INSTRUCTION MANUAL

EPOCH III

Part No. 910-130J
Software V4.00
3/10/04

PANAMETRICS-NDT™
A Business of R/D Tech Instruments Inc.

Printed in the United States of America.

WARRANTY

The Model 2300 Digital Ultrasonic Flaw Detector has been designed and manufactured as a high quality instrument. Under normal working conditions the Epoch III will provide long, trouble-free service.

Damage in transit - Inspect the unit thoroughly immediately upon receipt for evidence of external or internal damage that may have occurred during shipment. Notify the carrier making the delivery immediately of any damage, since the carrier is normally liable for damage in shipment. Preserve packing materials, waybills, and other shipping documentation in order to establish damage claims. After notifying the carrier, contact Panametrics-NDT™ so that we may assist in the damage claims, and provide replacement equipment, if necessary. Please note that your shipping container is re-usable and may be used in the future when returning the unit for recalibration or repair.

Panametrics-NDT guarantees the Model 2300 to be free from defects in materials and workmanship for a period of one year (twelve months) from date of shipment. This warranty only covers equipment that has been used in a proper manner as described in this instruction manual and has not been subjected to excessive abuse, attempted unauthorized repair, or modification. DURING THIS WARRANTY PERIOD, PANAMETRICS-NDT LIABILITY IS STRICTLY LIMITED TO REPAIR OR REPLACEMENT OF A DEFECTIVE UNIT AT ITS OPTION. Panametrics-NDT does not warrant the Model 2300 to be suitable of intended use, or fitness for any particular application or purpose. Panametrics-NDT accepts no liability for consequential or incidental damages including damage to property and/or personal injury.

This warranty does **not** include transducers, transducer cables, or battery. The customer will pay shipping expense to the Panametrics-NDT plant for warranty repair; Panametrics-NDT will pay for the return of the repaired equipment. (For instruments not under warranty, the customer will pay shipping expenses both ways.)

In this manual, we have attempted to teach the proper operation of the Epoch III, Model 2300 consistent with accepted flaw detection techniques. We believe the procedures and examples given are accurate. However, the information contained herein is intended solely as a teaching aid and should not be used in any particular application without independent testing and/or verification by the operator or the supervisor. Such independent verification of procedures become more important as the criticality of the application increases.

For these reasons, we make no warranty, expressed or implied, that the techniques, examples, or procedures described herein are consistent with industry standards nor that they will meet the requirements of any particular application. Panametrics-NDT expressly disclaims all implied warranties of merchantability and of fitness for any particular application.

Panametrics-NDT reserves the right to modify all products without incurring the responsibility for modifying previously manufactured products. Panametrics-NDT does not assume any liability for the results of particular installations, as these circumstances are not within our control.

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1 INTRODUCTION

Advances in microprocessors, flat panel displays, and battery technology have enabled Panametrics-NDT™ to develop what, in many ways, can be considered an ideal ultrasonic flaw detector: the EPOCH III. Extremely light in weight, with a high resolution display and documentation capabilities, the EPOCH III offers everything required from a field-portable flaw detector without making any compromises.

Borrowing from display technology developed for laptop computers, the EPOCH III features a high resolution, electroluminescent display. New electronics drive the display at a rate of change that is faster than can be perceived by the human eye. This combination of resolution and display speed enables the EPOCH III to bridge the gap between the responsiveness and visual clarity of analog instruments and the precision, repeatability, and documentation capabilities of fully digital flaw detectors. By providing all modes of Waveform displays; full-wave, half-wave, and an unrectified RF display at high display update rates, the EPOCH III provides high end performance in a compact package.

The light weight EPOCH III has available a number of battery options to make it even lighter in weight when necessary. The standard 12 volt battery pack provides eight hours of continuous operation while an optional 6 volt pack provides four hours of operation while reducing the weight of the EPOCH III to 2.2 Kg (4.9 pounds). Another, optional version of the 12 volt battery pack can be mounted on a utility belt reducing the carrying weight of the EPOCH III to 1.2 Kg (2.6 pounds) - light enough to be held and operated with one hand - an important advantage when climbing or carrying out an inspection in a difficult to access area.

The highly visible electroluminescent display provides the inspector with all necessary test data in a clear, logically organized format. The instrument's gain and range settings and current measurement mode are constantly displayed at the top of the screen. A large numeric display provides an instantaneous readout of material thickness which can be calculated by gating either a single back echo or by measuring in an echo-to-echo measurement mode. The echo-to-echo mode is particularly useful when testing heavily coated structures, performing simple immersion tests, or measuring thin materials. When using an angle beam transducer, the EPOCH III will display the surface distance, soundpath, and depth to a flaw as well as which leg (up to 4) of the soundpath the reflector is in.

The documentation capabilities of the EPOCH III can store up to 130 A-Scans or 3,000 thickness readings. The alpha-numeric Datalogger allows calibration and test data to be labeled with an eight character file name as well as sixteen character identifiers for each individual piece of data. In addition, a MEMO feature allows unlimited entry of comments and descriptions of data as it is stored. A memory display screen makes it possible to review the contents of any file by scrolling through the actual data - including Waveforms, on the EPOCH III's screen. Finally, any stored data can be sent directly from the EPOCH III to a printer to create an on-site, "mini report" or uploaded to the optional Windows™

based interface program that makes it easy to move test data into word processing software for professional quality reports.

We have only touched upon a few of the EPOCH III's many features. This manual is written in a functional format. The information contained within can read in modular format to answer questions about how to perform specific functions. We suggest that you read through the information completely at least once with your EPOCH III in hand so that you can combine reading the descriptions and examples with actual use of the instrument.

Note: Panametrics-NDT recommends that all operators have a thorough understanding of the principles and limitations of ultrasonic testing. We assume no responsibility for incorrect operational procedure or interpretation of test results. It is highly recommended that any operator seek adequate training prior to using this equipment. Panametrics-NDT offers a full range of training courses including Level I and Level II Ultrasonic Testing, Advanced Detection and Sizing, and Ultrasonic Thickness Gaging. For further information regarding ultrasonic training courses, contact Panametrics-NDT.

While the EPOCH III is a continuously self-calibrating instrument, it is up to the customer to determine regulatory calibration and recalibration requirements. Panametrics-NDT offers calibration and documentation services. Please contact Panametrics-NDT or your local representative with any special requests.

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2 POWER SUPPLY

The Epoch III may operate from either AC line power or from batteries. AC line power is supplied via the 23MCA Mini Charger/Adapter which can be used with line voltages ranging from 100-240VAC, 47-63Hz, 30W max, without the need for any operator adjustment.

2.1 Operation from AC Line Power without Battery

Connect the power cord to the Charger/Adapter unit and to an appropriate line power source.

Connect the DC Output power cable from the Charger/Adapter unit to the Charger/AC Adapter input jack on the side of the Epoch III. To simplify connection, line up the red marks on the plug and the input jack.

Turn the Epoch III on via the front keypad, and proceed with normal operation.

2.2 Operation from Battery Power without The Charger/Adapter

Panametrics-NDT™ Epoch III uses lead-lead dioxide batteries. Upon powering up the unit with the **[ON/OFF]** key, and after the initial status screen, the Epoch III will proceed to the split screen display. In the right hand column, the remaining battery life, in hours, is shown.

Note that all batteries will show some “rebound” effects, that is, the initial reading of remaining life will appear higher than it actually is. This effect is temporary and a stable battery reading can be obtained after 5-10 minutes of operation.

In addition, you will notice at the bottom right hand corner of the display, a battery symbol which indicates the battery charge remaining. This symbol is present at all times. When the 12 volt battery is fully charged, the battery symbol indicator will show 100% capacity. Just prior to auto shutdown the battery symbol indicator will begin to flash. The Epoch III will then perform an automatic shutdown to prevent damage to the battery.

2.3 Replacing a Battery

To remove a battery tray which is currently installed on the Epoch III, first slide the release lever on the front face (bottom) of the unit in the direction of the arrow (see Figure 3-1). Doing so will release the catch and allow the battery to slide out and be removed. See Figure 2-1 below for further details.

After removing the battery tray, install the replacement battery in the same manner, being careful to line up the connector on the battery with the connector on the unit. The battery should follow the guides on the bottom of the unit and will fit precisely into place.

If the 12V belt-mount battery pack is used, simply slide the plug at the end of the coil cord into the battery connector on the bottom of the unit and snap the wire bail into place to secure the connection.

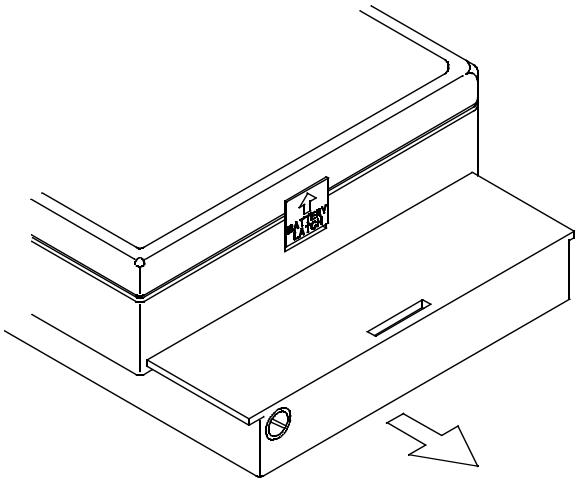

Figure 2.1

2.4 Battery Charging

Warning: The 23MCA charger/adapter is designed to charge Epoch III, 12 Volt batteries only. **DO NOT ATTEMPT TO CHARGE ANY OTHER BATTERIES.** Doing so may cause an explosion and injury! Do not attempt to charge other electronic equipment. Permanent damage will occur.

2.4.1 Using the 23MCA as a Battery Charger

Epoch III batteries should be charged with the 23MCA Charger/Adapter only.
The 23MCA has a universal AC POWER input, so it will operate with any line voltage from 100 to 240 Volts AC, and with either 50 to 60Hz line frequency. There is no line voltage selector switch. The 23MCA will automatically turn on when AC power is applied. There is no on/off switch.

The 23MCA output cable can be plugged directly into a battery, or into the receptacle on the right side of the Epoch III. Batteries may be charged separately or while connected to an Epoch III. To ensure complete charging, when connected to an Epoch III, batteries should be charged with the Epoch III turned off.

The 23MCA has a yellow indicator light which illuminates when the 23MCA is in its “fast charge” mode or when the Epoch III is on. The green indicator light is for its “slow charge” mode, and typically indicates that a battery has been charged to at least 75% of its fully charged states.

2.4.2 Proper Cycling Charge

If the battery is to be used daily (or frequently), it should be connected to the 23MCA charger when not in use.

Whenever a 23MCA is connected to a completely or partially discharged battery, its indicator will be yellow and green, showing that the battery is less than full charge. The indicator may remain yellow for up to eight hours, depending upon the battery’s depth of discharge. When the 23MCA has determined that the battery is above 75% of full charge, the indicator will change to green only and the 23MCA will switch to a “slow charge” mode.

It is best to leave the battery on the “slow charge” mode for several additional hours after the 23MCA indicator has charged to green. Earlier usage is possible, and indeed, in an urgent situation, the 23MCA may be disconnected and the battery used for power even while the indicator is still yellow. Repeated “short cycling” however, is not recommended. Whenever possible, the battery should remain connected to the 23MCA overnight or over a weekend, so that it remains on a “slow charge” and slowly achieves 100% of full charge. Reaching full charge on a regular basis is essential for the maintenance of proper capacity and cycle life.

2.4.3 Battery Usage with an Epoch III

Optimum cycle life can be achieved by manually shutting the Epoch off prior to automatic shutdown. If an Epoch automatically shuts itself down because of a discharged battery, DO NOT turn the Epoch back on before recharging the battery. Permanent degradation of the battery may result.

Discharged batteries should be placed on recharge as soon as possible after use and given a full recharge, as described above. Discharged batteries should never be placed in storage without receiving a full recharge.

2.4.4 Long Term Storage

Batteries should be stored 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, batteries should be given a full recharge at least once every 2-3 months. Batteries may be stored a long time on “slow charge”. This removes any chance of self discharge, but over an excessive period of time, such as a year, may itself cause some capacity degradation.

2.5 Battery Operating Time

- 8 hours with 12V tray or 12V belt mount pack at 25°C

3 OPERATION

3.1 Keypad

3.1.1 Layout of the Epoch III Keypad

The keypad of the EPOCH III is laid out so that the most commonly used keys (the Gain, Item Select, Gate Position, and Slewing Keys) are close to the left thumb of the operator. The logic behind this layout is that it permits virtually all instrument settings to be changed while keeping the left hand in a natural position.

While the use of a direct access keypad makes operation of the EPOCH III faster than most instruments that use a menu format, it generally requires the addition of more keys to the keypad. In order to help orient the operator, these keys have been grouped and color coded according to function. The row of yellow keys at the bottom is for controlling most of the functions used when calibrating the EPOCH III (i.e. Range and Zero Offset). The red keys are used to position the gates. The blue keys are the vertical controls (i.e. Gain and Reject). The orange key group contains general display functions such as peak memory or the display of amplitude or depth data. The purple keys are for high repetition functions such as controlling the EPOCH III with the **[ITEM SELECT]** key or saving thickness data. Finally the tan colored keys are for auxiliary functions and to activate optional features such as on-screen DAC curves.

The EPOCH III also has extensive data storage features. The Datalogger is controlled by a separate group of keys at the right side of the keypad. The yellow keys are used to enter alpha-numeric characters while the blue-gray keys control the various modes of character entry.

3.1.2 Use of the Item Select Key

While there are several functions that can be directly accessed via the instrument keypad, all essential ultrasonic controls can be changed with the use of three keys; the **[ITEM SELECT]** key and one of the slewing keys  or  . This method of operation provides control of virtually all instrument settings with the thumb of the left hand. Multiple presses of the **[ITEM SELECT]** key will toggle through each of the instrument parameters. When a parameter is opened, it will appear highlighted in the Abbreviated Status Window at the center of the screen in the area beneath the A-Scan display. Once a parameter is

opened, its value can be changed using the slewing keys or . An example of how the screen appears when a parameter is being adjusted is shown below.

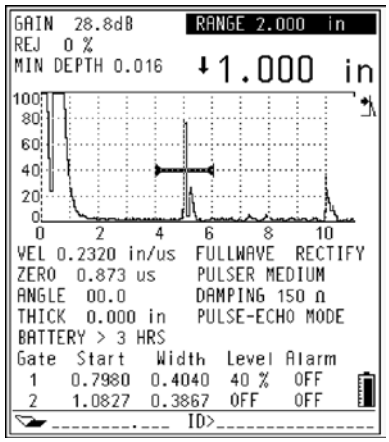

Figure 3.1: Changing a Parameter

Multiple presses of the **[ITEM SELECT]** key toggles through the instrument settings in the following order:

GAIN
REJECT
RANGE
MATERIAL VELOCITY
ZERO OFFSET
REFRACTED ANGLE (for angle beam transducers)
MATERIAL THICKNESS (for angle beam transducers)
DISPLAY RECTIFICATION
PULSE ENERGY
PULSER DAMPING
PULSER MODE
GATE 1
- Start
- Width
- Level
- Alarm

GATE 2
- Start
- Width
- Level A
- Alarm
- .
- .
- .

GAIN

To move quickly through the sequence, the **[ITEM SELECT]** key can be pressed and held until the desired function is opened.

Once the end of this sequence has been reached, the next press of **[ITEM SELECT]** will bring the EPOCH III back to the top of the list (Gain). **It is important to note that all other keys function on their own as outlined in Section 3.2 below.**

3.1.3 Direct Access Operation

Most commonly used parameters also have their own individual keys to provide direct access to the parameter setting. Typically, when the EPOCH III is used in this manner the parameter is changed by pressing the appropriate key and adjusting the value using the slewing keys or . For example to increase the gain, press **[dB]** and then .

In some cases the parameter appears as a second function above another key. To change these parameters, press **[2nd F]** and the appropriate key and then use the slewing keys or to adjust the parameter value. For example, to increase the reject level, press **[2nd F]**, **[FREEZE]** to open the reject function and then the key to adjust it upward. Pressing any other key will then close the current function.

Note: Whenever a function is opened, the EPOCH III provides prompts in the Abbreviated Status Window on the two lines directly beneath the A-Scan display. The current function will appear centered and in reverse video and any additional key presses will also be noted and highlighted.

3.2 Summary of Keypad Functions

The keypad of the EPOCH III is laid out with functional groupings of keys that are color coded for easy identification:

Main Keypad:

Blue:	Sensitivity/vertical adjustment key
Yellow:	Time base/horizontal adjustment keys
Red:	Gate adjustment keys
Orange:	Display function keys
Purple:	High repetition functions
Tan:	Second functions soft keys and options
Green:	Slewing keys and On/Off key

Datalogger Keypad:

Yellow:	Alpha-numeric characters
Blue-Gray:	Control mode/type of data entry or editing

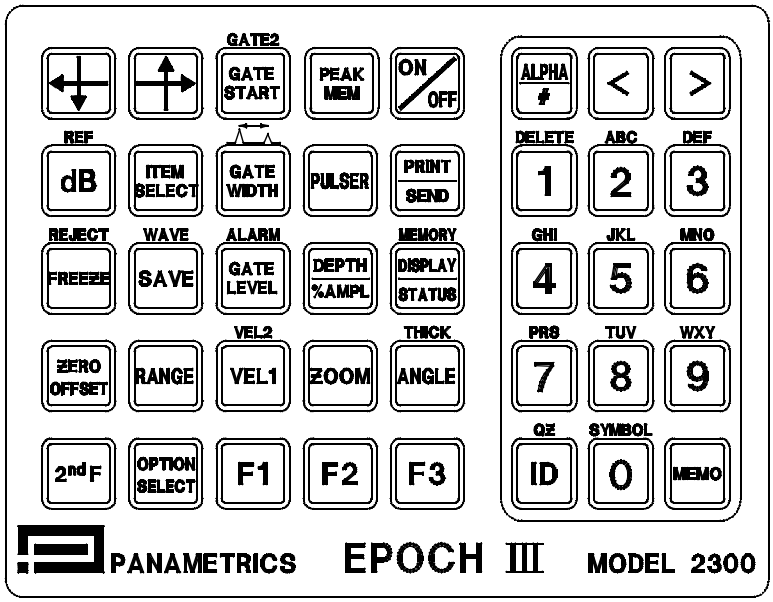

Figure 3.2: English Keypad

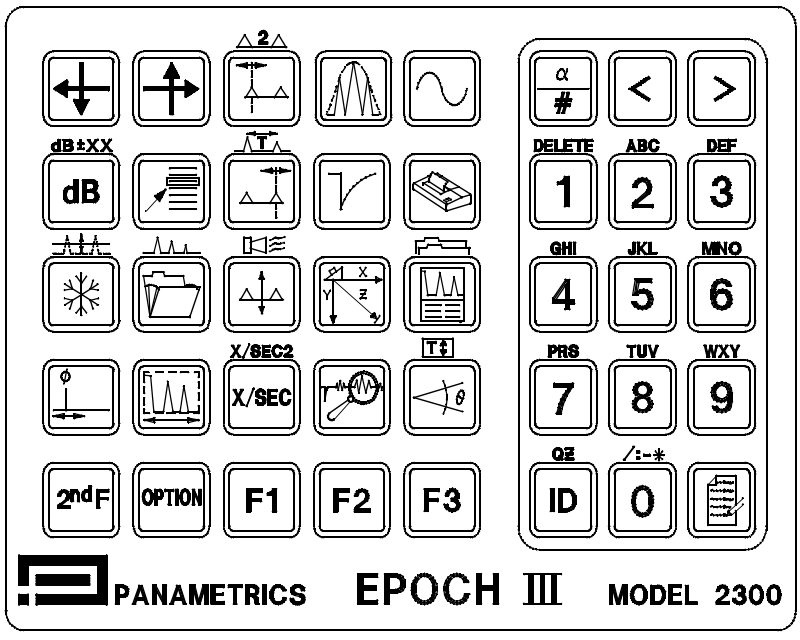

Figure 3.3: International Keypad

3.2.1 Main Keypad Functions

ENGL. KEYS	INT'L KEYS	COLOR	FUNCTION
		BLUE	SENSITIVITY: Adjust system sensitivity by pressing **[dB]** and using the ▼ or ▲ keys (0-100.0dB).
		TAN	
		BLUE	REFERENCE LEVEL: Sets a gain 'reference level' and allows addition of scanning gain in 6 or 0.1dB increments.
		BLUE	SCREEN FREEZE: Holds displayed Waveform until **[FREEZE]** is pressed a second time.
		TAN	
		BLUE	REJECT: Reject level is set by pressing **[2nd F] [FREEZE]** and using ▼ or ▲. (0-80%, 1% increments.)
		YELLOW	ZERO OFFSET: Compensates for time offset between electric and acoustic zero points. To adjust, press **[ZERO OFFSET]** and ▼ or ▲. (0-350µSec)

