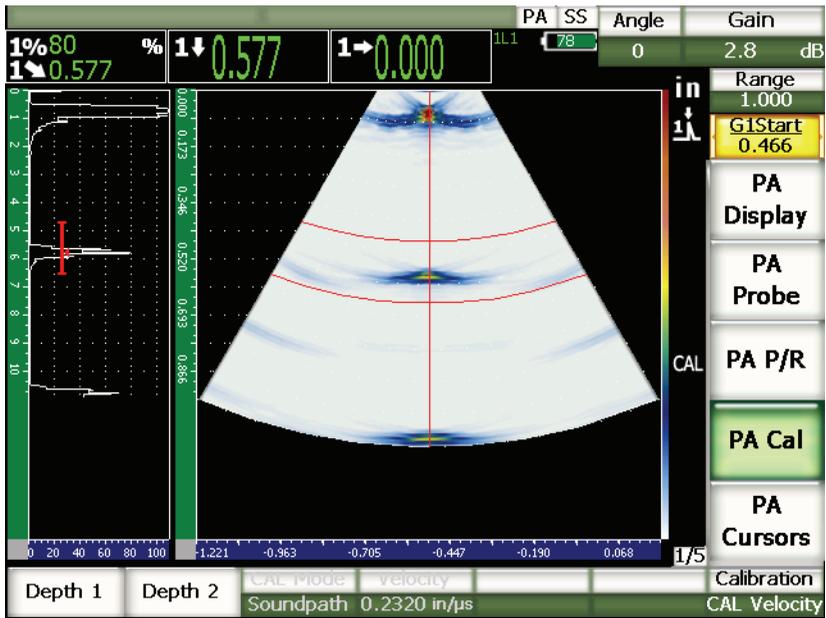
Figure 17-3 Example of the second gated calibration signal

12. Once a steady reading is achieved, choose **1/5 > 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 (0.500 in. in this example), and then choose **Continue** to continue to complete the calibration process.

17.3.2   Calibrating the Wedge Delay With a Zero Degree Transducer

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 first back wall of the IIW block is used to calculate the wedge delay.

To calibrate the wedge delay with a zero degree transducer

1. Press **[RANGE]** to enter an appropriate range for the calibration.
    For this example, use 10 in. (254 mm).
2. Select **1/5 > PA CAL > CAL Mode = CAL Zero**.
3. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 0°.
4. Couple the transducer to the side of the block.
5. Use the **[GATE]** key to position gate 1 to surround only the first back-wall echo from the block.
6. Adjust the gain so that the echo amplitude is at approximately 80 %.
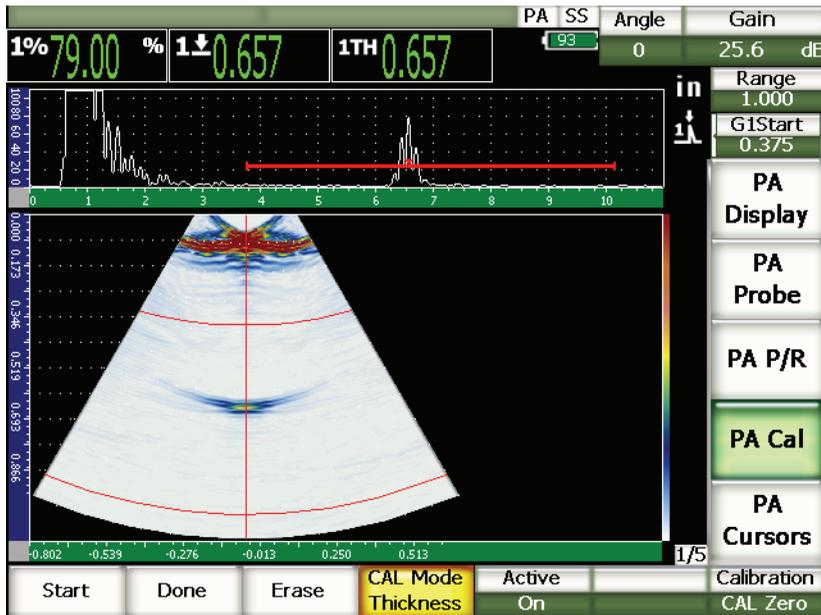
Figure 17-5   Example of gated calibration signal

7. Choose the **1/5 > PA CAL > Start** to begin the calibration process.

The screen freezes and the **Enter Value for Zero Cal** dialog box appears.
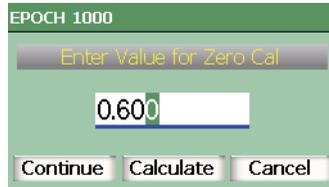
Figure 17-6 The Enter Value for Zero Cal dialog box

8. Adjust the value to match the known thickness of the gated indication (0.600 in. in this example), and then choose **Continue** 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 284). Ideally, the thickness measurement reading line should be a straight line, indicating 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 uncalibrated line should look like the one shown in Figure 17-7 on page 284.

Figure 17-7 The Wedge Delay acquisition screen with thickness measurement reading at the top

9. If necessary, move the probe back and forth 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.

---

10. Choose **1/5 > 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. Choose **1/5 > PA Cal > Done** to accept the drawn line and to calculate the wedge delay.