ENGL. KEYS	INT'L KEYS	COLOR	FUNCTION
RANGE		YELLOW	RANGE ADJUST: Used to set the timebase in units of material travel distance. Multiple presses of **[RANGE]** provides coarse adjustment. For fine adjustment, press **[RANGE]** and ↓ or ↑. (0.038 - 200 in 1-5000mm). [Note: 0.038 - 400 in, 1 - 10000mm with extended range option.]
VEL2 VEL1	X/SEC2 X/SEC	YELLOW	MATERIAL VELOCITY SETTING: Used to set material velocity for distance calculations. To adjust, press **[VEL1]** and ↓ or ↑. (0.025 - 0.6000 in/µ Sec, 655 -15240m/Sec).
2nd F	2nd F	TAN	
VEL2 VEL1	X/SEC2 X/SEC	YELLOW	VELOCITY #2: Allows storage of second material velocity to simplify switching from a longitudinal to shear wave transducers or any two commonly used settings. To toggle back and forth, press **[2nd F]**, **[VEL1]**.
ZOOM		YELLOW	ZOOM: Expands area covered by Gate 1 to full screen width for high resolution viewing of portions of the Waveform.
THICK ANGLE		YELLOW	REFRACTED ANGLE: Allows entry of angle when using angle beam transducers. Multiple presses will toggle through fixed settings of 30^{o}, 45^{o}, 60^{o}, and 70^{o}. For fine adjustment, press **[ANGLE]** and ↓ or ↑. (0-85^{o} , 0.1^{o} increments)

ENGL. KEYS	INT'L KEYS	COLOR	FUNCTION
		TAN	
		YELLOW	MATERIAL THICKNESS: Allows entry of material thickness when testing with an angle beam transducer. To enter value, press **[2nd F]** and ▲ or ▼.
		RED	GATE START: Controls starting point of selected gate. To move, press **[GATE START]** and ▲ or ▼.
		RED	GATE WIDTH: Controls width of selected gate. To adjust, press **[GATE WIDTH]** and ▲ or ▼.
		RED	GATE LEVEL: Controls level of selected gate. To adjust, press **[GATE LEVEL]** and ▲ or ▼. (2-95% FSH, 1% increments)
		TAN	
		RED	GATE 1/GATE 2 TOGGLE: When Gate 1 is active, pressing **[2nd F]** , **[GATE START]** will toggle the gate control keys; GATE START, GATE WIDTH, and GATE LEVEL to Gate 2. Pressing **[2nd F]**, **[GATE START]** a second time will toggle the gate control keys back to Gate 1. To shut off Gate 2 entirely or turn Gate 2 back on, press **[F1]** at the prompt.

ENGL. KEYS	INT'L KEYS	COLOR	FUNCTION
		TAN	
		RED	ECHO-TO-ECHO MEASUREMENT: Activates echo-to-echo measurement mode. Opens Gate 2 Start to facilitate set-up. To shut off echo-to-echo measurement mode, press **[2nd F]**, **[GATE WIDTH]** a second time. A prompt will appear at the bottom of the instrument screen to allow choice of edge to edge or peak to peak measurements.
		TAN	
		RED	GATE ALARMS: Activates alarms for selected gate.A prompt will appear at the bottom of the instrument screen to allow choice of Threshold, MinDepth, or deactivation of alarm (OFF).
		ORANGE	PEAK MEMORY: Activates Peak Memory function allowing continuous accumulation of peak envelope data with the live Waveform. To deactivate, press **[PEAK MEM]** a second time.
		ORANGE	PULSER/RECEIVER ADJUSTMENT: Multiple presses of the **[PULSER]** key allows adjustment of the following settings: Waveform rectification, pulse energy, damping, and test mode. To change a particular setting, use the slewing keys, ⊞ or ⊞.
		ORANGE	DEPTH/AMPLITUDE DISPLAY: Allows selection and display of peak or edge depth or signal amplitude.

ENGL. KEYS	INT'L KEYS	COLOR	FUNCTION
		ORANGE	PRINT OR SEND DATA: Pop-up menu allows selection of data to be sent to either a printer or computer.
		ORANGE	FULL SCREEN/SPLIT SCREEN TOGGLE: Switches between full A-Scan display and split screen display with half-sized A-Scan and set-up data.
		TAN	
		ORANGE	MEMORY SCREEN: Provides access to the memory screen for viewing of files and recall of calibration data.
		PURPLE	ITEM SELECT: Toggles through settings of all basic instrument functions. The selected function may be changed using the slewing, ◄► or ▲▼ keys. This key is also used as an "Enter" command on certain screens.
		PURPLE	SAVE THICKNESS DATA: Saves displayed thickness reading in current file.
		TAN	
		PURPLE	SAVE WAVEFORM: Saves current Waveform and instrument set-up data in current file.

3.2.1.1 Datalogger Keypad Functions

ENGL. KEYS	INT'L KEYS	COLOR	FUNCTION
		BLUE-GRAY	ID ENTRY: Allows entry of new, or editing of current location code.
		BLUE-GRAY	MEMO ENTRY: Allows entry of notes/comments regarding inspection data.
		BLUE-GRAY	ALPHA/NUMERIC TOGGLE: Switches yellow keys back and forth between entry of numbers or text.
		BLUE-GRAY	CURSOR CONTROL: Increment or decrement cursor during alpha-numeric entry or editing.
NUMERIC KEYS 0 - 9		YELLOW	ALPHA-NUMERIC ENTRY: Entry of numeric or alphabetic characters. Toggle between modes of entry by pressing **[ALPHA/#]**.

3.3 Power-up Screen

Upon pressing the **[ON/OFF]** key, you will notice an initial beep and a series of relay clicks. The electroluminescent display does NOT light up for approximately 3 seconds. After 3 seconds, you will see a self-test display which lasts for approximately 5 seconds.

The **[MEMO]** key is active during this five second self-test display. A custom setup can be created for the power-up screen to indicate company name and address (please refer to Section 8.3.11). In addition, a master reset of the instrument's parameters and/or Database information can also be performed (please refer to Appendix I).

3.4 The Display

A feature of the EPOCH III is the ability to present the A-Scan in two different display formats. A split screen display allows simultaneous viewing of the Waveform as well as all instrument set-up data. In addition, the full screen display presents a large, high resolution Waveform as well as important basic information.

After the EPOCH III has been powered up and the self test routine has been completed, the split screen display will appear. To switch to full screen display, press **[DISPLAY/STATUS]**. To switch back to the split screen display, press **[DISPLAY/STATUS]** a second time.

3.4.1 The Full Screen A-Scan Display

As shown below, the full screen A-Scan display presents a large, high resolution Waveform as well as some basic data to aid with interpretation of the display.

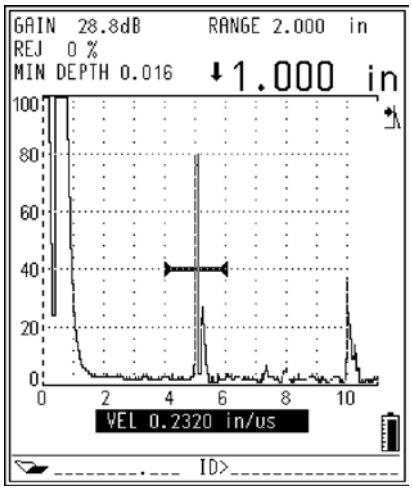

Figure 3.4: Full Screen Display

In the full screen display, the screen is effectively broken up into four regions. At the top of the screen, current Gain level, Range, and Reject settings are constantly displayed. Just beneath, a large numeric display will show thickness, soundpath, or amplitude data pertaining to a gated signal. The **[DEPTH/%AMPL]** key is used to select which information is shown.

The middle of the display is used to present the Waveform. In the background, a numbered graticule shows signal amplitude on the vertical axis and screen division number along the horizontal axis. Near the upper right hand corner of the Waveform display, a set of display flags and markers may appear. These symbols appear when certain functions are active. For further details and descriptions regarding each of these symbols, please refer to the section on Display Flags and Markers.

The bottom of the display, below the Waveform, is used to present the instrument function that is currently in use. While the function is open, the current value or state is shown and adjustment to the function is possible. In addition, the battery level icon is displayed to the right.

Note: This feature is useful for quickly checking instrument settings. To check a particular setting, press the appropriate key and glance at the line beneath the Waveform display.

Finally, on the very bottom of the display, the current file name and location code are continuously displayed.

3.4.2 The Split Screen Display

As shown below, the split screen display presents a condensed Waveform as well as a status display that shows all instrument set-up data. This screen is particularly useful when establishing the initial instrument settings as it enables the operator to quickly check all set-up information and make adjustments while viewing the Waveform display. It should be noted that even in the split screen mode, the A-scan still has enough resolution to produce accurate Waveforms.

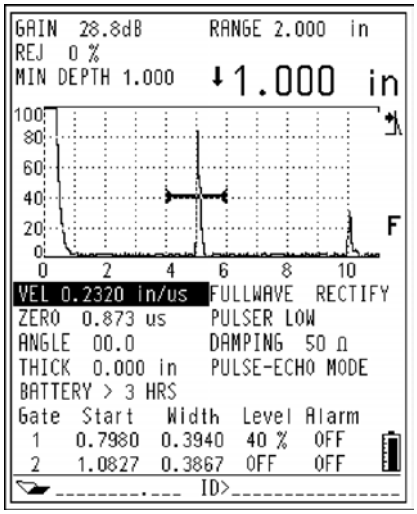

Figure 3.5: Split Screen Display

The utility of the split screen display can be seen when the **[ITEM SELECT]** key is used. To see how this works, toggle the display to the split screen by pressing the **[DISPLAY/ STATUS]** key. Now press the **[ITEM SELECT]** key several times. As in the full screen display, the current function is highlighted and can be changed using the slewing keys, ⊞ and ⊞.

3.4.3 Display Flags and Markers

In order to indicate when particular display functions are active, a set of flags and markers may appear near the upper right hand side of the Waveform display as shown below.

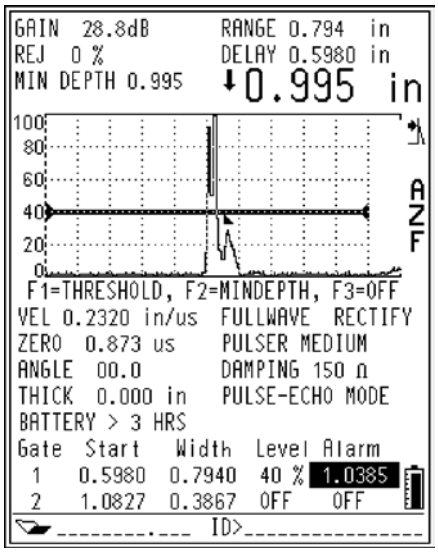

Figure 3.6: Display Flags and Markers

The purpose of these markers is to allow easy identification of particular display functions. Below is a list of each symbol and a description of its meaning:

Indicates that the EPOCH III is in the 'PEAK DEPTH' mode, that is thickness and soundpath measurements are made to the peak of the highest amplitude signal within the flaw gate. This symbol will also appear when the amplitude display is active as all amplitude measurements are made to the peak of the signal.

Indicates that the EPOCH III is in the 'EDGE DEPTH' mode and all thickness and soundpath measurements are to the leading edge of the first signal within the flaw gate.

Indicates that the Epoch III is in the Echo-to-Echo measurement mode and that the measurement is being made between the peaks of the two selected signals.

Indicates that the Epoch III is in the Echo-to-Echo measurement mode and that the measurement is being made between the leading edges of the two selected signals.

P - Indicates that the PEAK MEMORY function is active.

F - Indicates that the display is frozen because the FREEZE function has been activated.

Z - Indicates that the ZOOM function has been activated to expand the region within the flaw gate to full screen width.

A - Indicates that the gate alarm has been tripped.

TVG - Indicates that Time Varied Gain is active.

Battery level indicator. The remaining battery life is constantly displayed in the lower right hand corner of the Waveform display. This symbol will flash when the remaining battery life is less than 1 hour.

Also note that remaining battery life (in hours) is displayed in thethe split screen mode.

For a detailed description of the use of each of these functions, please refer to the appropriate section of this manual.

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4 CALIBRATION

4.1 Initial Settings

Until the operator is completely comfortable with the operation of the EPOCH III, it is recommended that a basic review and set-up procedure be used prior to starting the actual calibration. The split-screen feature of the EPOCH III is particularly useful for this as it allows the operator to simultaneously view the Waveform display and all instrument calibration data.

To set up the EPOCH III for calibration proceed as follows:

1. Select the split screen display by pressing the **[DISPLAY/STATUS]** key.
2. Set the reject level to 0% by pressing the **[2nd F]**, **[FREEZE]** and using the ⊞ key to adjust the value.
3. Select an initial gain value that is appropriate for the calibration by pressing the **[dB]** key and adjusting the value by using the ⊞ or ⊞ key. If the appropriate gain level is unknown, set the initial gain at 40 to 50dB and adjust it as necessary during calibration.
4. Enter an approximate velocity for the test material by pressing **[VEL 1]** and adjusting the value with the ⊞ or ⊞ keys. If the velocity value is unknown, a starting value may be found in the velocity table in Appendix IV of this manual.
5. Set the range coarse adjustment by toggling the **[RANGE]** key. Fine adjustments can be made using the slewing ⊞ or ⊞ key.
6. Set the material thickness to 0.00" or 0.00mm by pressing **[2nd F] [ANGLE]** and the ⊞ key.
7. Set the zero offset value to 0.00µSec by pressing **[ZERO OFFSET]** and using the ⊞ key to bring the initial pulse to the left hand side of the instrument screen.
8. Enter the correct refracted angle for the transducer (0 for a straight beam or 90^{o} probe, 45 for a 45^{o}, etc.). This is done by pressing the **[ANGLE]** key. Multiple presses of this key toggle through preset values while 0.1 degree adjustments can be made using the ⊞ or ⊞ keys.
9. Once the transducer is coupled to the block, adjust the pulser to create a “clean” A-Scan. Multiple presses of the **[PULSER]** key allow access to the various pulser functions. Each pulser function can be adjusted using the ⊞ and ⊞ keys.

The EPOCH III is calibrated in a manner that is very similar to virtually any ultrasonic flaw detector. For the following examples, the important keys to remember are:

ZERO OFFSET: 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.

RANGE: The **[RANGE]** key is used to set the time base of the instrument and to adjust the separation between echoes.

Note: Use Zero Offset on the left echo and Range on the right echo. This also corresponds to each key’s position on the keypad (i.e. Zero Offset on left, Range on right).

VELOCITY: The Velocity key is used to set the precise material velocity. In order to make use of the EPOCH III’s on-screen distance calculator, the velocity must be correctly set. Once the initial setup has been completed, the Epoch III’s calibration data will appear as shown below:

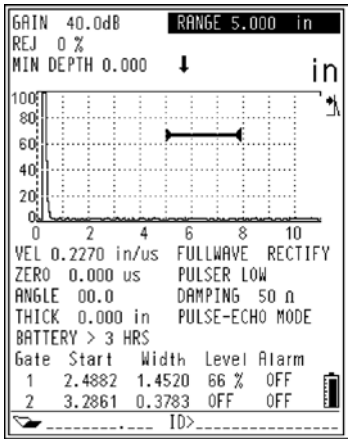

Figure 4.1

Following are examples of calibrations for the four basic configurations of contact transducers: straight beam, delay line, dual element, angle beam. Each calibration is broken down into two steps; display calibration and adjustment of material velocity to allow use of the distance calculator.

4.2 Straight Beam Calibration

4.2.1 Basic Procedure for Display Calibration

Note: This section is intended strictly as a guideline. No specific calibration standards or references have been used. For specific details, refer to Section 4.2.3, Sample Straight Beam Calibration.

1. Follow the initial set-up procedure as outlined in the previous section.
2. Connect the transducer to the top (red) connector and couple the transducer to the desired calibration standard.
3. Adjust the gain using **[dB]** and ◄► or ▲▼ so that the calibration echoes are clearly visible.
4. Bring the first calibration echo to the appropriate division using **[ZERO OFFSET]** and the slewing keys; ◄► or ▲▼. Note the left and right arrows on the slewing keys correspond to the direction of movement of the echo. For example, to move an echo to the left use the ◄► key. Once the echo is aligned with the screen graticule, a dotted line will appear along the leading edge of the signal.
5. Bring the second calibration echo to the appropriate division using **[RANGE]** and the ◄► or ▲▼ slewing keys. Once the echo is aligned with the screen graticule, a dotted line will appear along the leading edge.
6. Repeat Steps 4 and 5 until both echoes are correctly aligned.

4.2.2 Setting Material Velocity

Once the display has been properly calibrated, adjustment of the material velocity will allow the operator to obtain direct, accurate readings of soundpath. The procedure for setting the material velocity is simple.

1. Position Gate 1 over the second calibration echo using the **[GATE START]**, **[GATE WIDTH]**, **[GATE LEVEL]** and the ◄► and ▲▼ keys.
2. Press the **[DEPTH/%AMPL]** key to obtain a soundpath reading in the upper right hand corner of the display. Select “edge depth” mode by pressing **[F1]**.
3. Adjust the material velocity using **[VEL1]** and the ◄► and ▲▼ keys until the correct soundpath reading is obtained.

To ensure that the instrument has been calibrated correctly, check the accuracy of the thickness measurements and be sure the range has been returned to it’s initial setting. It should be noted that changing the velocity will also change the range value. If the range value is correct and the thickness measurements are accurate, the calibration is complete.

If the range value is incorrect, any or all of the calibration parameters should be checked and readjusted.

4.2.3 Sample Straight Beam Calibration

Following is an example of how to set up for a 5MHz straight beam transducer when both the zero offset and material velocity values are unknown. A 1" (25mm) test block and a 5" (125mm) screen range are used. Adjust the instrument settings to match the display shown below.

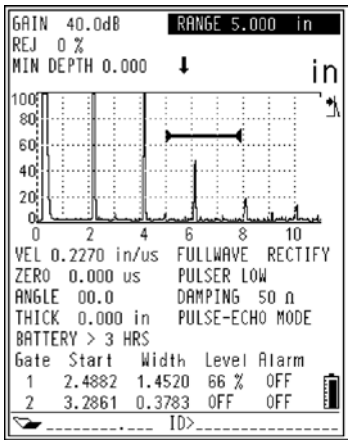

Figure 4.2

1. Make sure that the range is set to 0.500"/Div (12.5mm/div). Access the full A-Scan display by pressing the **[DISPLAY/STATUS]** key. Press the **[ZERO OFF-SET]** key once and then use the slewing keys to line up the leading edge of the first back echo with the second screen division. When the echo is precisely aligned, a dotted line will appear on the leading edge of the signal. In the example below, the echo at the second screen division is aligned, all others are not.

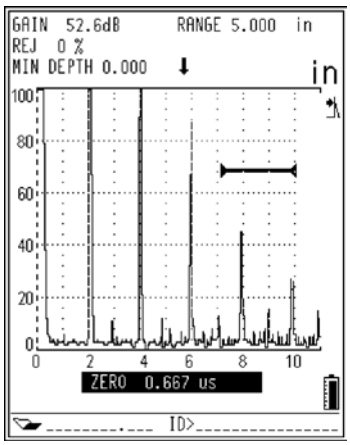

Figure 4.3

Note that the second screen division represents 1" (25mm) based upon 0.500"/div (12.5mm/div). Remember that the instrument is set for a 5" (125mm) range; 0.500"/div (125mm/div) x 10 divisions = a 5" (125mm) range full scale.

2. Press the **[RANGE]** key once and then use the slewing keys to position the leading edge of the fifth back echo on the tenth screen division. Notice that as the last echo is adjusted, the first echo may have moved from its position. Therefore it may be necessary to repeat steps 1 and 2 until both the first and fifth back echoes line up with the second and tenth divisions respectively.

3. Once the display has been calibrated as shown, the last step is to set the material velocity. To do this, position Gate 1 over the fifth back echo and obtain a depth reading (select edge depth mode). If the reading is incorrect, change the material velocity by pressing the **[VEL1]** key and using the slewing keys. If the reading is too low, adjust the velocity upward. If it is too high, adjust the velocity downward until the correct depth reading of 5" appears in the upper right hand corner of the display as shown below.

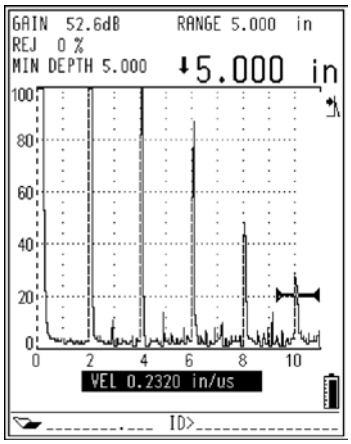

Figure 4.4

4. Also note that changing the velocity will change the depth value as well as the range (in/div.). After the velocity has been adjusted to display the correct depth, the range will return to it's original .500 in./div (12.5mm/div).

4.3 Delay Line Transducer Calibration

4.3.1 Display Calibration

Note: This section is intended strictly as a guideline. No specific calibration standards or references have been used. For specific details, refer to Section 4.3.3, Sample Delay Line Transducer Calibration.

1. Follow the initial set-up procedure as outlined in Section 4.1.
2. Connect the transducer to the top (red) connector and couple the transducer to the desired calibration standard.
3. Adjust the gain using **[dB]** and the ⊟ or ⊞ slewing keys so that the calibration echoes are clearly visible.
4. With a Zero Offset of 0.00µSec, the Main Bang (or excitation pulse) should appear on the left of the screen. Increase the zero offset until the Main Bang goes off the left side of the screen and the interface echo (from the end of the delay line) appears on the screen. You may verify that the echo represents the end of the delay by tapping your finger on the end of the transducer's couplant-coated delay line. This will dampen the signal and the echo should jump up and down on the screen. Once you have located this echo, couple the transducer to the thin section of your test block. Using **[ZERO OFFSET]** and the ⊟ and ⊞ slewing keys, bring the

first calibration echo to the appropriate graticule. Once the echo is aligned with the screen graticule, a dotted line will appear along the leading edge of the signal.

5. Couple the transducer to the thick section of your test block. Bring this echo, called the second calibration echo, to the appropriate division using **[RANGE]** and the ⊞ or ⊞ slewing keys. Once the echo is aligned with the screen graticule, a dotted line will appear along the leading edge.

6. Repeat steps 4 and 5 until both echoes are correctly aligned.

4.3.2 Setting Material Velocity

Once the display has been properly calibrated, adjustment of the material velocity will allow the operator to obtain direct, accurate readings of sound path. The procedure for setting the material velocity is simple and is described below.

1. Position Gate 1 over the second calibration echo using the **[GATE START]**, **[GATE WIDTH]**, **[GATE LEVEL]** and the ⊞ and ⊞ slewing keys.

2. Press the **[DEPTH/%AMPL]** key, then **[F1]** to obtain a sound path (edge depth mode) reading in the upper right hand corner of the display.

3. Adjust the material velocity using **[VEL1]** and the ⊞ and ⊞ slewing keys until the correct sound path reading is obtained.

   To ensure that the instrument has been calibrated correctly, check the accuracy of the thickness measurements and be sure the range has been returned to it's original setting. It should be noted that changing the velocity will also change the range value. If the range value is correct and the thickness measurements are accurate, the calibration is complete. If the range value is incorrect, any or all of the calibration parameters should be checked and readjusted. In this case start by re-calibrating the display to be sure that the echoes are lined up on the appropriate graticules and the dotted line appears on the correct screen division. When the echoes are lined up properly, proceed again to the material velocity calibration section.

4.3.3 Sample Delay Line Transducer Calibration

Following is an example of how to set up for a 10MHz delay line transducer when both zero offset and material velocity values are unknown. Adjust the instrument settings to match the display shown below.

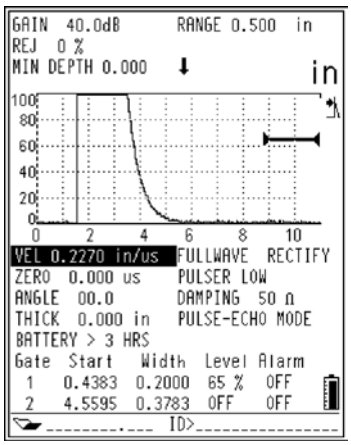

Figure 4.5

1. In this example you will be using a steel 5-step test block with steps of 0.100", 0.200", 0.300", 0.400", and 0.500" (2.5mm, 5mm, 7.5mm, 10mm and 12.5mm). Make sure the range is set to 0.050"/div (1.25mm/div). Access the full A-Scan display by pressing the **[DISPLAY/STATUS]** key. Press the **[ZERO OFFSET]** key once and then use the ◄ and ► slewing keys to locate the interface signal from the end of the delay line. Once the delay line echo has been located, continue using **[ZERO OFFSET]** to line up the leading edge of the first back echo with the second screen division. When the echo is precisely aligned, a dotted line will appear on the leading edge of the signal.

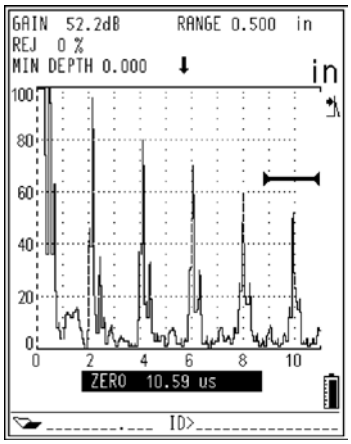

Figure 4.6

Note that the second screen division represents 0.100" (2.5mm) based upon a 0.050"/div (1.25mm/div) screen range.

2. Couple to the 0.500" (12.5mm) step. Press the **[RANGE]** key once and then use the ⊞ and ⊞ slewing keys to position the leading edge of the back echo on the tenth screen division. Notice that as the last echo is adjusted, the first echo may have moved from its position. Therefore it may be necessary to repeat steps 1 and 2 until the echoes from both the 0.100" (2.5mm) step and 0.500" (12.5mm) step line up with the second and tenth divisions respectively.

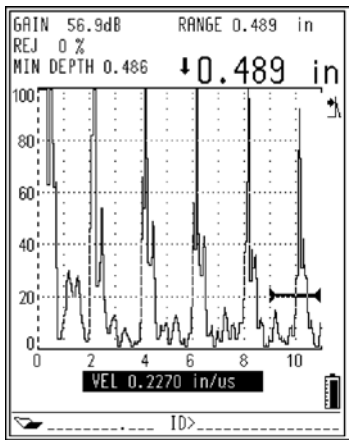

Figure 4.7

3. Once the display has been calibrated as shown, the last step is to set the material velocity. To do this, position Gate 1 over the fifth back echo and obtain a depth reading. If the reading is incorrect, change the material velocity by pressing the **[VEL1]** key and using the slewing keys. If the reading is too low, adjust the velocity upward. If the reading is too high, adjust the reading downward. Continue this procedure until the correct depth reading appears in the upper right hand corner of the display as shown below.

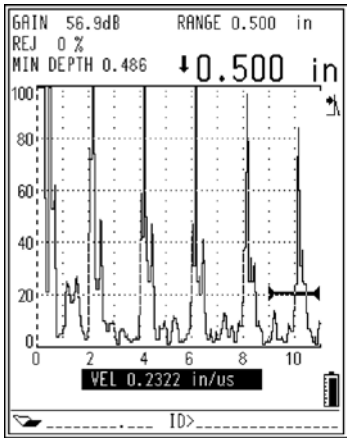

Figure 4.8

4.4 Dual Element Transducer Calibration

4.4.1 Basic Procedure for Display Calibration

Note: This section is intended strictly as a guideline. No specific calibration standards or references have been used. For specific details, refer to Section 4.4.3, Sample Dual Transducer Calibration.

1. Follow the initial set-up procedure as outlined in Section 4.1. Change the test mode to dual transducer mode by pressing the **[PULSER]** key four times and using the ⊞ and ⊞ slewing keys. The initial calibration should now read as follows:

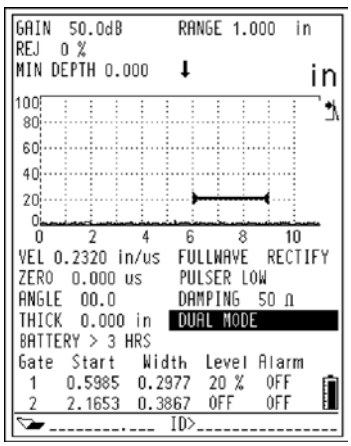

Figure 4.9

Caution: Due to acoustic characteristics of dual or pitch-and-catch transducers, a non-linearity in the distance calibration occurs as the thickness of the material decreases. This non-linearity is usually not serious until the amplitude of the backwall echo drops to half the maximum value that occurs at the point of beam intersection (or what is often referred to as the focus).

The point of maximum sensitivity is determined by the "roof angle" of the particular dual transducer. It is recommended that the distance calibration be carried out using a step block that covers the range of interest. Care should be taken in the interpretation of thickness readings made outside the calibrated range.

Ultrasonic flaw detectors such as the Epoch III do not have V-Path Correction. Therefore, there may be some nonlinearity within the calibrated range, depending on the minimum thickness used in the calibration process.

2. Connect the transmit side of the transducer to the top (red) connector and the receiver side of the transducer to the bottom (blue) connector. Couple the transducer to the calibration standard.

3. Adjust the gain using the **[dB]** key so that the calibration echoes are clearly visible. A dual transducer will require a higher gain setting in order to produce a clean leading edge. Do not be concerned with the jagged peaks of the echo. Concentrate on the leading edge only.

4. Begin with a Zero Offset value of 0.000µSec. Note that in dual transducer mode, the Main Bang will not appear on the instrument screen as data from the receive side of the transducer is being displayed. Couple the transducer to the thin section of your test block. Using **[ZERO OFFSET]** and the slewing keys; ◄► or ►◄, bring the first calibration echo to the appropriate graticule. Once the echo is aligned with the screen graticule, a dotted line will appear along the leading edge of the signal.

Caution: The zero offset value can vary significantly at extreme temperatures. If the temperature changes more than a few degrees from the temperature at which the value of the zero offset was established, its value should be rechecked. If thickness measurements are to be made over a wide temperature range, we strongly recommend the use of Panametrics-NDT™ dual transducers which are designed for high temperature applications and have built-in delay lines with a stable sound velocity that does not change significantly with temperature. Specific recommendations are Pan-

ametrics-NDT D790 and D791 dual element transducers. Please specify BNC or Large Lemo connectors for appropriate cables.

5. Couple the transducer to the thick section of your test block. Bring the second calibration echo to the appropriate division using **[RANGE]** and the ◄► and ▲▼ slewing keys. Once the echo is aligned with the screen graticule, a dotted line will appear along the leading edge.
6. Repeat steps 4 and 5 until both echoes are correctly aligned.

4.4.2 Setting Material Velocity

Once the display has been properly calibrated, adjustment of the material velocity will allow the operator to obtain direct, accurate readings of soundpath. The procedure for setting the material velocity is simple and is described below.

1. Position Gate 1 over the second calibration echo using the **[GATE START]**, **[GATE WIDTH]**, **[GATE LEVEL]** and the ◄► and ▲▼ slewing keys.
2. Press the **[DEPTH/%AMPL]** key to obtain a soundpath reading in the upper right hand corner of the display.
3. Adjust the material velocity using **[VEL1]** and the ◄► and ▲▼ slewing keys until the correct soundpath reading is obtained.

To ensure that the instrument has been calibrated correctly, check the accuracy of the thickness measurement and be sure the range has been returned to it's initial setting. It should be noted that changing the velocity will also change the range value. If the range value is correct and the thickness measurements are accurate, the calibration is complete. If the range value is incorrect, any or all of the calibration parameters should be checked and readjusted. In this case, start by re-calibrating the display to be sure that the echoes are lined up on the appropriate graticules and the dotted line appears on the correct screen division. When the echoes are lined up properly, proceed again to the material velocity calibration section.

4.4.3 Sample Dual Transducer Calibration

Following is an example of how to set up for a 5MHz dual transducer when both zero offset and material velocity values are unknown. Adjust the instrument settings to match the display shown below.

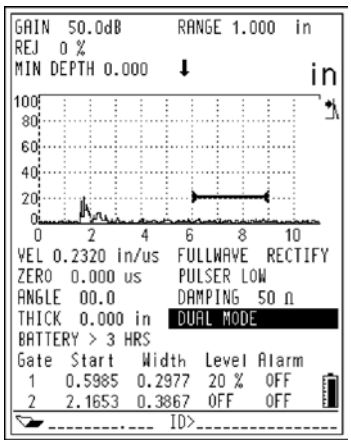

Figure 4.10

1. In this example you will be using a steel 5 step test block with step increments of 0.100", 0.200", 0.300", 0.400", and 0.500" (2.5mm, 5mm, 7.5mm, 10mm, and 12.5mm). Couple the transducer to the 0.100" (2.5mm) step. Make sure the range is set to 0.100"/div (2.5mm/div). Access the full A-Scan display by pressing the **[DISPLAY/STATUS]** key. Press the **[ZERO OFFSET]** key once and then use the ◀ and ▶ slewing keys to line up the leading edge of the first back echo with the first screen division. When the echo is precisely aligned, a dotted line will appear on the leading edge of the signal.

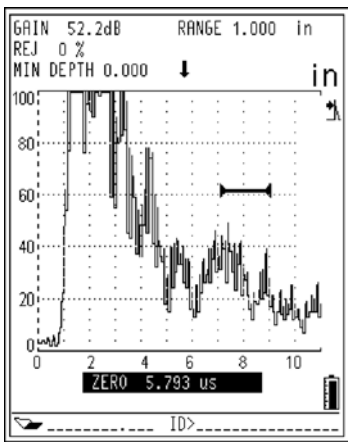

Figure 4.11

Note that the first screen division represents 0.100" (2.5mm) based upon a 0.100"/ div (12.5mm/div) screen range.

2. Couple the transducer to the 0.500" (12.5mm) step. Press the **[RANGE]** key once and then use the and slewing keys to position the leading edge of the second calibration echo on the fifth screen division. Notice that as this echo is adjusted, the first echo may have moved from its position when you recouple to the 0.100" (2.5mm) step. Therefore it may be necessary to repeat steps 1 and 2 until both the first and second calibration echoes line up with the first and fifth divisions respectively.

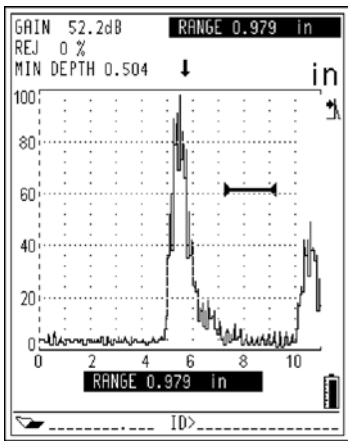

Figure 4.12

3. Once the display has been calibrated as shown, the last step is to set the material velocity. To do this position Gate 1 over the echo from the 0.500" (12.5mm) step and obtain a depth reading by pressing the **[DEPTH/%AMPL]** key. If the reading is incorrect, change the material velocity by pressing the **[VEL1]** key and using the slewing keys. If the reading is too low, adjust the velocity upward. If the reading is too high, adjust the reading downward. Continue this procedure until the correct depth reading appears in the upper right hand corner of the display as shown below.

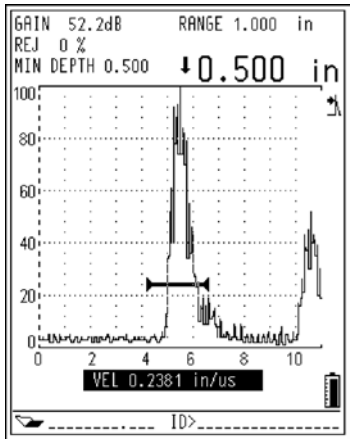

Figure 4.13

4.5 Angle Beam Transducer Calibration

There are four basic steps in calibrating with angle beam transducers:

1. Locate the Beam Index Point (B.I.P.) of the transducer
2. Verify the Refracted Angle (Beta)
3. Calibrate for Distance
4. Calibrate for Sensitivity

4.5.1 Basic Procedure for Display Calibration

Note: This section is intended strictly as a guideline. No specific calibration standards or course adjustment references have been used. For specific details, refer to Section 4.5.2, Sample Angle Beam Transducer Calibration.

1. Follow the initial set-up procedure as outlined in Section 4.1. Be sure to enter the correct refracted angle for the transducer/wedge combination that is being used.This is done using the **[ANGLE]** key. Also, be sure to change the material velocity. For example, if using a shear velocity for steel, set it to .1270 in/µSec, 3200 m/Sec.
2. Connect the transducer to the top (red) connector and couple the transducer to the desired calibration standard.
3. Locate the beam index point and mark the appropriate location on the transducer wedge.

4. Verify the refracted angle (BETA) and enter this value into the Epoch III using the **[ANGLE]** key and the and slewing keys. Repeated presses of this key will toggle through fixed settings of 0^o, 30^o, 45^o, 60^o, and 70^o. Fine adjustment (in 0.1^o increments) is done with the slewing or keys.
5. Align the beam index point (BIP) of the wedge with the zero point marked on the calibration block.
6. Adjust the gain using the **[dB]** and or key so that at least the first calibration echo is visible on the screen.
7. Press the **[ZERO OFFSET]** key once and then use the and slewing keys to position the first calibration echo at the correct screen division. Once the echo is aligned with the screen graticule, a dotted line will appear along the leading edge of the signal. At this point it may also be necessary to readjust the gain so that the second calibration echo is clearly visible on the instrument screen.
8. Press the **[RANGE]** key once and use the and slewing keys to position the second calibration echo at the correct screen division. Notice that as the second echo is adjusted, the first echo may have moved from its position. Therefore it may be necessary to repeat steps 7 and 8 until the echoes line up with the appropriate screen divisions.
9. Further adjust the instrument sensitivity according to the appropriate procedure. If it is necessary to add “scanning gain” apart from the initial sensitivity setting, this can be done using the reference gain function. This is accessed by pressing **[2nd F] [dB]** and allows additional gain to be added or subtracted in 6dB or 0.1dB increments.
10. Set the material velocity to obtain accurate readings of all sound path components.

4.5.2 Sample Angle Beam Transducer Calibration

Note: We recommend the use of either an ASTM E-164 IIW Type I or U.S. Air Force IIW-2 Calibration Block for this calibration procedure.