Figure 17-8 A 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.

⚠️ | 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 laws.

17.3.3 Calibrating the Sensitivity (Gain) With a Zero Degree Transducer

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 transducer

1. Press **[RANGE]**, and then enter an appropriate range for the calibration. For this example, use 2 in. (50 mm).
2. Select **1/5 > PA CAL > CAL Mode = PA CAL**.
3. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 0°.
4. Couple the transducer to the IIW block over the side-drilled hole.
5. Use the **[GATE]** key to position gate 1 to surround only the first reflection from the side-drilled hole.
6. Adjust the gain so that the echo amplitude is at approximately 80 %.

Figure 17-9 Example of the captured echo

7. Choose **1/5 > 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 284). Ideally, the thickness reading line should be a straight line, indicating 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 uncalibrated line should look like the one shown in Figure 17-10 on page 288.
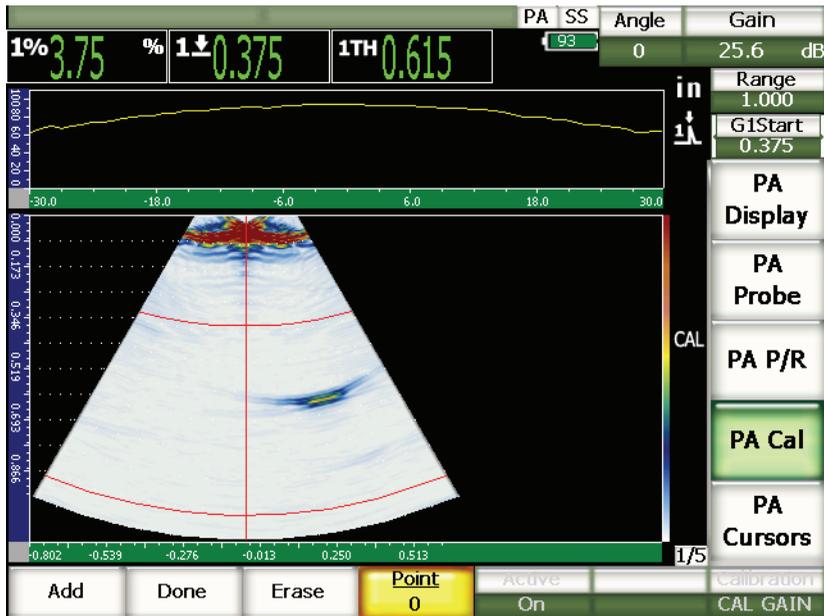
Figure 17-10 The CAL Gain acquisition screen

8. Move the probe back and forth over the side-drilled hole to acquire uncalibrated peak amplitude measurement data across all focal laws.

<div style="border:1px solid">TIP</div>

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. Choose **1/5 > PA CAL > Erase** to clear the current gain curve and to redraw a new curve.

<div style="border:1px solid">NOTE</div>

If the yellow gain curve saturates the screen, adjust the gain to a lower value and redraw the curve.

---

10. Choose **1/5 > PA CAL > Done** to accept the drawn line and calculate sensitivity.
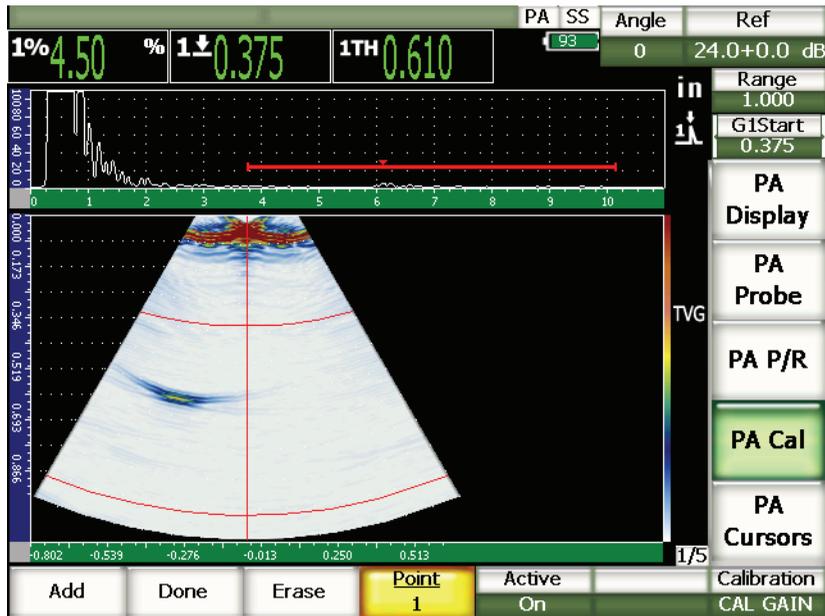
Figure 17-11 The completed gain calibration

⚠️ **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.