In this example you will be using an IIW “Type I” block. Therefore, you will be looking for echoes at 4" (100mm) and 9" (225mm). If you are using a “Type II” block, the procedure is the same. However, you will be looking for echoes at 2" (50mm) and 4" (100mm). Make sure the range is set to 1.00"/division (25mm/division). A 2.25MHz, 70^o shear wave transducer will be used for this calibration.

a. Adjust the instrument settings to match the display shown below:

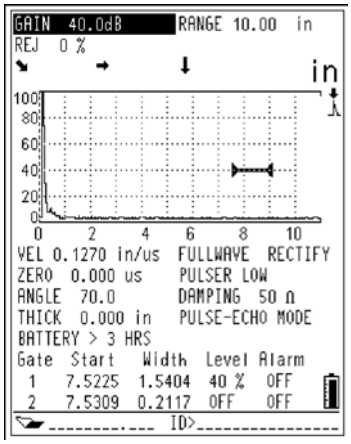

Figure 4.14

b. Adjust the gain using the or slewing keys so that the calibration echoes are clearly visible.

c. With a Zero Offset of 0.00µSec, the Main Bang (or excitation pulse) should appear on the left of the screen. Increase the zero offset using the slewing key until the Main Bang goes off the left side of the screen.

1. Locating the Beam Index Point (B.I.P.)

Couple the transducer to the test block at the “0” mark (see Figure 4.16). Manipulate the probe until a high-amplitude signal appears on the screen after the Main Bang. This is the reflection from the large arc of the block which is located on the “Type I” block at 4" (100mm). Bring this echo to its maximum amplitude (i.e., peak it up) by moving the probe forward and backward (Figure 4.16). Make sure the echoes do not exceed 100%. Reduce gain if necessary.

Note: We recommend the use of the PEAK MEMORY function to determine the “peak” of the signal. The PEAK MEMORY will draw and collect the envelope of the signal while also drawing the live Waveform. Simply match the live Waveform with the maximum point corresponding to the previously accumulated echo dynamic curve. This will make “peaking” the signal very quick and easy.

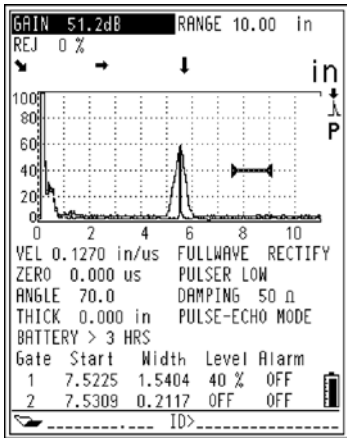

Figure 4.15: Use of Peak Memory

Once you have peaked up, hold the probe stationary and mark the side of the transducer's wedge directly over the "0" point on the block. This is the Beam Index Point: the point at which the sound leaves the wedge and enters the material with maximum energy.

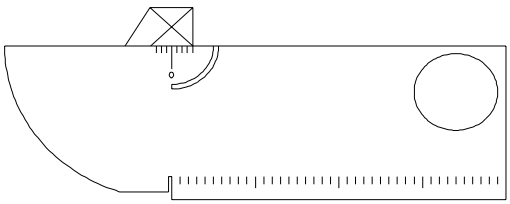

Figure 4.16: Location the Beam Index Point

2. Verify the Refracted Angle (Beta)

You should have already entered an angle into the Epoch III. However, although your wedge may be marked "70^{o}" (for example), the actual refracted angle may be slightly different due to the properties of the test material or the amount of wear on the wedge. At this point, it is necessary to verify what the actual angle is. If it is not as marked, then the correct angle must be entered into the Epoch III. This will ensure that the Epoch III's sound path calculations are accurate.

Position the probe over the appropriate angle mark on the block. In the example shown below (Figure 4.17), a 70^{o} wedge is being used. Now move the probe back and forth to "peak up" on the echo coming from the large circular hole in the side of the block. Please note that the circular hole in the block may be filled with Plexiglas, but the procedure is the same.

Note: Again we recommend the use of the PEAK MEMORY function to obtain the “peak” of the signal.

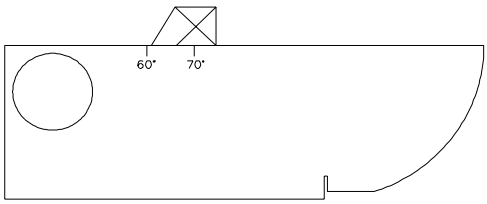

Figure 4.17: Verifying the Refracted Angle

Once you have peaked up, hold the probe stationary. Note the degree mark on the block that lines up with the BIP, which you marked on the wedge in Step 1. This is the actual refracted angle (Beta) for this particular transducer and wedge in steel. If this value for Beta differs from the value entered previously, enter the corrected angle value now via the **[ANGLE]** key.

3. Calibrate for Distance

Note: This step differs depending on which IIW type block is used. The ASTM E-164 type block, which has a crescent cut in the side, will produce echoes at 4" (100mm) and 9" (225mm) on the screen. The U.S. Air Force IIW-2 block, which has a cutout in the side, will produce echoes at 2" and 4" on the screen.

a. Couple the probe to the block so that the BIP is directly over the “0” mark on the ASTM test block (or the Air Force block). **Do not move the transducer from this point during this step.** The objective in this step is to position the echoes over the appropriate graticules on the screen. In this example, we will use a “Type I” block. Therefore, we will be looking for echoes at 4" (100mm) and 9" (225mm) (see Figure 4.18). If you are using Type II test block, the procedure is the same, however, the echoes will occur at 2" (50mm) and 4" (100mm).

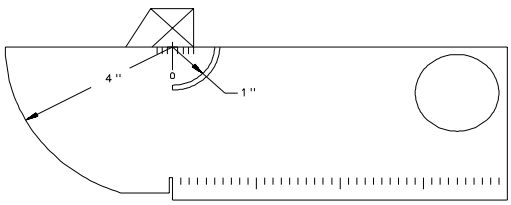

Figure 4.18: Calibrate for Distance

When the transducer's BIP is positioned directly over the "0" mark on the ASTM E-164 IIW type block, sound travels from the transducer to the arc of the block which is 4" away. The sound reflects off the arc and comes back to the transducer to produce an echo at 4" on the screen. (Remember, the EPOCH III automatically divides the round-trip travel time by two.) The sound does not stop at this point. Rather, it bounces backwards to the crescent and travels back to the transducer. However, the sound is not received by the transducer because it comes in at the wrong angle. In fact, the sound is not received until it bounces off the arc and back again. (i.e., after another 4" of travel). Therefore, the second reflection will be a total of 9" of sound travel; four inches to the arc the first time, one inch to the crescent, then four inches to the arc the second time. This will give us two backwall echoes on the screen; one at 4" and the other a 9".

In most cases, when the probe is positioned over the "0" mark and the range is set at 1 in/div., you should see four prominent signals on the screen as follows: 1) the Main Bang (the left-most echo), 2) an echo at approximately the fourth graticule, 3) an echo near the eighth graticule (disregard this echo), and 4) an echo near the ninth graticule. If you do not see all of these echoes, increase the gain (dB) and zero offset until you can.

b. At this point, use the **[ZERO OFFSET]** key and the ◄► and ◄► slewing keys to bring the first echo from the arc to the fourth graticule. Once the echo is aligned with the screen graticule, a dotted line will appear along the peak of the signal.

c. Use the **[RANGE]** key and the ◄► and ◄► slewing keys to adjust the last echo to the graticule representing nine inches (see display below).

d. Repeat steps b and c until both echoes are correctly aligned.

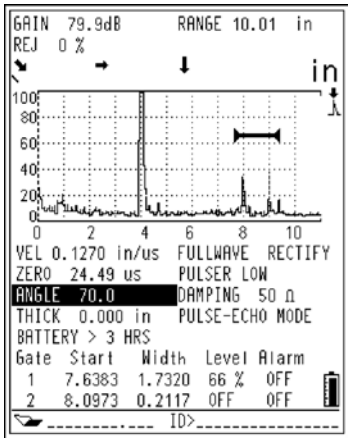

Figure 4.19

4.5.3 Setting Material Velocity

Once the display has been properly calibrated, adjustment of the material velocity will allow the operator to obtain direct, accurate readings of all sound path components. The procedure for setting the material velocity is simple and is described below.

1. Position the flaw gate over the second calibration echo using the **[GATE START]**, **[GATE WIDTH]**, **[GATE LEVEL]** and the and slewing keys.
2. Press the **[DEPTH/%AMPL]** key to obtain a sound path reading in the upper right hand corner of the display.
3. Adjust the material velocity using **[VEL1]** and the and slewing keys until the correct sound path reading is obtained.

   To ensure that the instrument has been calibrated correctly, check the accuracy of the soundpath measurements and be sure the range has been returned to it's initial setting. It should be noted that changing the velocity will also change the range value. If the range value is correct and the thickness measurements are accurate, the calibration is complete. If the range value is incorrect, any or all of the calibration parameters should be checked and readjusted. In this case start by re-calibrating the display to be sure that the echoes are lined up on the appropriate graticules and the dotted line appears on the correct screen division.

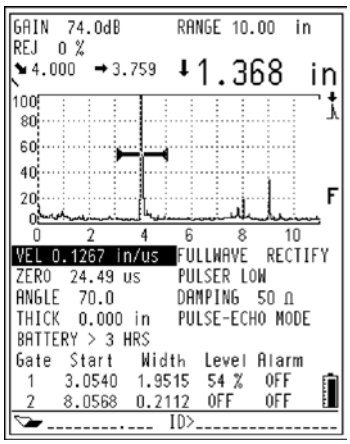

Figure 4.20

4. **Calibrate for Sensitivity**

   The final step in this calibration is to calibrate for sensitivity. This will allow you to set up a reference gain level.

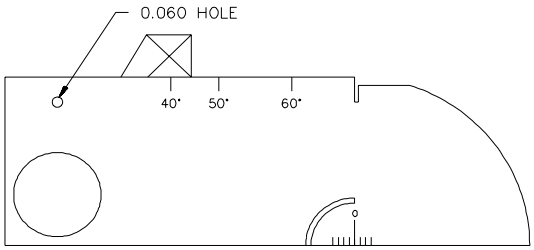

Figure 4.21: Calibrate for Sensitivity

Couple the probe to the block so that the transducer is aimed at the 0.060" side-drilled hole, which we use as the reference reflector (see Figure 4.21).

Move the transducer forward and backward until you have “peaked up” on the hole (i.e., found the maximum amplitude). Be sure not to confuse the reference reflector echo with the echo from the side of the block. With this set-up (and a 70 degree refracted shear wedge) you can expect the echo to peak a little before the second screen division.

Once you have peaked up on the reference reflector, adjust the sensitivity (dB) to bring the reference reflector signal to a predetermined reference line on the screen. In this case, we have set the reference line at 80% of Full Screen Height. To lock in the reference gain level and add scanning gain separately, press **[2nd F] [dB]**. Once the reference gain functions have been activated, use the **[dB]** key to toggle between adding or subtracting gain in 6dB or 0.1dB increments.

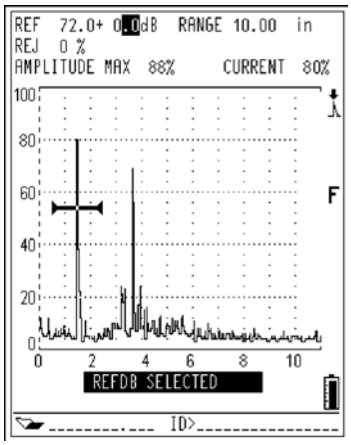

Figure 4.22

4.6 Verification of Horizontal Linearity and Amplitude Control Linearity

4.6.1 Horizontal Linearity

The horizontal linearity has significance when determination of depth of a discontinuity is required. Non-linearity of the time base scale may affect accuracy of flaw depth or thickness determination made directly from a screen. This effect is eliminated by the thermally stable time base of the Epoch III.

The calibration for verifying the horizontal linearity is done in a manner very similar to the method used for a Straight Beam Calibration as described in section 4.2. In this example we will use a 1" (25mm) thick test block on a 10" (250mm) range adjusting the zero offset, range, and velocity so that all ten of the back echoes appear at every one of the ten divisions. It may be necessary to adjust the Gate Level at this time. If any of the depth readouts are incorrect by an error of greater than 0.5% of screen range or in this case by 0.050" (0.25mm), either your instrument is not calibrated properly or internal adjustments may need to be performed.

After your Epoch III is calibrated, the Waveform should look similar to the printouts below:

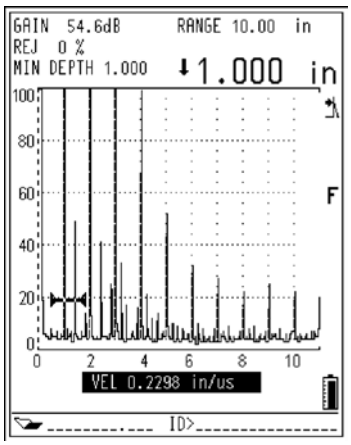

Figure 4.23

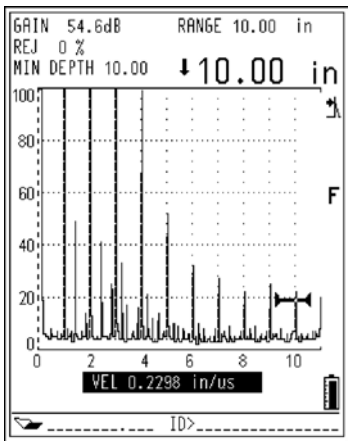

Figure 4.24

4.6.2 Amplitude Control Linearity

Vertical linearity has significance when echo signal amplitudes are to be determined from the screen or corresponding output signals, and are to be used for evaluation of discontinuities or acceptance criteria.

Although there are several methods used to verify the amplitude control linearity, a quick verification is done by first coupling the transducer to the test block to obtain an echo on the screen. Make sure that constant pressure is being applied to the transducer while verifying the amplitude control linearity. We recommend that you put a weight on top of the transducer to insure this.

1. Position the gate over the echo and obtain an amplitude readout by pressing the **[DEPTH/%AMPL]** key, then **[F3]**. (Make sure the gate level is set at the lowest value of 2% or just above the baseline noise.)

2. Using the gain **[dB]** key, adjust the amplitude so that the echo height is set at 80% Full Screen Height (FSH). Make sure there is at least 24dB of system sensitivity. You may need to gate a signal further in time in order to raise the gain to at least 24dB. Otherwise, this may be achieved using a flat bottom hole.

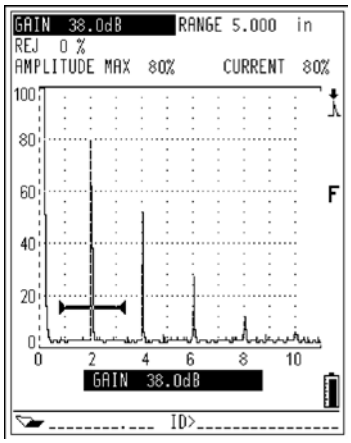

Figure 4.25

3. Set the Reference Level to record the amount of gain needed to bring the signal to this height (in this example 80%). This will allow you to vary gain in 6dB increments. To do this, press **[2nd F] [dB]** and then **[dB]** again to position the marker to the left of the decimal point as shown in Figure 4.26. This will allow you to add or subtract gain in 6dB increments using the slewing keys.

Note: Next you will be subtracting gain in 6dB increments. Each time 6dB is subtracted the echo amplitude should drop by one half (±2%).

---

4. Now reduce gain by 6dB; this should bring the amplitude of this signal to 40% FSH (Figure 4.26). Removing another 6dB of gain should cause the amplitude of the signal to drop to 20% FSH (Figure 4.27). The Reference gain should now read X .X dB - 12dB. Remove another 6dB and the amplitude should read 10% FSH. Finally, after removing 6dB a final time, the amplitude should read 5% FSH.

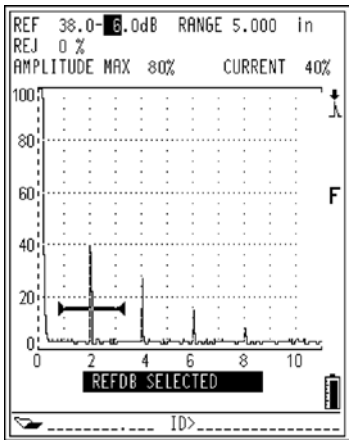

Figure 4.26

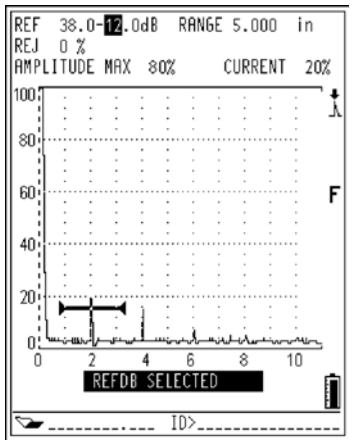

Figure 4.27

If any of the above full screen heights do not read appropriate percentages within 2%, the instrument is not performing to specification.

Note: The above examples are simply a quick reference in trying to verify that the unit is performing within the manufacturer's specifications. Panametrics-NDT™ offers several types of calibration certifications including the following:

1. ASTM-E317 for Horizontal & Amplitude Control Linearity.

2. Calibration traceable to the National Institute of Standards and Technology.

3. American Welding Society Code (AWS).

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5 USING THE GATES

The EPOCH III is equipped with two gates. The gates appear on the instrument screen as solid horizontal lines and can be used to make thickness, echo-to-echo thickness, and soundpath readings or to trigger either threshold or minimum depth alarms. The following sections describe the movement and use of the EPOCH III's gates.

5.1 Positioning Gate 1

Gate 1 is the primary flaw gate. It can be used to provide thickness readings in both the A-Scan and unrectified RF displays, soundpath data when using an angle beam transducer, signal amplitude, or to trigger minimum depth or threshold alarms.

Movement of Gate 1 is controlled via the red gate control keys; **[GATE START]**, **[GATE WIDTH]**, and **[GATE LEVEL]**. The starting position, width, or level of Gate 1 can be changed by pressing the appropriate gate control key and then using the slewing keys and to position the gate.

5.2 Positioning Gate 2

Gate 2 is a secondary gate and is used when making echo-to-echo thickness readings or when multiple alarm gates are required.

Movement of Gate 2 is also carried out using the red gate control keys. These keys can be "toggled" to control Gate 2 directly. Control of Gate 2 is activated by pressing **[2nd F] [GATE START]**. If Gate 2 had previously been shut off, the following prompt appears beneath the A-Scan: "F1=GATE 2 ON". To switch Gate 2 on, press **[F1]**. All gate control keys now provide direct control of Gate 2 and it can be moved as described above. Once Gate 2 is enabled, all gate key presses will refer to Gate 2 until control is switched back to Gate 1.

In order to switch back to control of Gate 1, press **[2nd F] [GATE START]** and all controls will revert back to Gate 1. To switch Gate 2 off, press **[2nd F] [GATE START]** again and the prompt "F1=GATE 2 OFF" will appear. Press **[F1]** and Gate 2 will be shut off.

5.3 Taking Thickness Readings

The EPOCH III is equipped with a high resolution distance calculator which provides a direct readout of thickness or soundpath data across the top of the A-Scan. Depth measurements can be made in a couple of different ways. Some applications may require measuring to the leading edge of the signal, while others may require measuring to the peak of the signal.

Assuming that the EPOCH III has been properly calibrated, The following steps are used to take thickness readings:

1. Position Gate 1: Since Gate 1 is used to obtain single echo thickness readings, it must be positioned correctly. Make sure that the gate start is less than the minimum expected thickness value and that the gate width exceeds the maximum expected value. When used for thickness gaging, the gate level should be set just high enough to avoid false readings. When used for flaw detection, it should be set according to the appropriate acceptance/rejection criteria.

2. Select the measurement mode: As mentioned above, the EPOCH III can measure to either the leading edge or the peak of a signal. To select the appropriate mode, press the **[DEPTH/%AMPL]** key. The following prompt will appear below the A-Scan display:

   F1=EDGE F2=PEAK F3=%AMPL

   Selecting [F1] or **[F2]** will put the EPOCH III in the corresponding depth measurement mode while selecting **[F3]** puts the EPOCH III into the amplitude measurement mode. Depending on which measurement mode is selected, an icon will appear next to the upper right hand corner of the A-Scan.

    Edge Depth =  Peak Depth

   While in 'EDGE' depth mode, thickness readings will be made to the leading edge of the first signal to exceed the flaw gate level. In 'PEAK' depth mode, thickness readings are made to the peak of the highest amplitude signal that falls within the gate.