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 Calibrating With an Angle Beam Transducer

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 transducer

1. Follow the initial setup procedure described in section 17.1 on page 275.
2. For this example, open the **Beam** setup page by choose **1/5 > PA Probe > Beam**.
3. Highlight **Wedge ID**, and then select **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 Transducer

To calibrate the velocity with an angle beam transducer

1. Press **[RANGE]**, and then enter an appropriate range for the calibration. For this example, use 10 in. (250 mm).
2. Select **1/5 > PA Cal > Calibration = CAL Velocity**.
3. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 45°.
4. Couple the probe to the test block at the 0 mark.
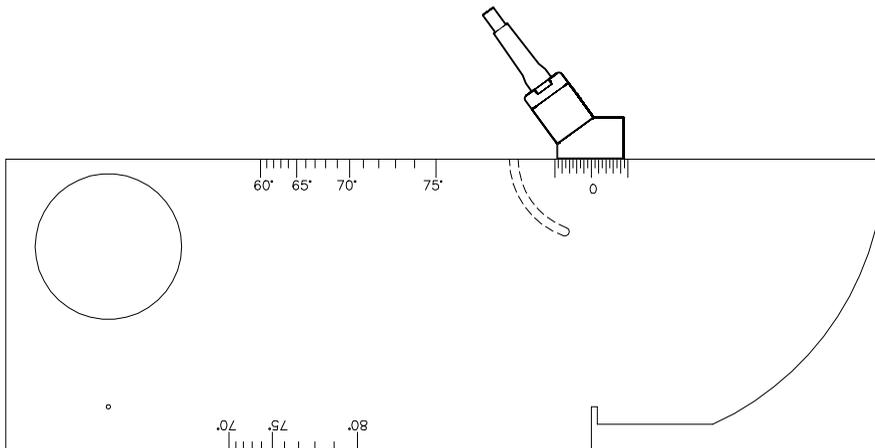
Figure 17-12 The IIW block with the probe

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 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.

---

7. Use the **[GATE]** key to position gate 1 so that the first reflection from the arc of the block is exceeding the gate threshold.
   This reflection should be close to 4 in. (100 mm).

8. Adjust the gain so that the echo amplitude is at approximately 80 %.

   A thickness measurement reading appears in large text as shown in Figure 17-13 on page 291.
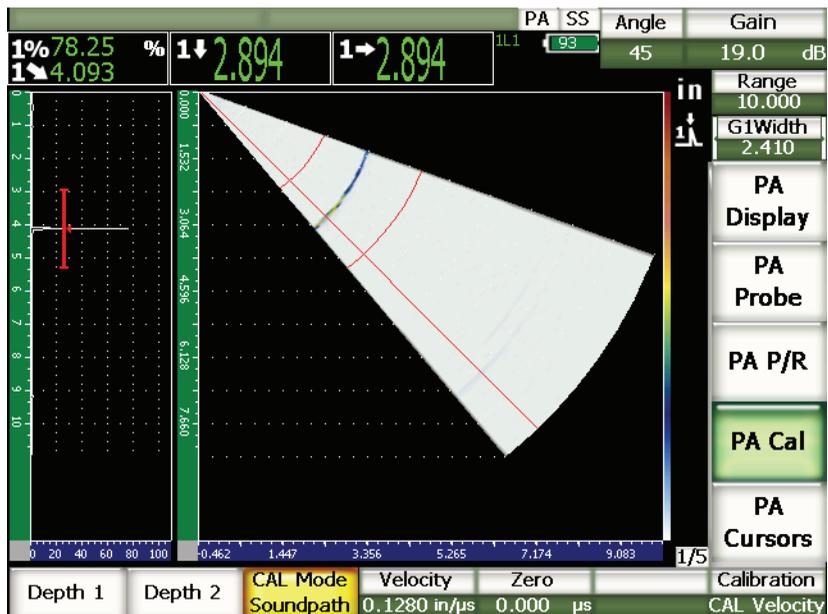
Figure 17-13 The gated calibration signal

9. Once a steady reading is achieved, choose **1/5 > 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

10. Adjust the value to match the known thickness of the gated indication (4.000 in. in this example), and then choose **Continue** to continue to the second calibration step.

NOTE

If for any reason you need to exit without acquiring calibration data, use the **[LEFT]** or **[RIGHT]** arrow key to highlight **Cancel**, and then press **[CHECK]**.
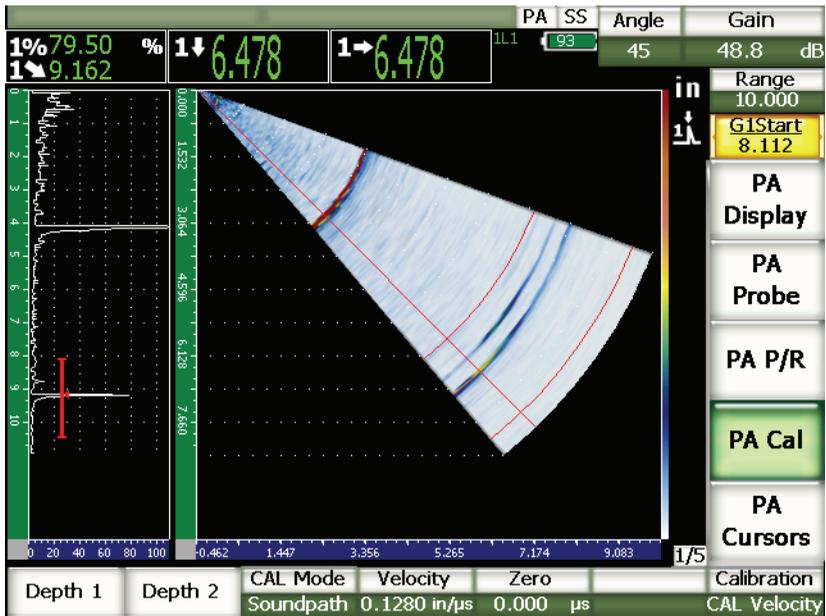
Figure 17-15 The second gated calibration signal

11. Continue coupling the transducer 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. (225 mm).

13. Adjust the gain so that the echo amplitude is at approximately 80 %.
    A thickness measurement reading appears in large text above the image.

14. Once a steady reading is achieved, choose **1/5 > 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

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15. Adjust the value to match the known thickness of the gated indication (9.000 in. in this example), and then choose **Calculate** to complete the calibration process.

17.4.2   Calibrating the Wedge Delay With an Angle Beam Transducer

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 transducer

1. Press **[RANGE]**, and then enter an appropriate range for the calibration. For this example, use 6 in. (150 mm).
2. Choose **1/5 > PA Cal > Calibration = CAL Zero**.
3. Choose **1/5 > 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 **1/5 > 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 transducer to the test block at the 0 mark.
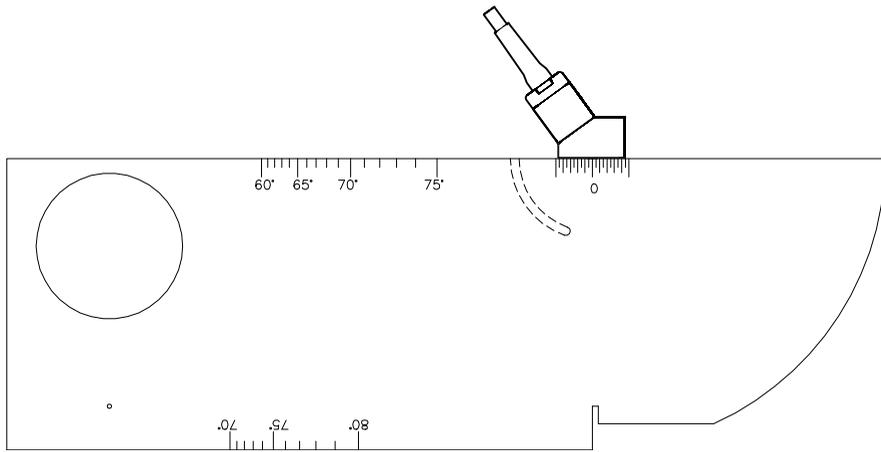
Figure 17-17 The transducer coupled to the 0-mark of the IIW block

6. Use the **[GATE]** key to position gate 1 so that the first reflection from the arc of the block is exceeding the gate threshold. This reflection should be close to 4 in. (100 mm).

7. Adjust the gain so that the echo amplitude is at approximately 80 %.
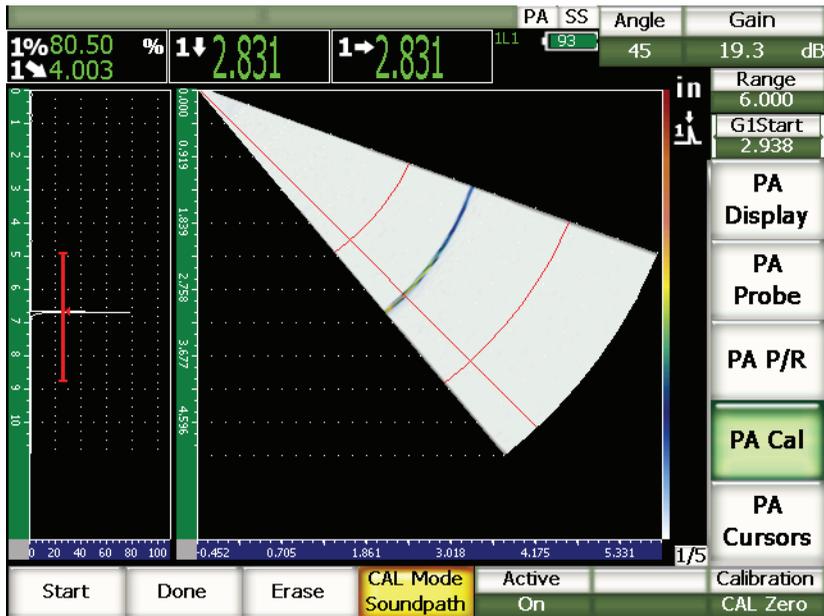
Figure 17-18 The first echo

8. Choose **1/5 > 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 (4.000 in. in this example), and then choose **Continue** 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, indicating 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 uncalibrated line should look like the one shown in Figure 17-20 on page 297.