   If there is no refracted angle entered, a "Minimum Depth" value will be shown above the upper left corner of the display. This value refers to the minimum detected thickness value and is only updated if a lower value is measured. To reset the minimum depth value, press any one of the red gate keys.

Note: To obtain the most accurate and consistent thickness or soundpath readings, the Peak Depth mode should be selected. The apparent arrival time of the leading edge of a signal will vary with the amplitude of the signal. As a result, the instrument gain setting, coupling conditions, and any other factor affecting signal amplitude, will have an impact on the accuracy of a reading made in the Edge Depth mode. While the effects of these factors are not completely eliminated in the Peak Depth mode, they are greatly reduced. If Peak Depth is selected, it should be noted that calibrations should have been performed using the Peak of the signal. However, when using a dual transducer, due to the jagged peaks, it is recommended that Edge Depth be used.

5.4 Echo-to-Echo Thickness Readings

The EPOCH III is also equipped to make measurements between successive echoes. Measurements can be made between two consecutive backwall echoes or between an interface echo and any other selected signal. This provides the capability to measure thickness through coatings and improve minimum thickness resolution or to do low speed immersion testing. A second gate (Gate 2) is used to capture data from the second back echo. Echo-to-echo readings are made by calculating the separation between the detected echoes in Gate 1 and Gate 2.

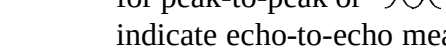
Note: Echo-to-Echo thickness readings cannot be made in the unrectified RF display mode.

Assuming that the EPOCH III has been properly calibrated, the following steps should be followed in order to make echo-to-echo thickness readings.

1. Position Gate 1: Use the **[GATE START]**, **[GATE WIDTH]**, and **[GATE LEVEL]** controls to position Gate 1 over the region where the first back echo is expected to appear.

2. Activate The Echo-to-Echo Measurement Mode: The echo-to-echo measurement mode is activated by pressing **[2nd F], [GATE WIDTH]**. Once echo-to-echo is activated, a prompt appears at the bottom of the display.

   F1 = EDGE, F2 = PEAK

   This allows selection of edge-to-edge or peak-to peak. An icon of  will appear for peak-to-peak or  will appear for edge-to-edge to the right of the display to indicate echo-to-echo measurements are being used. This sequence activates Gate 2 so that it may be moved into position. If Gate 2 is off and the echo-to-echo mode is turned on, Gate 2 is automatically activated and GATE 2 START is opened.

3. Define The Blanking Period: In order to avoid possible false readings that could occur due to transducer ringing or material noise, a “dead zone” or blanking period is necessary after the detection of the first echo. This period is defined during set-up as the separation between the start of Gate 1 and the start of Gate 2. When an echo is detected in Gate 1, Gate 2 start will automatically adjust to trail the detected echo by the blank period.

   For example, if Gate 1 Start is set to 0.25" (6.35mm) and Gate 2 Start is set to 0.40" (10mm), then the blank period is 0.15" (3.8mm) of metal path. If the first detected echo breaks Gate 1 at 0.35" (8.9mm), then Gate 2 Start will automatically adjust by the value of the blanking period to 0.50" (0.35" + 0.15") or 12.7mm (8.9mm + 3.8mm).

Note that there is a trade-off in defining the blanking period. While a relatively long period may prevent false readings, the minimum measurable thickness will be limited to a value slightly greater than the blanking period.

An example of a set-up for peak-to-peak measurement is shown below in Figure 5.1:

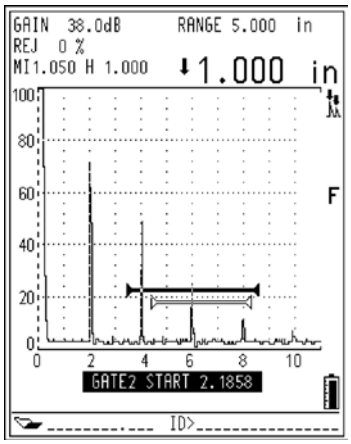


Figure 5.1

5.5 Locating Flaws with an Angle Beam Transducer

When performing an angle beam inspection, it is possible to attain accurate and reliable soundpath information using the Epoch III's high resolution distance calculator.

If a refracted angle has been entered into the EPOCH III, all angular soundpath components will be displayed at the top of the A-Scan display as shown below:

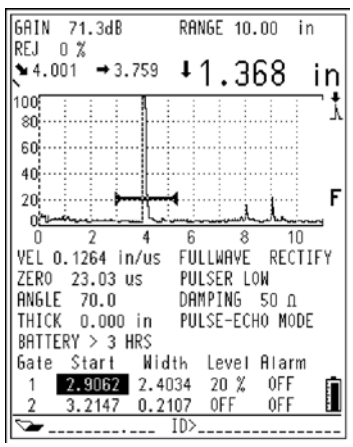


Figure 5.2

Note that these symbols represent the following distances:

= angular (soundpath) distance to the reflector

= surface distance (projection) to the reflector

= depth to the reflector

 = soundpath leg - 1st, 2nd, 3rd, 4th, beyond 4th

The mode of measurement ("Edge" or "Peak") is indicated by the icon to the right of the depth measurement as shown above. The icons indicating the measurement mode are as follows:

 = Peak depth

 = Edge depth

Pressing the **[DEPTH/%AMPL]** key will provide the following prompt:

"F1 = Edge, F2 = Peak, F3 = AMPLITUDE"

Pressing one of these keys will automatically put the instrument into the corresponding measurement mode.

Displayed beneath the soundpath readout is an icon which shows which leg of the soundpath a particular reflector is located in. This icon will show up to 4 segments to indicate whether the gated reflector is in the 1st, 2nd, 3rd, or 4th leg of the soundpath. For example, in the 1st leg we would see a single, slanted line  . The second leg would be indicated by a  , the 3rd by a , and in the 4th leg, the icon would be a . Beyond the fourth leg, an arrow is added to the icon .

Any signal breaking the gate threshold will generate the display of soundpath data. When performing a calibration, it is best to enter a value of " 0 " for material thickness into the Epoch III. This is done by pressing **[2nd F], [ANGLE]** and using the ⊞ key until the thickness value reads 0.00 . With this set-up, all soundpath data is treated as if it is in the first leg.

When working beyond the first leg, it is imperative that you enter an exact thickness of your material into the Epoch III. This is achieved by pressing **[2nd F], [ANGLE]** and using the ⊞ and ⊞ keys. This value will then be used to calculate the depth to a reflector that lies beyond the first leg.

5.6 Measuring Signal Amplitude

When estimating discontinuity size, the instrument is adjusted so that a particular gain setting and screen height represent the echo amplitude produced by a known size reflector in a reference standard. In general, a signal with smaller amplitude may indicate a smaller

reflector and a signal with higher amplitude may indicate a larger reflector than the reference standard.

With the Epoch III it is possible to display a direct on-screen readout of amplitude information. To access the amplitude mode, press the **[DEPTH/%AMPL]** key and then **[F3]**.

If an echo is within the gate and the Epoch III is in the amplitude mode, the amplitude information for that echo will be displayed as a percentage of Full Screen Height as both "CURRENT" amplitude and "AMPLITUDE MAX" as shown below:

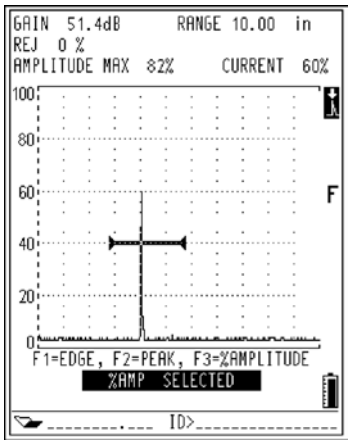


Figure 5.3

"CURRENT" refers to the "real time" percentage of screen height of the highest amplitude signal within the gate.

The "AMPLITUDE MAX" display retains the highest amplitude of a signal that has broken the gate threshold. If a signal of higher amplitude is read, the "AMPLITUDE MAX" value will be updated. This maximum amplitude value is reset by pressing any one of the red gate keys.

If there is no echo within the gate, "CURRENT" will read "_____%", indicating that no reading was taken.

5.7 Use of the Zoom Feature

The Epoch III has the ability to magnify or "zoom in" on an echo or a portion of the A-Scan display. The purpose of this function is to provide a more detailed view of a particular indication in flaw detection applications or to provide greater accuracy when making distance calculations.

In order to zoom in on an indication, position Gate 1 over the area of interest and press the **[ZOOM]** key. The instrument automatically uses material delay to bring the point which corresponds to the gate start to the left side of the instrument screen and also adjusts the displayed range to match the gate width. The new range will be equal to the unzoomed

gate width. The lowest value of the expanded range that can be achieved is equivalent to the minimum range of the instrument at the current material velocity setting. The Zoom function is particularly useful in the following types of situations.

5.7.1 Flaw Detection

The use of the Zoom function is a great benefit in certain flaw detection applications. For example, in the detection of faceted defects such as inter-granular stress corrosion cracking (IGSCC) the job of the inspector can be greatly complicated by the geometry of the test specimen and also by the specific characteristics of the defect itself. In instances where the pipe counterbore is close to the weld root, it is possible to have three signals that all appear quite close to each other; from the weld root, the counterbore, and the crack itself. The use of the Zoom function dramatically improves the visual resolution of the EPOCH III's display so that each individual signal can be more easily identified.

When evaluating a crack signal, the inspector's attention is usually focussed 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 facets of the crack. By using the Zoom function, the inspector can get a much more detailed view of an indication and thus make better judgements regarding flaw location and depth.

Similarly, Zoom is quite useful when inspecting particularly large or thick components. In this type of inspection a great deal of detail is lost due to the long screen ranges that are commonly used. By using the Zoom function it is possible to look at small sections of the test piece without disturbing the instrument's original calibration.

5.7.2 Making Distance Calculations

One major advantage of using a fully digital flaw detector such as the Epoch III is the instrument's ability to display thickness or soundpath data on screen. However, because a digitally generated display is used, the maximum accuracy of the distance calculator is dependent on the range that has been selected. The Epoch III display incorporates 20 display points (pixels) per horizontal division, and thus the best calibrated accuracy for any given range setting will be one pixel width or:

$$\frac{\{Range\ (^{in}/_{Div} \text{ or } ^{mm}/_{Div})\}}{20}$$

In any distance measurement application, improved resolution can be obtained by using the Zoom function to expand the screen display around the echo of interest, and thus switch the display to a lower horizontal range. To obtain the best accuracy possible, calibration of zero offset and velocity should always be done at minimum range and in the peak depth mode.

5.8 Gate Alarms

The EPOCH III features a variety of alarm configurations that can be utilized in either the single or dual gate modes. Each gate can be set up to independently provide either a positive or negative logic threshold alarm. In addition, a minimum depth alarm can be set when using a single gate or the echo-to-echo measurement mode.

5.8.1 Setting and Using the Threshold Alarms

To set a threshold alarm for a particular gate, the following sequence should be followed:

1. Use the gate control keys, **[GATE START]**, **[GATE WIDTH]**, and **[GATE LEVEL]** to position the gate(s) over the appropriate areas as described in Section 5.

2. To set the alarm for a particular gate, that gate must be active. For example, to set an alarm for Gate 1, make sure that the gate control keys are set to control Gate 1. Similarly, to set an alarm for Gate 2, the gate control keys must be toggled to control Gate 2. This is done by pressing **[2nd F], [GATE START]**.

3. To activate the alarm, press **[2nd F], [GATE LEVEL]** and the following prompt will appear on the first line below the A-Scan display:

   F1=Threshold F2=MinDepth F3=Off

   Press **[F1]** to select the threshold alarm.

4. Use the ↓ or ↑ keys to select positive or negative logic. A positive logic alarm will be triggered when an indication is present within the gate. A negative logic alarm will be triggered when an indication is absent from the gate. Either Gate 1 or Gate 2 can be set positive or negative.

   Once a threshold alarm has been activated, markers at the starting and ending points of the gate will point upwards or downwards to indicate which type of alarm

has been set. The following figures show how each alarm type will appear on the A-Scan display.

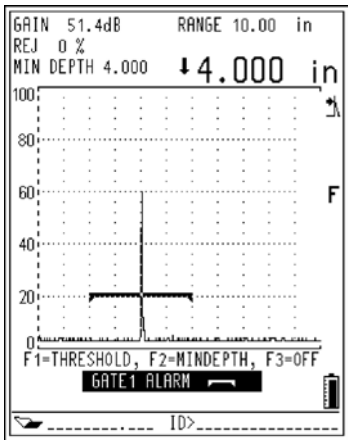


Figure 5-4: Negative Logic Alarm

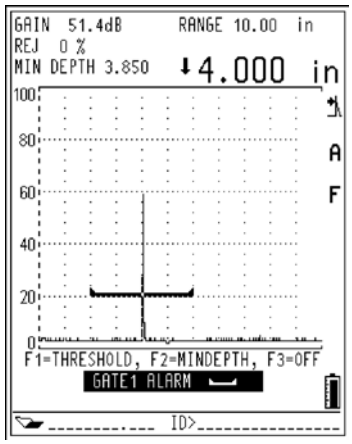


Figure 5-5: Positive Logic Alarm

5.8.2 Setting and Using the Minimum Depth Alarm

The EPOCH III is also equipped with a minimum depth alarm which will be triggered whenever the current thickness reading falls below an operator defined level. The minimum depth alarm can be used with a single gate or in the echo-to-echo measurement mode. (In echo-to-echo, the cursor appears on the second gate. A cursor will appear at the bottom of Gate 2 to indicate this level.)

5.8.3 Using the Minimum Depth Alarm with a Single Gate

To set the minimum depth alarm when using a single gate, use the following sequence:

1. Use the gate control keys (**[GATE START]**, **[GATE WIDTH]**, and **[GATE LEVEL]**) to position the gate over the appropriate areas as described in Section 5. It is important to ensure that the gate start position is set to cover a range below the minimum depth value that will be used for the alarm.

2. To activate the alarm, press **[2nd F]**, **[GATE LEVEL]**. The following prompt will appear on the first line below the A-Scan display:

   "F1=THRESHOLD F2=MINDEPTH F3=OFF"

   Press **[F2]** to select the minimum depth alarm.

3. Use the ⊞ or ⊞ keys to set the desired minimum value. Note that the available range of minimum depth values is limited by the gate start and width settings. In

other words, the minimum depth alarm value must be greater than the gate start value and less than the gate width value.

Once the minimum depth alarm has been set, a marker will appear on the gate to indicate the current setting. Any indication that exceeds the gate threshold to the left of the marker will cause the minimum depth alarm to be activated. Press **[F3]** to shut off alarm.

5.8.4 Using the Minimum Depth Alarm in the Echo-to-Echo Measurement Mode

The minimum depth alarm can also be used when making echo-to-echo thickness readings. Note that in the echo-to-echo mode the minimum depth marker will appear on Gate 2. To set the minimum depth alarm when in the echo-to-echo mode, use the following sequence:

1. Use the gate control keys (**[GATE START]**, **[GATE WIDTH]**, and **[GATE LEVEL]**) to position the gates over the appropriate areas as described in Section 5.4. It is important to ensure that the start position of Gate 2 is set to cover a range below the minimum depth value that will be used for the alarm.
2. Activate the echo-to-echo measurement mode by pressing **[2nd F] [GATE WIDTH]**.
3. To activate the alarm, press **[2nd F]**, **[GATE LEVEL]** and the following prompt will appear on the first line below the A-Scan display:

   "F1=THRESHOLD F2=MINDEPTH F3=OFF"

   Press **[F2]** to select the minimum depth alarm.

4. Use the ◄ or ► keys to set the desired minimum value. Note that the available range of minimum depth values is limited by the start and width settings of both gates. Gate 1 must be positioned to detect the first back echo. In addition, the minimum depth alarm value must be greater than the blank period between Gate 1 and Gate 2 and less than the Gate 2 width value.

5.8.5 Storage of Alarm Conditions

When an alarm is active, a capital letter "A" will flash near the upper right hand corner of the display. Alarm conditions can be saved in the EPOCH III's Datalogger and all data which is accompanied by an alarm will be flagged in the memory by the character "@" prior to the ID.

6 PULSER RECEIVER ADJUSTMENTS

6.1 Adjusting System Sensitivity

To adjust the instrument sensitivity (gain), press **[dB]**, then adjust the gain upward or downward with either of the slewing keys or . The current system sensitivity will be displayed and highlighted in the upper left corner of the display.

Gain may be adjusted in 0.1dB increments by pressing the slew key once. Holding down either of the slewing keys will result in a gradually increasing slewing rate. This allows access to the complete range of system sensitivity in only a few seconds.

Note: Total system sensitivity is 100.0dB.

6.2 Setting a Gain Reference Level & Adding Scanning Gain

By pressing **[2nd F], [dB]** the current system gain is established as the 'reference level'. This feature is useful for inspections which require the operator to establish a reference (base) gain level, then add or subtract additional scanning gain.

After accessing the reference function, the gain display will read as follows:

REF XX.XdB + 0.0dB

Pressing the **[dB]** key allows the scanning gain to be added independent of the reference (base) gain level. To add or subtract scanning gain in 6dB increments, press the **[dB]** key to position the cursor to the left of the decimal point, then use the slewing keys to increment or decrement. To make adjustments in 0.1dB increments, press the **[dB]** key to position the cursor to the right of the decimal point. Again, use the slewing keys to increment and decrement the scanning gain. For example:

REF 56.2dB + 6.0dB

Press **[2nd F], [dB]** to turn off the reference level. The following prompt will appear and the current scanning gain can either be added to the reference (base) gain, reset to zero or shut off.

F1 = ADD, F2 = RESET, F3 = OFF

Pressing **[F1]** will add the reference gain and scanning gain together and exit the Reference Level function. Pressing **[F2]** resets the scanning gain to 0.0dB while keeping the function active. Pressing **[F3]** will exit the Reference Level function without adding the entered scanning gain.

6.3 Use of the Pulser Key

The following pulser-receiver parameters can be adjusted on the Epoch III via the keypad:

- Waveform Rectification
- Pulse Energy
- Damping
- Test Mode

This section of the manual explains each adjustment in detail.

The **[PULSER]** key provides access to these parameters in the order that they are listed above. Multiple presses of the **[PULSER]** key will toggle through the four features. Alternatively, the **[ITEM SELECT]** key can be used.

Adjustments to each pulser-receiver characteristic can be performed in either of the two screen modes; Full A-Scan or Split Screen. In the full A-scan, the current parameter being adjusted will appear at the bottom center of the screen, below the Waveform. In the split screen mode, the pulser-receiver parameter will be highlighted on the lower half of the Epoch III screen. For the purposes of reviewing the adjustments in this manual, we will use the split screen mode. Press and toggle the **[PULSER]** key. Notice that the highlight bar in the lower half of the screen will move between the four pulser-receiver parameters with each press of the **[PULSER]** key.

To view how the selections of the pulser-receiver affect a Waveform, it is suggested that a transducer be coupled to a sample or block, and an echo displayed on the top half of the screen.

6.3.1 Waveform Rectification

The Epoch III can operate in one of four different rectification modes:

Full Wave, Half Wave Positive, Half Wave Negative, and RF (unrectified)

Note: The RF (unrectified) mode is not active while operating in DAC mode, Peak Memory mode, or Echo-to-Echo mode. While operating in any of these modes, the Epoch III will not allow access to the RF mode and one of the following prompts will be displayed:

"RF INVALID IN DAC"
"RF INVALID IN PEAK MEMORY"
"RF INVALID IN ECHO-TO-ECHO"

Press the **[PULSER]** key once to display the current screen rectification. This will be highlighted and displayed at the bottom of the screen. Press either of the slew keys to toggle through the different Waveform rectification modes.

6.3.2 Pulse Energy

The Epoch III utilizes a shock excitation pulser which is designed to provide a combination of good near surface resolution for testing thin materials and excellent penetration power for testing thick or attenuating materials. There are three different energy settings which can be selected depending upon test conditions; Low (100V), Medium (200V), and High (400V) energy.