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. Choose **1/5 > 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. Choose **1/5 > PA Cal > Done** to accept the drawn line and calculate wedge delay.
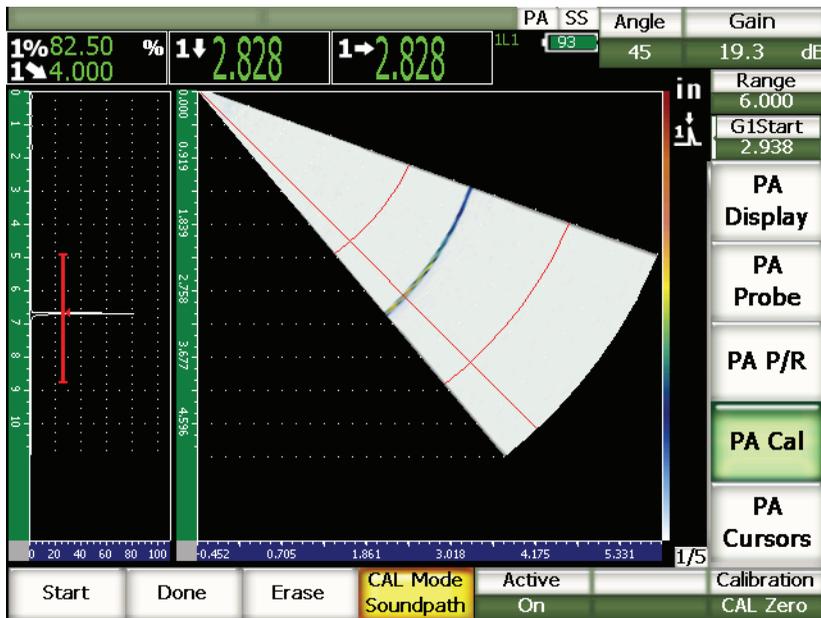
Figure 17-21 The completed wedge delay calibration

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.

⚠️ **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 laws.

17.4.3 Calibrating the Sensitivity (Gain) With an Angle Beam Transducer

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 transducer

1. Press **[RANGE]**, and then enter an appropriate range for the calibration. For this example, use 2 in. (50 mm).

2. Choose **1/5 > PA Cal > Calibration = CAL Gain**.

3. Press **[ANGLE]**, and then adjust the selected focal law (angle) to 45°.

4. Couple the transducer to the IIW block over the side-drilled hole.

5. Use the **[GATE]** key to position gate 1 to surround only the first reflection from the side-drilled hole.

6. Adjust the gain so that the echo amplitude is at approximately 80 %.

Figure 17-22 The captured echo

7. Choose **1/5 > 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, indicating 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 uncalibrated line should look like the one shown in Figure 17-23 on page 301.
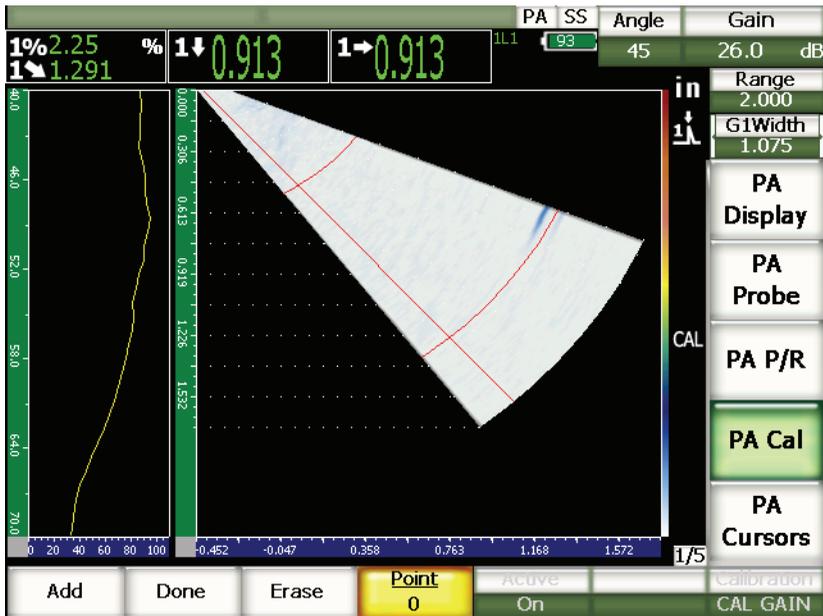
Figure 17-23 The Gain acquisition screen

8. 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.

---

9. Choose **1/5 > 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.

---

10. Choose **1/5 > PA Cal > Done** to accept the drawn line and calculate sensitivity.

Figure 17-24 The completed gain calibration

⚠️ **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.

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 other reflectors occur 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.
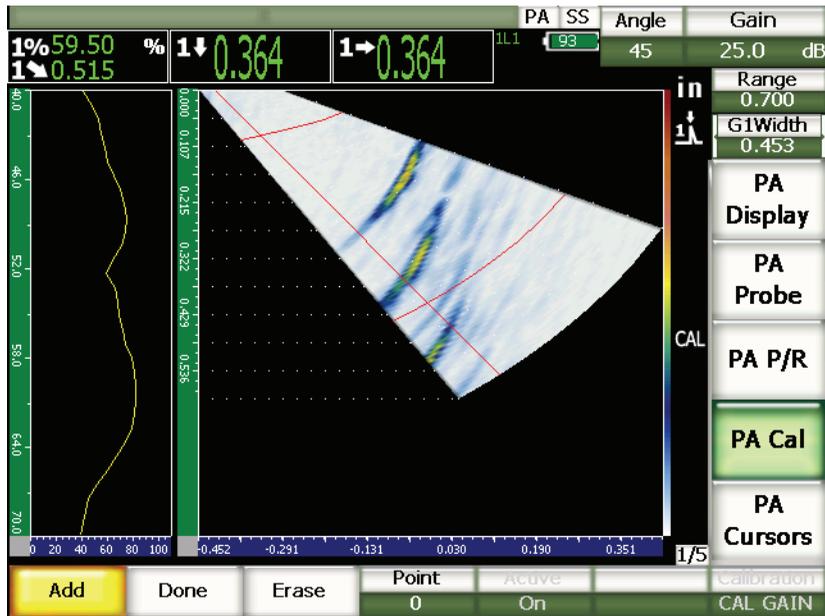
Figure 17-25 Wide gate with two echoes interfering

The EPOCH 1000 Series allows 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.
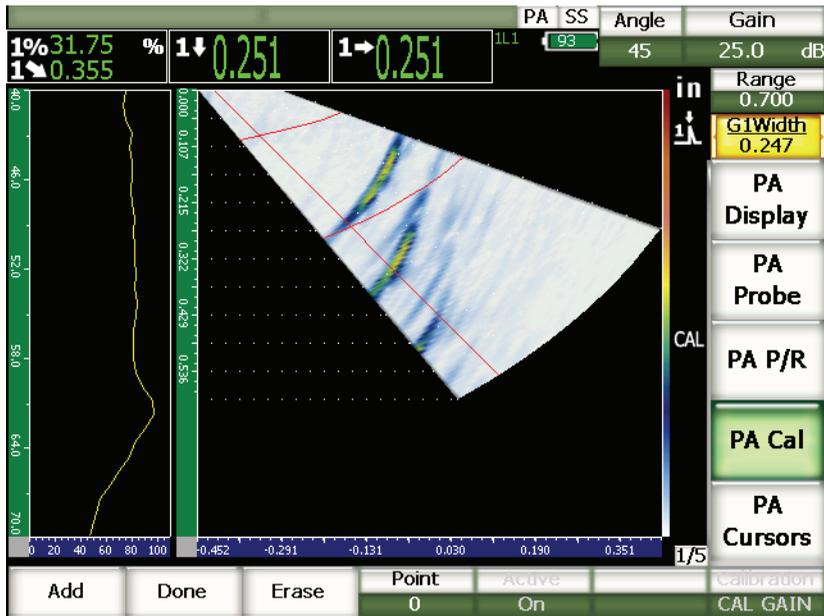
Figure 17-26 Narrow gate to capture only one echo

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

The EPOCH 1000 Series allows 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 advantages in 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 either calibration on or off

◆ Choose **1/5 > PA Cal > Active**.

17.7   Curved Surface Correction

The EPOCH 1000 Series allows 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 EPOCH 1000 Series allows you to correct for curved surface inspections where the transducer 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 chapter 12 on page 239.

18. Maintenance & Trouble Shooting

18.1 Instrument Cleaning

When needed, wash the instrument only with mild soap and water on a damp cloth.

18.2 Verifying O-Ring Gaskets and 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
- 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 transducer gasket

Regularly clean and verify the state of the above seals and gaskets to ensure the integrity of the hardware protection.

18.3 Protecting the Display

EPOCH 1000 Series instruments include a clear-plastic sheet protecting the instrument's display window. Leave the clear-plastic sheet in place when using the instrument to continuously protect the display. Clear-plastic sheet replacements are available from Olympus in packages of 10 (PN: EP1000-DP).

![triangle warning symbol] **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.

18.4 Annual Calibration

Send your EPOCH 1000 Series instrument once a year to an Olympus service center for annual calibration. The service includes calibration, o-ring gasket, and membrane seal evaluation and replacement as needed to assure environmental durability. Contact Olympus for details.

18.5 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

3/5 > Meas Setup > Trigger = External or **Single**. In these modes, the instrument fires only when an external command is active.

Solution

Select **3/5 > 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 pressing the **[ON/OFF]** power key (following a software update).

Possible cause

Interrupted, incomplete, or corrupted software update.

Solution

1. Remove the battery from the EPOCH 1000 Series as well as the AC line power.
2. Replace the battery in the EPOCH 1000 Series.
3. Start the unit.

Symptom

The instrument indefinitely stays in the start up process.

Possible cause

Corrupted data.

Solution

Force a hard instrument reset. Refer to section 10.7 on page 192 for the procedure.