Press the **[PULSER]** key to access the energy level settings. In the split screen mode, the energy level will be highlighted on the lower half of the screen. Press either slewing key to toggle between the three selections; Low, Medium, and High.

6.3.3 Damping

Similar to the function of Pulser Energy, the damping control allows the operator to optimize the shape of the Waveform for high resolution measurements via an internal resistive circuit. Selection of the right damping setting will fine tune the Epoch III to operate with a particular transducer selection. Depending upon the transducer being used, the various damping settings will either improve near surface resolution or alternately the instrument's penetration power. Selections are 50, 150, and 400 ohms.

Press the **[PULSER]** key to access the Damping parameter. Use either slewing key to toggle through the three available damping selections.

As a general rule of thumb, the 50 ohm setting increases the system damping and will improve near surface resolution, while the 400 ohm setting decreases system damping and improves the instrument penetration power.

Note: In through-transmission mode, the variable damping resistor is across the transmitter output to the transducer. On the receiver side, there is a fixed 500 ohm damping resistor.

6.3.4 Test Mode

The Epoch III can operate in three different Test modes:

- Pulse-Echo
- Through-Transmission
- Dual

Press the **[PULSER]** key to access the test mode parameter. Press either slewing key to toggle through the three selections.

Pulse-Echo Mode: Single element transducers. Either connector may be used.

Dual Mode (Pitch and Catch): One connector acts as a transmitter, the other acts as a receiver. The top (red) connector is designated as the transmitter.

Through Mode: Two separate transducers, typically on opposite sides of the test specimen. Use the top (red) connector as the transmitter.

Note: In order to compensate for the one way soundpath, the thickness measurements in Through Mode do not divide transmit time by two.

6.3.5 Filter Setting

The EPOCH III can operate in either a Standard or High Pass Filter setting. The High Pass Filter is useful when testing thin materials to improve near surface resolution. Low frequency noise is reduced providing a better signal to noise ratio.

Press the **[PULSER]** key to access the filter setting. Press either slewing key to toggle through the two selections.

FILTER STD: Broadband Filter setting. 0.4-16.5MHz at -6dB

FILTER HP: High Pass Filter setting. 1.4-17.5MHz at -6dB

7 SPECIAL WAVEFORM FUNCTIONS

7.1 Overview

The fully digital display of the EPOCH III allows the Waveform to be manipulated in ways that can provide additional, detailed information. The absolute linearity of the display allows for the use of Reject without distorting the signals above the reject level. An enhanced Peak Memory function is extremely useful when finding the peak of a signal or when testing high temperature materials as it allows for simultaneous viewing of both the live Waveform and the accumulated peak envelope or echo dynamic. Finally, the Freeze function holds the current Waveform to free the operator's hands to make notes or obtain additional data before continuing the inspection. This section describes the use of each of these functions.

7.2 Using Reject

The purpose of the REJECT function is to eliminate unwanted, low-level signals from the EPOCH III's display. Because the EPOCH III features a digital Waveform display, the reject function is linear. **Increasing the reject level does not affect the amplitude of the signals above the reject level.** The reject level is continuously adjustable from 0 to 80% of full scale with 1% resolution and is constantly displayed in the upper left hand corner of the screen.

To operate the reject function, press **[2ndF]**, **[FREEZE]** and use the slewing keys, ⊞ or ⊞ to adjust the reject level upward or downward. Any signal whose amplitude is less than or equal to the specified reject level will be eliminated from the display.

Note: It is not possible to add reject while in the unrectified, RF display.

7.3 Peak Memory

The PEAK MEMORY function enables the display to capture and store on the screen, the amplitude of each display point. Each pixel of the display will be updated if a signal of greater amplitude is acquired. When a transducer is scanned over a reflector, the signal envelope or "echo dynamic", as a function of transducer position, will be held on the screen. In addition, the current, "live" Waveform will be displayed at the appropriate place within the echo envelope.

This function is particularly useful when it is necessary to "peak up" on an indication as is done during an angle beam calibration. The technique is very simple. To activate PEAK MEMORY press the **[PEAK MEMORY]** key. A "**P**" will appear at the right hand side of the display to indicate that the function is active. Next, scan over the reflector to acquire

the echo envelope. Continue to scan slowly until the peak of the live Waveform matches the peak amplitude of the echo envelope. When these two points match, the signal will be peaked up. To shut off PEAK MEMORY, press the **[PEAK MEMORY]** key a second time. Note that the Peak Memory function cannot be activated in the RF display mode.

7.4 Screen Freeze

The purpose of this function is to hold or "freeze" the information on the screen at the moment the **[FREEZE]** key is pressed. Once the FREEZE function has been activated, the pulser/receiver of the EPOCH III will become inactive and no further data will be acquired. An "**F**" will appear to the right of the A-Scan display indicating that the function is active.

This function is particularly useful when storing Waveforms as it holds the current A-Scan and allows the transducer to be uncoupled from the test material. Once the display has been frozen, it is possible to perform a variety of functions including storage of the Waveform or thickness data as well as entry of an alpha-numeric location code or memo to describe the data. In addition, it is possible to manipulate the gates to obtain thickness or soundpath data. It is important to note that the FREEZE function differs from PEAK MEMORY in that no new data is acquired and added to the instrument display. The **[FREEZE]** key is ideal for high temperature measurements.

When Freeze has been activated, the following parameters cannot be changed/accessed:

- Zero Offset
- Range
- Zoom
- Reject
- Gain
- Reference Gain
- Peak Memory
- Pulser Receiver Settings

To disable the FREEZE function and return to normal operation, press the **[FREEZE]** key a second time.

8 DATALOGGER AND DATA COMMUNICATION FEATURES

The EPOCH III is equipped with a Datalogger that is designed to be simple to use while providing a wide range of features for virtually all flaw detection and thickness gaging requirements. The EPOCH III Datalogger includes the following capabilities:

1. Organization of data by file and location code.
2. Alpha-Numeric file names and location codes.
3. A memo mode to allow entry of detailed comments.
4. On-screen scroll/review of all file contents.
5. On the fly filtering of data to control what is sent to computers and printers.
6. Auto ID tracking when using data files that have been downloaded from a PC.
7. Instructional memos can be generated through the Epoch III Interface program and automatically recalled on the Epoch's display to inform the inspector of special test conditions at predetermined locations in the Database.

8.1 What and How Much may be Stored

The EPOCH III's Datalogger is designed to allow a variety of data to be stored quickly and easily. This includes the following:

1. Screen images along with the associated calibration data.
2. Thickness or soundpath data.
3. Detailed alpha-numeric comments.

Note that all types of data can be stored in a single file. This means that thickness and A-Scan data can coexist in a file.

When a screen display is stored, the following information is also saved:

- Current instrument settings
- Displayed soundpath or thickness data
- Alarm conditions
- Peak Memory status
- Freeze status
- Zoom status

When a thickness reading is stored, the following information is also saved:

- Alarm conditions

- Peak or Edge depth measurement mode

A maximum of 130 screen displays or 3,000 thickness readings may be stored.

8.1.1 Getting Started

The EPOCH III's memory is organized using a simple file structure. Within a file, each piece of information is marked by an alpha-numeric identifier. To save information, a file must be opened and a location code must be assigned to the data to be stored. At a given location, the operator may decide to save either a Waveform and the associated soundpath and calibration data or soundpath data only. Once the desired data has been stored, it is possible to use the **[MEMO]** function to add comments of unlimited length.

The procedure for saving data consists of three basic steps:

1. Selecting a file: if a new file is used, this step will include entering the file name.
2. Selecting the appropriate location code: in the case of a new file this step must include entry of the first location code.
3. Using the **[SAVE]** key to store either the entire screen display and calibration data or soundpath data only.

8.1.2 Starting a New File

Setting up a file from the memory screen.

To create a new file, press **[2nd F]**, **[DISPLAY/STATUS]** to enter the memory screen. The memory screen is split into two windows as shown in Figure 8.1. The lower window contains a list of files while the upper window is used to view the file contents. To toggle between the two windows, use the **[ITEM SELECT]** key.

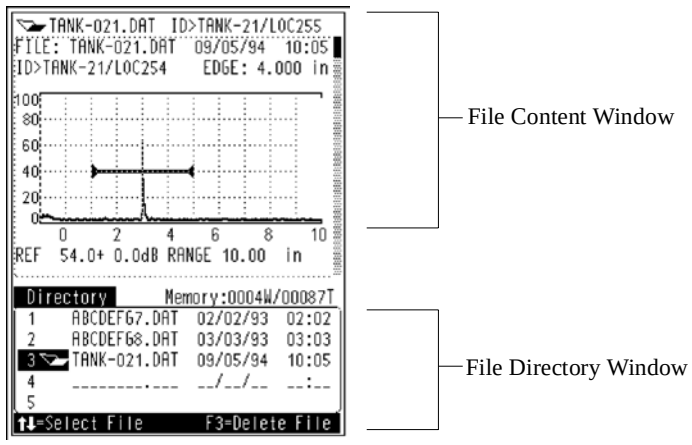


Figure 8.1: Memory Screen

Note: The remaining available memory is shown directly above the File Directory Window. It is expressed in the number of Waveforms or thickness readings that can be stored. In the figure above, there is enough memory left to store four Waveforms or 87 thickness readings.

After **[2nd F]**, **[DISPLAY/STATUS]** has been pressed, the memory screen will appear and a cursor will appear at the first available empty file location. At this point, the file name, extension, date, and time can be entered using the alpha-numeric keypad. The following rules and conditions apply to naming files.

1. The file name must follow basic DOS rules: no more than eight alpha-numeric characters with an extension of no more than three characters.
2. Entering a file extension, the date and time are optional.
3. If no filename is assigned, the instrument will automatically assign "UNTITLED.001", "UNTITLED.002", etc.

Before any data can be stored in the file, the first location code must also be entered. To create the first location code, press **[ITEM SELECT]**, and then **[ID].** A cursor will appear next to the ID entry line at the top of the file content window. Type in the location code using the alpha-numeric keypad (see Section 8.3). If a mistake is made when entering an ID, press **[ID]** a second time and a blank line will appear. To toggle back to the original ID, press the **[ID]** key again.

While entering the ID, the following prompt will appear at the bottom of the display:

"ITEM SELECT = FILE CONTENT"

Once the ID is entered, press the **[ITEM SELECT]** key to return the cursor to the File Content section of the stored memory.

If the ID mode is entered from the directory, the following prompt will be provided at the bottom of the display:

"ITEM SELECT = DIRECTORY"

After entering the ID, press the **[ITEM SELECT]** key to return the cursor to the file directory section of the stored files.

Note: To enter the ID mode from the directory, the cursor must be in numeric entry mode as indicated by the "n" cursor. Otherwise, in Alpha mode, a "Q" or "Z" will be entered into the directory name.

Once the filename and the first ID have been entered, the file set-up is complete and the file can now be used to store data. To begin saving data, press the **[DISPLAY/STATUS]** key to return to the A-Scan display. Notice that the filename and the current location code

are continually provided at the bottom of the display. To save a thickness reading, press **[SAVE]**. To save a Waveform and calibration, press **[2nd F]**, **[SAVE]**.

A date and time pertaining to a file can be entered or changed at any time when the Directory portion of the memory screen is accessed. To enter a date and time, use the **[>]** key to advance the characters to the right of the filename. Note that the cursor defaults to number (n) mode in the date and time section to simplify entry.

8.1.3 Setting up a File Directly from the A-Scan Display

It is also possible to set up a new file directly from the A-Scan display. This is useful when doing "spot checks" or there is a requirement to save unexpected data. This method eliminates the need to immediately enter a file name. The procedure for saving directly from the A-Scan display is as follows:

1. Enter a location code by pressing **[ID]** and using the alpha-numeric keypad.
2. Press the **[SAVE]** key to save a thickness reading or **[2nd F] [SAVE]** to save a Waveform and calibration. In order to track the saved information in the Database, a default filename will automatically be created. The EPOCH III will label any unnamed files "UNTITLED" and will assign a numeric extension. The purpose of the extension is to provide a feel for the chronological order in which the file was created. The first UNTITLED file will have an extension of ".001" and the second will have an extension of ".002" etc.
3. An "UNTITLED" file can be renamed after data has been saved into it. To do this, enter the memory screen by pressing **[2nd F]**, **[DISPLAY/STATUS]**. Select the "UNTITLED" file by using the  and  keys. Once the file has been selected, the new file name, extension, date and time can be entered directly using the alpha-numeric keypad.

8.1.4 How Data is Stored - Datalogger Organization

The EPOCH III allows data to be organized by two different, selectable methods.

1. The first method keeps stored location codes in a sorted (alphabetical) order. This organization is called **"Auto ID# Incrementing"** because location codes are automatically incremented by one value after each reading is saved.

2. The second method keeps location codes in the exact order in which they were transmitted to the EPOCH III from a computer. This organization is called **"Auto ID# Sequencing"** because the location codes automatically follow a pre-determined sequence.

These two different formats are not mutually exclusive. By allowing incremental Databases to be combined with sequential Databases, the EPOCH III's Datalogger makes it possible to note and record unexpected data while using an otherwise sequential Database.

Note: For a detailed explanation of the use of Databases, please refer to Section 8.2, Using The Datalogger For Thickness Gaging Applications.

8.1.5 Interface Program

Databases may also be generated on a PC through the Interface Program and downloaded to the Epoch III. Databases generated through the Interface Program can include custom templates and instructional memos. For details, see the Epoch III Interface Program Manual.

8.2 Using the Datalogger for Flaw Detection Applications

The simplicity and functionality of the EPOCH III's Datalogger makes it a powerful tool for flaw detection. In this capacity it is typically used to perform three basic functions.

1. Storing transducer calibration data and screen images.
2. Recalling transducer calibration data and screen images.
3. Making notes about inspection data through use of the MEMO function.

8.2.1 Saving Transducer Calibrations and Waveforms

The SAVE function can be used from either the full or split-screen displays. When a Waveform is saved, the corresponding transducer calibration data is also automatically saved. To save a transducer calibration or Waveform, proceed as follows:

1. If desired, enter a file name as described in Section 8.1.2, STARTING A NEW FILE.
2. Enter an ID by pressing **[ID]** and then using the alpha-numeric keypad.
3. Press **[2nd F]**, **[SAVE]** to save the Waveform and calibration. Note that the ID will be incremented by one value.
4. If an instructional memo has been inserted at a particular ID number in the Database, that memo will appear on the screen when the designated ID number is reached. When the memo appears, press **[F2]** to save it in the Database and continue, or **[F3]** to clear it from the Database and continue.

Note: In order to organize the storage of transducer calibration data, make good use of the alphanumeric file names and ID's to clearly label data. For example, use the eight character file name to label the file containing the calibrations (i.e. CALS.AWS) and the sixteen character ID's to label each calibration (i.e. ID/5MHz-STRAIGHTBM

or ID/AWS-60DEG-SHEAR and so on).

In order to free your hands to enter an ID or view a Waveform before saving it, use **[FREEZE]** to hold the displayed Waveform.

8.2.2 Recalling Transducer Calibrations and Waveforms

Since the EPOCH III's memory is configured to allow the contents of any file to be reviewed on the instrument screen, selecting and recalling data is straight forward. To find and recall a transducer calibration or Waveform, proceed as follows:

1. Enter the memory screen by pressing **[2nd F]**, **[DISPLAY/STATUS]**.
2. Use the and keys to scroll to the file containing the data to be recalled.
3. Press **[ITEM SELECT]** to toggle to the file contents window at the top of the instrument screen and use the and keys to scroll to the desired calibration or Waveform.
4. Scroll through the File Content until the stored Waveform appears on screen. Then press **[F3]** to recall the selected data.

Note that when a calibration or Waveform has been recalled, it will appear frozen on the display. To unfreeze the display and begin using the recalled calibration, press the **[FREEZE]** key.

8.2.3 Adding Comments to Stored Calibrations and Waveforms

The EPOCH III has a MEMO feature that allows descriptive comments of unlimited length to be included with stored data. Once typed in, comments will be held in the Database at the point that they are entered. To place comments in the Database before a particular Waveform, enter them prior to saving it. To place comments in the Database after a particular Waveform, press **[MEMO]** after the saved Waveform.

To enter comments, activate the MEMO mode by pressing the **[MEMO]** key at the bottom right of the Datalogger keypad. A field containing up to two blank lines will appear beneath the A-Scan display as shown below. Each line is preceded by a marker (>>>) to distinguish it from other text. As the first comment line is filled, the second becomes the

active entry line. To skip a line, press **[MEMO]** a second time. To exit the MEMO mode, press any key on the EPOCH III's main keypad.

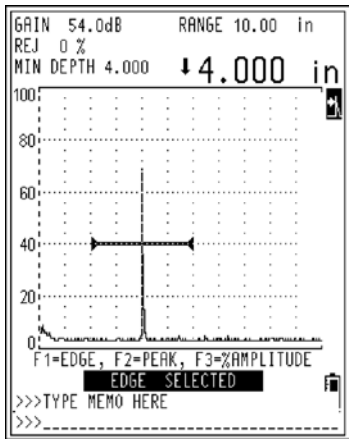


Figure 8.2: Memo Entry Screen

8.3 Using the Datalogger for Thickness Gaging Applications

With the ability to store up to 3,000 thickness readings with sixteen character alphanumeric location codes, the EPOCH III's Datalogger is well suited for use in thickness measurement surveys. In this capacity the Datalogger is designed to allow the use of two different Database formats.

8.3.1 Incrementally Organized Databases

When using the standard incrementally organized Database, the current location code is incremented by one character value after each save. This format is used whenever a series of location codes are initiated by entering an ID using the EPOCH III's alpha-numeric keypad. The following rules apply when incremental ID strings are used.

1. Only that portion of the ID number consisting of digits and letters (no punctuation marks) beginning with the rightmost character and extending leftward to the first punctuation mark or leftmost character (whichever comes first) is incremented.

2. In order to make the EPOCH III increment through a range of numbers several digits wide while beginning with a single digit ID number, the maximum number of digit positions must first be created and held by using zeroes. For example, to save 999 thickness readings, enter 001 as a starting ID. If ID 1 is entered, only 9 thickness readings can be saved. The same is true when it is desired to increment a single digit number through a range of several digits when coming to the right of a punctuation mark (delimiter) at the end of an alphanumeric string.

3. If an ID number cannot be incremented, a long beep will sound and the message "ID CANNOT INCREMENT F1=EXIT" will appear on the instrument screen. If

[F1] is pressed, the ID entry function will automatically be opened to allow editing of the current location code. Until characters are added, the ID will not increment and non-incrementable numeric characters will appear as "?". While non-incrementable alpha characters will appear as "Ω". These changes serve as markers to show which portion of the ID should be updated.

8.3.2 Sequentially Organized Databases

Auto ID number sequencing causes the current ID number to change to the next ID number in a previously stored sequence of ID numbers when **[SAVE**] is pressed. A sequentially organized Database is typically unsorted and may be arranged in a grid pattern or any other arbitrary pattern or order.

The ID Number Sequencing feature is useful for taking thickness data at the same locations and in the same order as a previous thickness survey where the order was not incremental. In addition to relieving the operator of the necessity of manually entering each new ID number, it guides the operator along a preset path and allows for entry of unexpected auxiliary data.

The ID sequence is downloaded to the EPOCH III from a computer. The following sections describe how Auto ID Number Sequencing functions when the sequence has been sent to the EPOCH III using the EPOCH III Interface Program. In general, the rules and procedures described below will also apply if the ID sequence has been downloaded to the EPOCH III from another software package.

Once an ID sequence has been downloaded to the EPOCH III, it may be recalled for use from the memory screen. To access the Database use the following steps:

1. Enter the memory screen by pressing **[2nd F]**, **[DISPLAY/STATUS]**.
2. Select the desired Database file by using the ⊞ and ⊞ keys.
3. To begin saving data into the Database, press **[DISPLAY/STATUS]** to return to the A-Scan display and press **[SAVE]** to store a thickness reading.