19. Specifications

19.1 General and Environmental Specifications
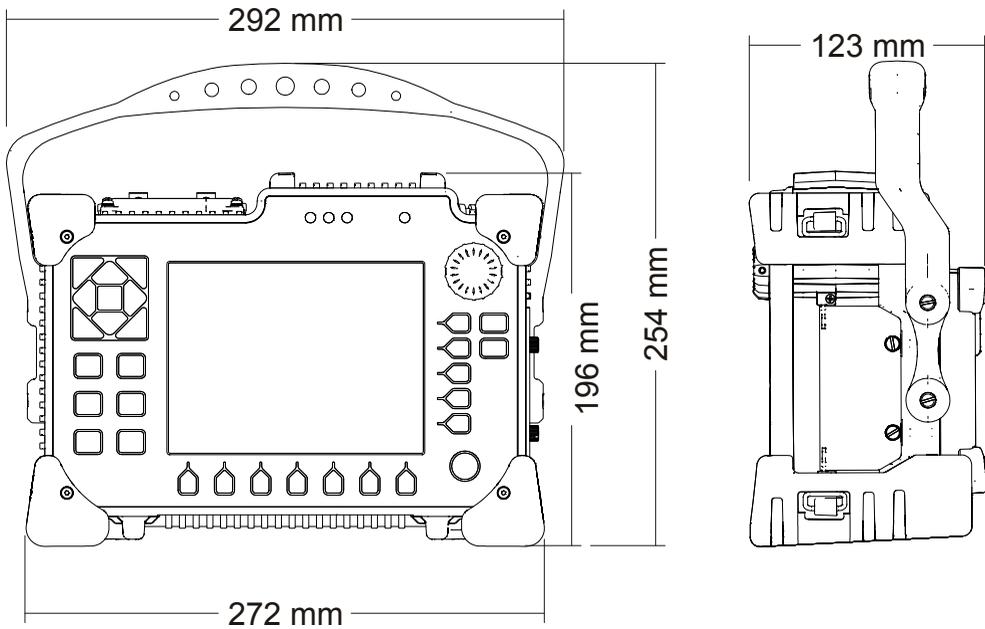
Figure 19-1 Overall EPOCH 1000 Series dimensions

Table 23 General specifications

Parameter	Value
Overall dimensions (W x H x D)	292 mm x 196 mm x 123 mm 11.5 in. x 7.7 in. x 4.8 in. (see Figure 19-1 on page 311)
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 10,000 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 x 480 pixels) transflective color LCD, 60 Hz update rate
Display dimensions (W x H, Diagonal)	132.5 mm x 99.4 mm, 165.1 mm (5.2 in. x 3.9 in., 6.5 in.)
Warranty	1 year limited

Table 24 Environmental ratings specifications

Parameter	Value
IP rating	Designed to meet requirements of IP66
Explosive atmosphere	MIL-STD-810F Procedure 1, NFPA 70E, Section 500, Class 1, Div. 2, Group D (PENDING)
Shock tested	IEC 60068-2-27, 60 g, 6 μs H.S., multiple axes, 18 total (PENDING)
Vibration tested	Sine vibration, IEC 60068-2-6, 50 Hz to 150 Hz at 0.03 in. DA or 2 g, 20 sweep cycles (PENDING)
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	0 °C to 50 °C (32 °F to 122 °F)

19.2   Channel Specifications

Table 25 EPOCH 1000i phased array specifications

Parameter	Value
Focal laws	60
Physical probe	16 elements
Virtual probe	16 elements
Video filtering	Off, Low, High
Display modes	A-scan, A-scan/S-scan, S-scan
Image update rate	60 Hz update for all A-scans 20 Hz update for all images

Table 26 Pulser specifications

Pulser	EPOCH 1000/1000iR/1000i (conventional UT mode)	EPOCH 1000i (PA mode)
Pulser	Tunable square wave	
PRF	5 Hz to 6000 Hz in 5 Hz increments	Automatic. Maximum 1360 Hz
Energy settings	50 V to 475 V in 25 V increments	40 V or 80 V
Pulse width	Adjustable from 25 ns to 5,000 ns (0.1 MHz) with PerfectSquare technology	Adjustable from 40 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 27 Receiver specifications

Parameter	EPOCH 1000/1000iR/1000i	EPOCH 1000i
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 27 Receiver specifications *(continued)*

Parameter	EPOCH 1000/1000iR/1000i	EPOCH 1000i
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 28 Calibration specifications

Parameter	EPOCH 1000/1000iR/1000i	EPOCH 1000i
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	1.86 mm to 25,400 mm (0.073 in. to 1000 in.)	Up to 762 mm (30 in.), 30 focal laws
Velocity	635 m/s to 15,240 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 25,400 mm (−2.323 in. to 1000 in.)	0 to max range
Refracted angle	0° to 85° in 0.1° increments	60 angular focal laws, 0.5° increments

Table 29 Gates specifications

Parameter	EPOCH 1000/1000iR/1000i	EPOCH 1000i
Measurement gates	2 fully independent gates for amplitude and time-of-flight measurements	

Table 29 Gates specifications *(continued)*

Parameter	EPOCH 1000/1000iR/1000i	EPOCH 1000i
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 30 Measurements specifications

Parameter	EPOCH 1000/1000iR/1000i	EPOCH 1000i
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, FBH (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 50 points, 40 dB dynamic range per angle
Special DAC modes	20 % to 80 % DAC, Custom DAC (up to 6 curves)	Not applicable
TVG table	Up to 50 points, 110 dB dynamic range, compatible with IF gate at all PRF settings	Up to 50 points, 40 dB dynamic range per angle
Curved surface correction	Standard. ID or OD correction for angle beam measurements	

19.3   Input/Output Specifications

Table 31 on page 316 provides the specifications for the input output signals.

Table 31 Input/output specifications

Parameter	Value
USB ports	1 USB client, 2 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) conventional UT only

Table 32 on page 316 describes all the connections available on the ALARMS 26-pin D-sub connector. Table 33 on page 317 describes all the connections available on the ANALOG OUT 9-pin D-sub connector.

Table 32 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
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

Table 32 Pinout of the ALARMS connector *(continued)*

Pin	Signal	Description
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 33 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
8	GND	Ground
9	NO CONNECT	No connection

19.4 Probe and Wedges Specifications

The EPOCH 1000i supports a series of phased array probes to meet the demands of critical inspections (see Table 34 on page 318). 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 34 EPOCH 1000i supported PA probes[a]

Part	Usage/Code compliance	Frequency (MHz)	Number of elements	Pitch	Active aperture (mm)	Elevation (mm)	Dimensions in mm (in.) L x W x H		
2.25L8-A10P	General purpose	2.25	8	1.2	9.6 x 10	10	22.5 (0.89)	15.6 (0.61)	20.0 (0.79)
5L16-A10P		5.0	16	0.6	9.6 x 10	10	22.5 (0.89)	15.6 0.61)	20.0 (0.79)
10L16-A10P		10.0	16	0.6	9.6 x 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 x 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 x 9	9	27.3 (1.07)	16.8 (0.66)	22.3 (0.88)
4L16-DGS1		4.0	16	0.5	8 x 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 x 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 35 EPOCH 1000i supported Wedges

Part	Matching probes	Nominal refracted beam angle (in steel)	Sweep (°)	Probe orientation	Dimensions in mm (in.) L x W x 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 35 EPOCH 1000i supported Wedges *(continued)*

Part	Matching probes	Nominal refracted beam angle (in steel)	Sweep (°)	Probe orientation	Dimensions in mm (in.) L x W x 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 36 on page 321 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 36 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 36 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
Polyvinylchloride, (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

References

1. Folds, D. L. "Experimental Determination of Ultrasonic Wave Velocities in Plastics, Elastomers, and Syntactic Foam as a Function of Temperature." *Naval Research and Development Laboratory.* Panama City, Florida, 1971.

2. Fredericks, J. R. *Ultrasonic Engineering.* New York: John Wiley & Sons, Inc., 1965.

3. *Handbook of Chemistry and Physics.* Cleveland, Ohio: Chemical Rubber Co., 1963.

4. Mason, W. P. *Physical Acoustics and the Properties of Solids.* New York: D.Van Nostrand Co., 1958.

5. Papadakis, E. P. Panametrics - unpublished notes, 1972.

Appendix B: Glossary

Table 37 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 37 Glossary *(continued)*

Term	Definition
Attenuation	The loss in acoustic energy that occurs between any two points of travel. This loss may be due to 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 which, when used in the transducer, results in a shorter ringing time of the piezoelectric crystal.

Table 37 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 due to beam spreading and attenuation.
Dual element probe	A probe containing two piezoelectric elements, one which transmits and one which 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.
Frequency	The number of complete cycles undergone or produced by an oscillating body.

Table 37 Glossary *(continued)*

Term	Definition
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 which 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.
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.

Table 37 Glossary *(continued)*

Term	Definition
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.
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	Another name for transducer.

Table 37 Glossary *(continued)*

Term	Definition
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	That 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 send to the screen for display.
Reference echo	The echo from a reference-reflector.
Reference level	The number of decibels of calibrated gain which 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.
Refraction, angle of	The angle of sound reflection in the wedge which 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	The minimum detectable flaw size.
Reject (control)	Also known as suppression, 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.

Table 37 Glossary *(continued)*

Term	Definition
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 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.
Single element probe	A probe containing only one piezoelectric element, which is used to both transmit and receive sound.
Skip-distance	In angle beam testing, the surface distance which represents one V-path of sound in the material.
Sound beam	The characteristic shape of the ultrasonic wave sent into the material.
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.

Table 37 Glossary *(continued)*

Term	Definition
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 device that transforms one form of energy into another.
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.
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 38 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 39 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 40 Instrument software options

Part	Description
EP1000-IG	EPOCH 1000 interface gate software

Table 41 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 42 Optional hardware accessories

Part	Description
EP4P-C-USB-6	USB client cable
EPXT-EC	External stand-alone battery charger
EP4-CH	Chest harness

Table 43 Spare parts

Part	Qty.	Description
EP1000-DP	Package of 10	Clear plastic protecting sheets for the EPOCH 1000 display window
EPXT-C-VGA-6	1	VGA output cable
EP1000-C-RS232-6	1	RS-232 communications cable
EP1000-C-HWIO-6	1	Hardware I/O cable for analog/alarm outputs and RS-232 communication

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