8.3.3 Using the Database Summary

Note that while an unused Database is being reviewed in the memory screen, it will appear in a "summary" form. This means that the ID sequence without the data will be shown. Each location code will have a marker next to it. This marker indicates the status of the location code. On a new Database, one without any data stored in it, each location code will be preceded with the marker "ID* ".

Below is an example of a basic sequential Database that was created using the EPOCH III Interface Program and sent to the EPOCH III (no measurements taken):

ID* TANK1-1A
ID* TANK1-1B

ID* TANK1-1C
ID* TANK1-1D

Once the Database has been recalled and data stored in it, the markers preceding locations where data has been saved, will change to “ID>” and the ID will be moved to the last position in the file. The Database Summary will be maintained at all times and will appear above the actual inspection data when the file is viewed in the memory screen.

The following sequence was created using the EPOCH III Interface Program and downloaded to the instrument.

ID* PIPE1-1A
ID* PIPE1-1B
ID* PIPE1-1C
ID* PIPE1-2A
ID* PIPE1-2B
ID* PIPE1-2C
ID* PIPE1-3A
ID* PIPE1-3B
ID* PIPE1-3C

Thickness data is then saved at the first four location codes and a Waveform is saved at the fifth. Data was not collected at the remaining locations. Now the summary will appear as follows:

ID* PIPE1-2C
ID* PIPE1-3A
ID* PIPE1-3B
ID* PIPE1-3C
ID>PIPE1-1A THICKNESS
ID>PIPE1-1B THICKNESS
ID>PIPE1-1C THICKNESS
ID>PIPE1-2A THICKNESS
ID>PIPE1-2B WAVEFORM

When this file is reviewed in the memory screen any remaining ID numbers (ID*) will appear at the beginning of the file. Stored data will appear after the last blank ID and will be displayed in the order it was saved.

In a sequentially organized Database, it is also possible to skip ID*’s. To skip an ID number (ID*) press the **[ID]** key and use the  or  slewing keys to move to the desired ID location.

8.3.4 Interrupting and Resuming a Sequentially Organized Database

In the event that not all the data for a sequentially organized Database can be collected, it is possible to resume the collection of data at the first uncollected location code.

1. Access the memory screen by pressing **[2nd F]**, **[DISPLAY/STATUS]**.
2. Select the file containing the incomplete Database by using the ⊞ or ⊞ keys.
3. Press **[DISPLAY/STATUS]** to return to the A-Scan display. The first available, uncollected location code will automatically be selected and displayed next to the file name at the bottom of the display.
4. Continue collecting data until the Database has been filled.

8.3.5 Adding Data Points to a Sequentially Organized Database

When using a sequentially organized Database, there may be situations when it is desirable to add data points that were not a part of the original sequence. This can be done at any time by pressing **[ID]** and entering in the new location code. This temporarily breaks the sequence and when data is stored at the newly entered location code, it is increased by one value as described in the rules for incrementally organized Databases. Note that any new location codes and data appear in the collected Database in the order that they were stored. As is the case with incrementally organized Databases, duplicate location codes are allowed to exist and will appear in the collected Database in the order in which they were created on the computer or manually added to the sequence.

To resume sequential operation, press **[ID]** a second time and the first uncollected location code will be located and displayed. Pressing the **[SAVE]** key will store data at this point and allow continuation of the sequence.

8.3.6 Adding Comments to Thickness Data Files

The MEMO feature can be used to enter descriptive comments to be included with stored data. In thickness gaging applications such comments usually pertain to unusual measurement conditions. To place a comment in the Database prior to a particular thickness reading, enter it prior to saving the reading. To place the comment in the Database after the thickness reading, press **[MEMO]** after the saved Waveform.

To enter a comment, activate the MEMO mode by pressing the **[MEMO]** key at the bottom right of the Datalogger keypad. A field containing two blank lines will appear beneath the A-Scan display. Each line is preceded by a marker “>>>” to distinguish it from other text. As the first comment line is filled, the second becomes the active entry line. To add a blank line to a comment field, press **[MEMO]** a second time. To exit the MEMO mode, press any key on the EPOCH III’s main keypad.

8.4 Entering Alpha-Numerics

As mentioned in the previous sections, the EPOCH III's Datalogger provides for thorough documentation of inspection data by allowing the entry of alpha-numeric strings. These strings are used in three ways:

1. To enter file names, extensions, dates, and times.
2. To enter location codes for thickness or A-Scan data.
3. To enter comments. For flaw detection these comments can be used to further document defects and for thickness gaging they may pertain to test conditions.

The following section describes the entry and editing of alpha-numeric sequences.

Entry of alpha-numerics is carried out by putting the instrument in either an "alpha" or a numeric mode. The mode is selected by pressing the **[ALPHA/#]** key on the Datalogger keypad. The first press of the key puts the instrument in alpha mode and locks out numerics. A second press of the **[ALPHA/#]** key puts the instrument in numeric mode and allows entry of numbers only.

The entry cursor will change to indicate which entry mode is active, "__" for alphabetic entry, and "n" for numeric entry. Multiple presses of the **[ALPHA/#]** key allow the operator to switch between the two modes when entering alpha-numeric strings. Summaries and examples of how to enter various character strings are outlined below.

8.4.1 Numeric Entry

To put the instrument into the numeric entry mode, press the **[ALPHA/#]** key once or twice until the numeric cursor (n) appears on the instrument screen. Pressing any numeric key will enter the selected digit and automatically advance the cursor one position to the right.

8.4.2 Entering Letters

The letters have been laid out on the keypad over the numeric keys. The "alpha" mode is activated by pressing the **[ALPHA/#]** key. When alpha mode is active, the alpha cursor "__" will appear on the instrument screen. To enter a letter, press the corresponding number key where the letter exists. More detailed descriptions of how to enter letters follow.

8.4.3 Entering a Single Letter

1. Activate the Alpha mode by pressing **[ALPHA/#]**
2. Press the appropriate numeric key until the desired letter appears on-screen. There are three character choices per key and the correct character can be chosen in the following way:

Repeatedly press the numeric key. For example, to select the letter **"B"**, the key sequence would be **[ALPHA/#]**, **[2]**, **[2]**.

8.4.4 Entering Multiple Letters

In order to avoid having to continuously use the **[>]** key when entering letters, an automatic advance is built into the ALPHA mode. When the alpha lock is on, any letters that are not over the same number key can be entered directly and the cursor will automatically advance. For example, to enter the word "WELD", the following sequence would be used:

W E L D
[ALPHA/#], [9], [3] [3], [5] [5] [5], [3]

This sequence does not apply while editing data. The use of the [>] key is required after each alpha key to advance the character field.

If two letters are over the same key, then the **[>]** key must be used to advance the cursor. For example, the sequence "AC" is entered in the following manner.

A adv. C
[ALPHA/#], [2], [>], [2] [2]

8.4.5 Combining Letters and Numbers

The most common character strings will likely be a combination of letters and numbers. The **[ALPHA/#]** key is used to switch between the alpha and numeric modes when switching from a letter at one position to a number at the next.

For example, to enter the sequence "PAN01-A2", the following key sequence will be used:

P A N 0 1 - A 2
[ALPHA/#] [7], [2], [6] [6], [ALPHA/#], [0], [1], [ALPHA/#], [0],[0],[0],[0], [2], [ALPHA/#], [2]

8.4.6 Creating Spaces

To enter a space, use the **[>]** key to advance the cursor to the next position where text is to be entered. Any empty positions are treated as spaces. For example, to enter the string "A 5", the following sequence would be used:

A SPACE 5
[ALPHA/#] [2], [ALPHA/#], [>], [5]

8.4.7 Delimiters

Delimiters are treated as letters and are accessed when the ALPHA mode is on. Multiple presses of the **[0]** key will slew through a list of delimiters including **[SPACE]**, " . ", " / ", " - ", " * ", and " : ", and " # ".

8.4.8 Changing an Alpha-Numeric Sequence

Alpha-numeric sequences can be changed by positioning the cursor at the point in the string that is to be changed. The cursor control keys, [<] and [>], are used for cursor control and editing. Note that the automatic advance of the cursor does function when re-entering letters in the edit mode.

The **[>]** key allows the cursor to be moved forward without disrupting the character string. To move quickly through the string, press and hold the **[>]** key.

The **[<]** key allows the cursor to be moved backward without disrupting the character string. To move quickly through the string, press and hold the **[<]** key.

To change a character within an alpha-numeric sequence, use the **[<]** or **[>]** keys to position the cursor under the character to be changed and simply enter the correct character. This will overwrite the previous character with the new one.

A special case is the deletion of an unwanted character. A **[DELETE]** function can be found over the **[1]** key. The **[DELETE]** function is treated the same as any other alpha character and is entered by pressing **[ALPHA/#] [1]**.

If a character is deleted in the middle of an ID string, the characters to the right are not compressed. Therefore if the characters to the right are to be "rejoined" to the ID, the operator must retype the rest of the string. For example, to edit "PANAMETTRICS" position the cursor under the second "T" and type in "RICS ". The last space is necessary to overwrite the "S" in the original (misspelled) word.

8.4.9 Adding a Character to the Middle of an ID String

To add a character to the middle of an ID string, position the cursor at the appropriate position using the **[<]** or **[>]** keys and retype the ID as it should appear from that point onward.

8.4.10 Special Function Keys

[ID]

The **[ID]** key opens the ID entry function. Pressing the **[ID]** key will highlight the displayed ID number and the cursor will appear at its last position. From this point it is possible to change the current ID.

A second press of the **[ID]** key gives a blank ID line and allows entry of a second ID number. Pressing **[ID]** again displays the previous ID. Multiple presses of this key allow you to toggle back and forth between the old and the newly entered ID. Both ID numbers are held until another function is used. When this is done, the displayed ID is retained and

the second ID is discarded.To exit the ID mode, press any key other than the alpha-numerics.

[MEMO] The **[MEMO]** key puts the Datalogger into a special mode that allows the entry of comments and notes. Once typed in, comments will be held in the Database at the point that they are entered. At a given ID, this could be either before or after a screen image or calibration has been saved.

When the MEMO mode is activated, a special memo field will appear at the bottom of the screen. This field contains two lines of text and is positioned immediately above the line containing the file name and current ID. Each line is 33 characters in length and is marked by a ">>>" so as to distinguish it from other text. As the field is filled, the second line will become the active "entry" line and the top line will display the text from the previous line. This format allows instant review of what has been entered.

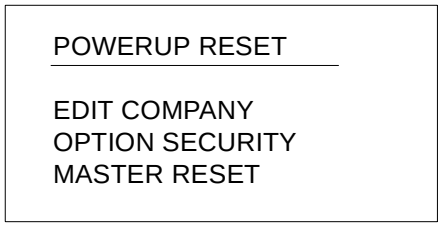
Once the MEMO mode is switched on, the EPOCH III automatically switches to alpha lock to enable fast and easy entry of letters. Numbers can be entered by pressing the **[ALPHA/#]** key to switch to numeric entry mode. Memos are entered according the rules described above for the entry of alpha-numeric identifiers. Also note that there is no need to confirm and save a memo. As memos are typed in, they are entered directly into the current file.

Review and editing of memos is carried out using the cursor control keys as described above. To exit the MEMO mode, press any key other than the alpha-numerics.

Note: Once a memo has been entered, it will be saved in the current file and cannot be edited.

8.4.11 Customizing the Power-up Screen

It is also possible to customize the Power Up screen to add your own company name and address. To do this, turn the unit off. Press and hold the **[MEMO]** key and turn the Epoch III back on. Once the display is illuminated, you may stop pressing the **[MEMO]** key. The following menu will appear:



Use the ⊞ and ⊞ slewing keys to position the highlight bar over “EDIT COMPANY” and press the **[ITEM SELECT]** key. The Epoch III will progress to the Power Up screen. You will notice that there is a flashing cursor next to the address field in the middle of the display. The size of the field is 5 lines of 33 characters each. F prompts (F1, F2, F3) appear along the bottom of the screen.

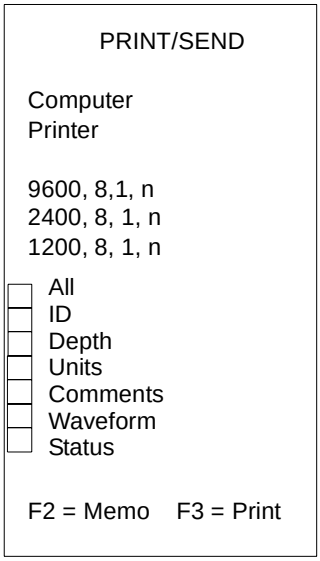
Press the **[F1]** key to clear the text field. Note that the cursor remains in the upper left corner of the field ready for entry of the new text. Use the alphanumeric keypad to type in new information. After completing the entry or modification to the text field, press **[F2]** to accept and return to the A-Scan display. The Epoch III will retain the newly entered text until it is edited again. If you wish to restore the Panametrics-NDT™ name and address to the text field, press **[F3]**.

8.5 Transmitting Data to Printers and Computers

Displayed or stored Waveform and thickness data can be sent directly to Epson FX-80 compatible printers . Stored data can be sent directly to a computer. Transmission of data is carried out by pressing the **[PRINT/SEND]** key. The first press of the **[PRINT/SEND]** key allows the communication parameters to be viewed in a pop-up menu as shown in Section 8.5.1 below. A second press of the **[PRINT/SEND]** key will exit the print function.

8.5.1 Setting Communication Parameters

Before data can be uploaded, the EPOCH III’s communication parameters must be set to match the configuration of the computer or printer. Note that the EPOCH III will always use a word length of 8 bits, 1 stop bit, and no parity bit, however the receiving device (computer or printer) and the baud rate must be selected. If “Computer” is selected, data is transmitted in an ASCII format. If “Printer” is selected, data is transmitted in a bitmap format. Pressing the **[PRINT/SEND]** key displays the following pop-up menu.



Note: If a group of items is preceded by " ", only one item in that group can be used at this time. If a group of items is preceded by "□", multiple items within the group may be chosen.

The boxes in front of each item indicate which parameters have been selected. The ⊞ and ⊞ keys are used to move a highlight bar up and down the list while the **[ITEM SELECT]** key is used to select or deselect the highlighted item. The pop-up menu is divided into two specific areas. The top half allows selection of communication parameters while the bottom half allows selection of which data is to be sent.

8.5.2 Filtering Transmitted Data

When uploading data from a file, it is possible to control which data is printed or sent to the computer. This is done by selecting or deselecting items related to the type of data to be sent, it is possible to "filter" the data as it is uploaded. This added level of control makes it possible to produce "custom" print-outs or to easily manipulate data that has been uploaded to the computer.

To filter data, simply select which information should be transmitted. For example, to upload only thickness readings with units and the associated location codes, select "ID", "Depth", and "Units". When the file is transmitted, all thickness readings and the associated location codes and units will be transmitted. All other data (Waveforms, memos, etc.) will be filtered out and will not be transmitted.

8.5.3 Sending Files

To send the contents of an entire file, proceed as follows:

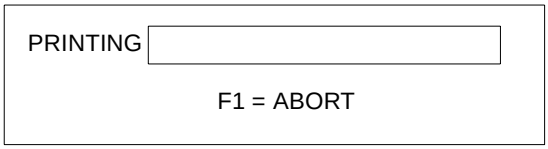
1. Enter the memory screen by pressing **[2nd F]**, **[DISPLAY/STATUS]**.

2. Use the ↓ or ↑ key to select the file to be sent.

3. Press **[PRINT/SEND]** once and select "computer" or "printer" and the appropriate baud rate by using the ↓ and ↑ keys to highlight and the **[ITEM SELECT]** key to choose the desired setting.

4. Choose which data from the file is to be sent by selecting the desired data to be transmitted by using the ↓ and ↑ and **[ITEM SELECT]** keys.

5. Press **[F3]** to begin transmitting. A pop-up window as shown below will appear:



The bar graph next to "PRINTING" shows approximately how much of the data has been sent. Since the size of print buffers vary, this will determine the time necessary for the Epoch III's keypad to return to normal.

To abort transmission, press the **[F1]** key.

Note: If the same computer or printer is to be used continually, the communication parameters only have to be set once. Once set, the last setting will be held until changed. This also applies to selection of data to be sent. Once the desired settings are established, it is possible to begin transmission of data by pressing **[PRINT/SEND]** and **[F3]** immediately afterwards.

8.5.4 Sending Individual Waveforms to a Printer

It is also possible to send a either live or stored individual Waveforms. To send a live Waveform to either a printer or computer, press **[PRINT/SEND]** once. If the communication parameters are set properly, press **[F3]** to begin transmission.

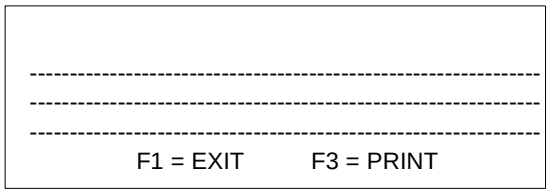
To send a stored Waveform, it must first be recalled to the instrument screen. To do this, proceed as follows:

1. Access the memory screen by pressing **[2nd F] [DISPLAY/STATUS]** and select the file containing the Waveform by using the ↓ and ↑ keys.
2. Select the Waveform by pressing **[ITEM SELECT]** and using the ↓ and ↑ keys to bring it onto the screen.
3. Press **[F3]** to recall the Waveform.
4. Press **[PRINT/SEND]** and then **[F3]** to begin transmission.

8.5.5 Adding a Memo to a Printout

When sending either an entire file or a single screen display to a printer, it is possible to add a four line MEMO prior to transmission. This feature makes it possible to create a brief description of the data to be printed. To add a MEMO to a printout proceed as follows:

1. Prepare to send the individual Waveform or file as described in Sections 8.4.3 and 8.4.4.
2. Press **[PRINT/SEND]** once.
3. A prompt at the bottom of the PRINT/SEND menu says “F2 = MEMO”. Press **[F2]** and a three line memo field will appear in the center of the display as shown below:



4. Type in the desired text and press **[F3]** to begin printing.

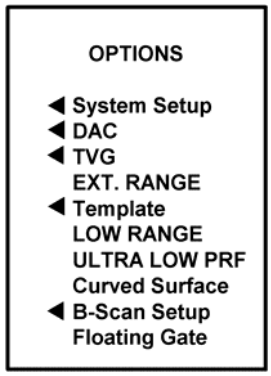
9 SOFTWARE OPTIONS

The Epoch III is intended to be a highly versatile general purpose flaw detector. As such, it is capable of being configured to perform a series of specialized functions related to certain applications or code requirements. Since some inspectors may not make use of these functions, they have been offered as software options. The options currently available for the Epoch III are DAC , TVG, Extended Range, Report Template, Ultra Low PRF, Curved Surface Correction and B-Scan. The setup and use of these options are described in the following sections of the manual.

Note: LOW RANGE (allowing a full screen range of 0.038" or 1mm) is now a standard option on all Epoch III instruments.

9.1 Use of the Option Select Key

The Option Select key is used to activate and deactivate the Epoch III's software options. When this key is pressed, the following menu will appear:



To select a particular item, use the and slewing keys to move the highlight bar up or down the list to the desired item and press **[ITEM SELECT]**. When an item has been selected, the appropriate Set-Up Menu will appear. For example, to review the basic system set-up, the following sequence is used:

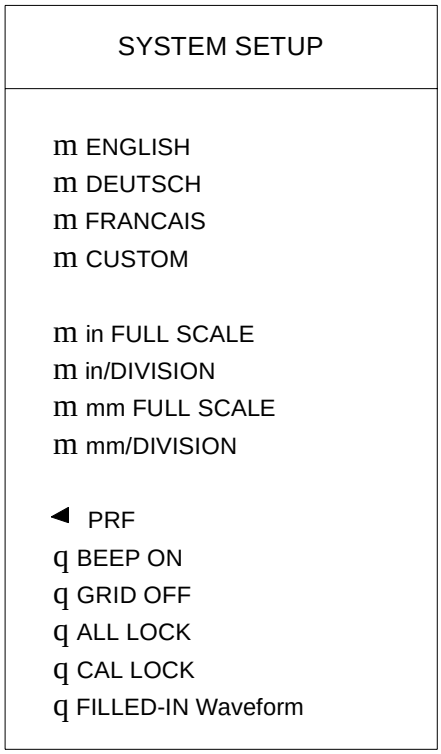
1. Press **[OPTION SELECT].**
2. Use the and keys to move the highlight bar over the System Set-up.
3. Press **[ITEM SELECT]** to select System Set-Up.
4. Press **[OPTION SELECT]** to exit the System Set-Up Menu.

9.1.1 System Setup

The System Setup selection allows you to adjust basic system parameters including the software language, English or Metric units, PRF rate, beeper, grid on/off, keypad lock functions, and filled Waveform/outlined Waveform display. To activate System Setup use the following steps:

1. Press **[OPTION SELECT]**.
2. Use the ⊟ and ⊞ keys to move the highlight bar to the System Setup selection.
3. Press **[ITEM SELECT]**.

When System Setup is chosen from the Options Menu the following menu will appear:



The selections in the System Setup Menu are grouped according to function (i.e. language, units). If a group of items is preceded by “m” then only one item in that group can be used at a time. For example, if the current language is English and French is selected, English will automatically be deselected. If a group of items is preceded by “q”, then multiple items within the group may be chosen.

9.1.2 Language Selection

To switch the Epoch III's operating language use the or key to slew to the desired language. To activate the language press **[ITEM SELECT]**, and then **[OPTION SELECT]** to return to the split screen A-Scan.

9.1.3 Selecting Units of Measure

The Epoch III is capable of displaying and calculating range and soundpath data in either English or Metric units**.** The four selections allow you to display the screen range in units per division (i.e. 1"/division or 25mm/division) or units full scale (i.e. 10" full scale or 250mm full scale).

9.1.4 PRF Selection

The Epoch III's Pulse Repetition Frequency (PRF) is selectable between Auto, Low, and Ultra Low PRF modes. The Auto PRF mode, in which PRF rate is automatically adjusted with respect to range setting, is the normal operating condition. The PRF Low mode may be used to minimize wrap-around noise when testing materials with long sound paths, especially when high gain levels are required in conjunction with long sound paths. The PRF Low mode operates only when full-screen range is greater than 0.464" or 11.8mm. The optional Ultra Low PRF mode reduces the Epoch III's Pulse Repetition Frequency to 30Hz regardless of the range settings.

9.1.5 Beep On

When the BEEP ON function is selected, keypad presses will be acknowledged with a beep.

9.1.6 Grid On/Off

When GRID OFF is selected, only the borders of the graticule will be shown behind the Waveform display. This is a real-time display condition only and will not be stored.

9.1.7 Keypad Lock Functions

ALL LOCK	When ALL LOCK is selected, all keys except **[DISPLAY/ STATUS]**, **[OPTION SELECT]**, **[ON/OFF]** are inactive. A full padlock will appear above the battery indicator to show that "ALL LOCK" has been selected.
CAL LOCK	When CAL LOCK is selected, the following keys are deactivated:

[dB]	[ZERO OFFSET]
[RANGE]	[VEL1/VEL2]
[REJECT]	[PULSER]
[ANGLE/THICK]	

When a calibration lock is active, a half padlock will appear above the battery indicator.

To unlock either a keyboard lock or calibration lock, return to the System Setup menu. To do this, press **[OPTION SELECT]** and move the highlight bar over the System Setup selection and press **[ITEM SELECT**]. Move the highlight bar to the current lock function and deselect it by pressing **[ITEM SELECT]**. To return to the Waveform display, press **[OPTION SELECT].**

9.1.8 Filled Waveform

This function selects a filled-in Waveform display in rectified modes. Alternatively, if this function is not selected, Waveforms will be displayed as outlines only. This is a real-time display condition only and will not be stored.

9.2 Distance Amplitude Correction (DAC) Curve Option

A Distance Amplitude Correction (DAC) Curve is used to plot amplitude variations of signals from reflectors that are the same size but at different distances from the transducer. Normally, such reflectors will produce echoes of varying amplitude due to material attenuation and spreading of the sound beam. The purpose of a DAC curve is to graphically compensate for material attenuation, nearfield effects, beam spread, and surface roughness. After plotting a DAC curve, reflectors that are the same size as those used for creation of the curve will produce echoes which peak along that curve despite their different locations within the test piece. Similarly, reflectors that are smaller than the those used to create the curve will fall below it while larger reflectors will exceed the curve level.

With the use of the DAC curve option, the Epoch III is capable of drawing user-defined DAC curves. It is possible to select formats that are consistent with either ASME, ASME-3 or JIS Z3060 code requirements. When the ASME format is selected, a single, continuous curve is drawn. The ASME-3 format allows the user to draw three curves simultaneously at 0dB, -6dB. and -14dB echo. When the JIS format is selected, up to eight segmented curves are drawn. In all formats, signal amplitude as a percentage of the primary curve level (“amplitude DAC”) is calculated and shown above the upper left hand corner of the Waveform display. In addition, DAC alarms can be set to activate whenever an echo exceeds the primary curve level. For inspections that require the use of multiple transducers, any DAC curve can be stored in the Epoch III’s Datalogger and recalled when needed.

9.2.1 Drawing DAC Curves

The procedure for drawing DAC curves is as follows:

1. Calibrate the Epoch III for the appropriate transducer.
2. Press **[OPTION SELECT]** to bring up the Options Menu.
3. Use the slewing keys, ⊞ or ⊞ to place the highlight bar over the DAC curve selection and press **[ITEM SELECT]**.
4. A second pop-up menu will allow selection of the curve format (ASME, ASME-3, or JIS). Use the slewing keys, ⊞ or ⊞ to place the highlight bar over the format selection and press **[ITEM SELECT]**.
5. Press **[OPTION SELECT]** to return to the A-Scan display.
6. Once you have returned to the A-Scan display, the following prompt will appear in the Abbreviated Status Window:

   "F1=DRAW DAC F2=DONE F3=CLEAR"

   To begin drawing the curve, position gate over the first echo and press **[F1]**. Note that the echo height must be greater than gate level.

Note: The peak of the highest amplitude echo that is to be used to draw the curve, must be visible on screen (<100% screen height). If it is not, adjust the gain until the peak is clearly visible.

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7. To capture the next point for the curve, move Gate 1 to the appropriate position and press **[F1]**. Repeat step 6 until all the points for the curve have been captured.
8. Once the last point has been captured, press **[F2]** to complete the curve. You may want to enter an ID and save the curve in memory.

To correct a mistake made while drawing a curve, or to begin drawing a new curve, press **[F3]** to clear the curve. A second prompt: "Are you sure? F1=Yes, F2=No" will appear to confirm clearing the curve.

When the DAC curve mode is active, any key that would affect instrument calibration is automatically locked. This includes the following keys:

[dB]	[ZERO OFFSET]	[ANGLE]
[RANGE]	[VELOCITY]	[REJECT]
[ZOOM]	[PULSER]	

To obtain amplitude information in the DAC mode, press the **[DEPTH/%AMPL]** key and select F3=%AMPLITUDE. The Epoch III will provide the following amplitude information above the A-Scan display for an echo within the gate:

"AMPLITUDE DAC XX% CURRENT XX%"

The "AMPLITUDE DAC" display provides data on the echo amplitude as a percentage of the primary curve level. This is useful because many codes describe echo amplitude in

terms of “percent of DAC”. The “CURRENT” value corresponds to the echo’s amplitude in terms of full screen height.

Once the curve is complete, you may wish to activate the Reference Gain function by pressing **[2nd F]**, **[dB]**. Doing so, will allow you to lock in a reference gain level and add scanning gain to accommodate specific applications. For example, if you are required to evaluate any reflector that exceeds 50% of the DAC level, you may want to add in 6dB of scanning gain. In this way, the curve, when used in conjunction with the Amplitude DAC display and DAC alarm (see below) becomes an easy reference to determine if any indication exceeds the evaluation level. Note that the additional scanning gain cannot be added to the original reference gain level as this would change the calibration of the Epoch III and invalidate the DAC curve.

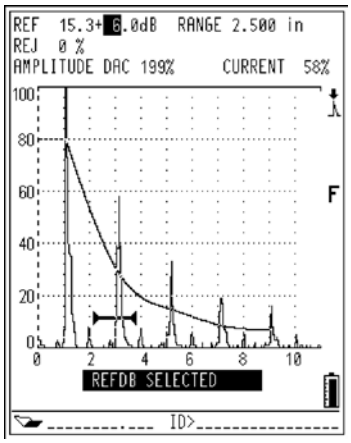


Figure 9.1: Changing a Parameter

9.2.2 Special Considerations for JIS Z3060 DAC Curves

In general, the instructions in Section 9.2 apply to the construction of all DAC curve sets however, there are some special provisions that have been made to address the requirements of JIS Z3060. These considerations are addressed in this section.

1. Because of the large number of curves that are drawn for the JIS DAC mode, it is possible to temporarily add in 6, 12, 18, or 24dB of additional gain while constructing the DAC curve set. The purpose of this feature is to facilitate construction of additional curves when testing at longer ranges. Once construction of the curve set has begun, up to 24dB of additional gain can be added through repeated presses of the **[dB]** key. In order to make it clear that gain has been added while constructing the curve, the gain display will appear as follows: “GAIN 46.2dB + 6” etc. Once the curve set has been completed, the gain will be reset to its original level (in this example, 46.2dB).

2. It is also possible to change Angle, Material Thickness, Zero Offset, and Gain (dB) in the normal manner when in the JIS DAC mode. Care should be taken in adjusting these parameters to insure that the relationship of DAC curves to material thickness or distance is not unintentionally altered.

3. Any of the six curves may be used to trip the alarm when in the JIS DAC mode. Additionally, the alarm may be set positive or negative. To select which curve will be used as the alarm reference level, first activate JIS DAC and then press **[GATE LEVEL]**. A prompt will appear on the display. The number at the left side of the prompt, next to the speaker symbol, indicates which curve has been selected as the alarm threshold. Additionally, the selected curve appears as a double-thickness line. To select a different curve, press **[F1]** to go up or **[F2]** to go down. Once a curve has been selected, you may activate the alarm, and set it as a positive or negative, in the usual way by pressing **[2nd F]**, **[GATE LEVEL]** and following the prompts.

4. When the JIS DAC mode is active, the amplitude (level) of a gated signal will always be displayed as a percentage with respect to the selected curve. If you select a different curve, the displayed amplitude percentage of a given signal will change accordingly.

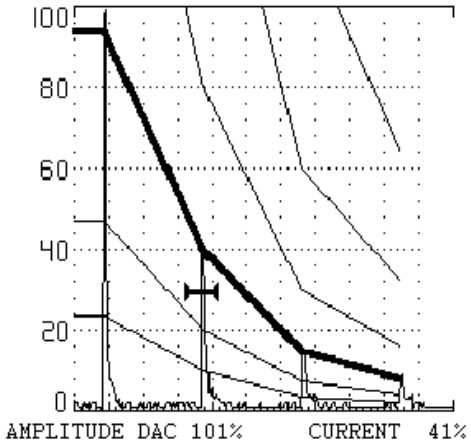


Figure 9.2: JIS DAC Screen Print

9.2.3 Saving DAC Curves

DAC Curves can be saved and recalled like regular Waveforms. Refer to Section 8.1 for more details.

9.2.4 Setting Alarms in DAC Mode

It is possible to use the gates to set alarms while DAC is active. When using the ASME or ASME-3 DAC modes, all alarms are referenced to the primary curve. When using the JIS DAC mode, alarms are referenced to the highlighted alarm curve. For example, a DAC alarm can be set by using the positive threshold alarm on either Gate 1 or Gate 2. Any echo that falls within the gate and exceeds the DAC level will trigger the alarm. That is, the alarm will be triggered only if an echo exceeds the portion of the DAC curve immediately above the gate. This same rule applies to the use of the Minimum Depth and negative threshold alarms while in DAC. Note that the alarms will not function in the area outside of the DAC curve.

9.2.5 Exiting DAC Mode

To clear the DAC curve and return to normal operation use the following steps.

1. Press **[OPTION SELECT]** to enter the Options Menu.
2. Use the slewing keys or to highlight the DAC mode.
3. Press **[ITEM SELECT]** to select the DAC option.
4. In the DAC Set-up menu, use the slewing keys or to highlight DAC-OFF. Press **[ITEM SELECT]** to shut the DAC curve option off.
5. Press **[OPTION SELECT]** to return to the A-Scan display.

9.3 Time Varied Gain (TVG) Option

The Time Varied Gain option (TVG) compensates or corrects for the changes in echo amplitude from equal size reflectors at different distances due to material attenuation and beam spreading. When TVG is properly set up, equal size reflectors will produce indications of equal screen height regardless of their distance. TVG has a dynamic range of 40dB with a minimum echo height of approximately 5%. Up to 130 TVG setups can be stored in memory.

9.3.1 Activating and Calibrating TVG

In order for TVG to be activated, the Epoch III must be in one of the rectified display modes (Full Wave, Half Wave +, or Half Wave -). TVG and DAC may not be activated simultaneously. Up to 20 TVG calibration points may be programmed, separated by a minimum of 1.28 microseconds (approximately 0.150" or 3.75mm at longitudinal velocity in steel). TVG operates over a range from approximately 1" (25mm) to 135" (3425mm) at longitudinal velocity in steel. TVG must be set up with the aid of reference standards that will generate representative echoes at the points of interest.

To implement a TVG setup, follow these steps:

1. Press the **[OPTION SELECT]** key and select TVG using the slewing keys and the **[ITEM SELECT]** key. Select "On" using the slewing keys and the press **[OPTION SELECT]** to return to the Waveform display screen, which will now display a prompt below the Waveform:

   F1 = TVG F2 = DONE F3 = CLEAR

2. To set a point, set the gate on the desired echo, making sure the echo breaks the gate threshold, and press **[F1]**. Gain will be adjusted so that the selected echo appears at 80% screen height. Repeat this process on each calibration echo within the area of interest, up to a total of 20 times. Generally, you should start with the largest calibration echo and work down to the smallest one. You can go back to fine-tune the gain level at any selected point by repositioning the gate on the echo and pressing **[F1]** again. If a point is invalid (outside the allowable time/range limits), the unit will beep to indicate an error. If there is no detected echo within the gate, the point will not be accepted and there will be no gain adjustment based on that point. If you make a mistake, press **[F3]** to clear the setup.

3. When all echoes have been set, press **[F2]** to lock in the setup. The letters TVG will appear to the right of the screen to indicate that TVG is active, and a double-thickness line will appear at the top of the display to mark the area over which TVG has been programmed.

4. When TVG is active, normal gain (dB), Range and Pulser settings are locked and may not be changed. Reference Gain must be adjusted in the usual manner. Care should be taken in adjusting these parameters to insure that the relationship of TVG to the material sound path is not inadvertently altered.

5. To exit the TVG mode, press **[OPTION SELECT]**, and choose TVG from the menu using the slewing keys. Press **[ITEM SELECT]**. From the TVG menu, select OFF using the slewing keys, and press **[OPTION SELECT]** again to return to the display screen.

9.3.2 Saving and Recalling TVG Setups

TVG setups are saved and recalled the same way as any stored display. With TVG active, you may save setups that include TVG calibrations as described in Section 8.1 of this manual. When a setup that was stored with TVG active is recalled, the instrument will automatically come up in the TVG mode.

9.4 Extended Range Option

The standard Epoch III has a maximum range of 200 inches or 5,000 millimeters at longitudinal velocity in steel. The Extended Range option permits testing up to 400 inches or 10,000 millimeters at longitudinal velocity in steel. In addition, the delay is extended to 400 inches or 10,000 millimeters to allow full use of the Zoom function.

Extended Range is a factory installed software option and cannot be switched on or off by the user. To check whether a particular Epoch III has extended range, press **[OPTION SELECT]** and look at the dotted box adjacent to the words EXT. RANGE. An "X" in the box indicates that the Extended Range option has been installed. Any empty box indicates that it has not.

9.5 Customized Report Template Option

The Customized Report Template option allows the user to create customized-formatted templates for reporting and datalogging. These templates can be created through the Epoch III Interface Program and downloaded to the instrument. See the Epoch III Interface Program manual for information on how to create and download templates.

If there is a template in a Database file, it will always appear at the beginning of the file, and the template lines will be marked with the symbols >>*. There can be only one template per file. To insert information into a template, follow these steps:

1. Press **[OPTION SELECT]**. Using the slewing keys, highlight Template from the menu and press **[ITEM SELECT]**. An edit window will appear with a flashing cursor. You can fill in the blanks using the alphanumeric keys. Use the right and left arrow keys to move to the next or previous line.
2. You can edit up to five lines from one screen. If the template consists of more than five lines, press **[F2]** to save the screen information and move to the next page. If you wish to skip to the next page without saving the current screen, or to exit without saving anything, press **[F3]**. (You will have to press **[F2]** or **[F3]** the same number of times as there are pages in order to return to the normal operating mode.) When a page has been saved, the >>* symbol at the beginning of each line turns to >>>.
3. If you wish to delete or change the format of a template, you must use the Interface Program from a PC. For details, consult the Epoch III Interface Program Manual.
4. To exit the template without further changes, press **[F3]**.

9.6 B-Scan Option

The B-Scan option for the Epoch III is used primarily for verification of acquired ultrasonic data. This verification can be used as a quantitative comparison of thickness readings or a visual verification where data from critical areas is presented in an easy-to-understand cross-sectional profile.

A scanner equipped with an internal encoder mechanism allows the ability to map thinning areas by providing transducer location information (Distance Traveled) along with the thickness reading. This feature increases the functional value of the B-Scan as relative location in the material is directly correlated with the depth at that location.

The Epoch III B-Scan has three separate operating modes:

1. Bi-Directional Encoded Mode

   This mode requires the use of a bi-directional encoder which will keep track of location information as data is collected in both forward and backward directions.

2. Uni-Directional Encoded Mode

   This mode requires the use of a bi-directional or uni-directional encoder which will keep track of location information as data is collected in the forward direction only.

3. Manual Mode

   This mode does not keep track of location information and does not require the use of an encoder. This mode provides a continuous scan of thickness data with no correlation to it's location along the scan. Readings are timed from 1 to 60 readings per second and are not related to transducer movement.

9.6.1 Choosing an Encoder and Accessories

Panametrics-NDT™ offers a handheld portable scanner with internal encoder for use with the Epoch III B-Scan option. It is well suited for a variety of applications. The scanner and general B-Scan package are available with the following optional accessories:

- Magnetic Wheels
- Extension Pole Bracket
- Extended Probe Holder Wear Cap
- Transducer and Encoder Cables of various lengths
- B-Scan Interface Program (Available separately or as a package with the standard Epoch III Interface Program)

Other encoders may be used with the following requirements. The encoder selected must be a standard TTL quadrature position encoder, four conductor connection with a single +5V power supply. A remote control scanner may also be used to provide a more automated inspection.

9.6.2 Getting Started

Required cables and connections.

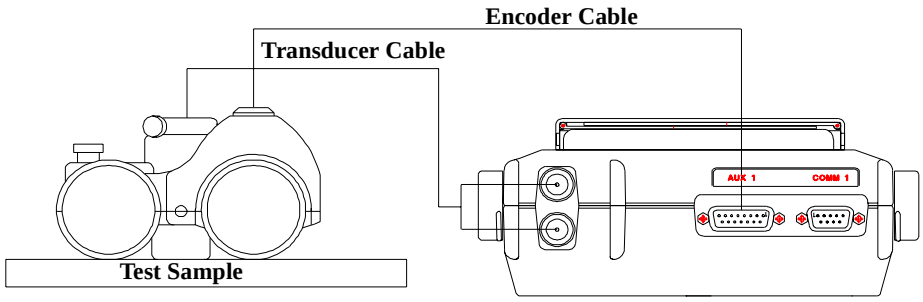


Figure 9.3: Epoch III B-Scan Setup Diagram

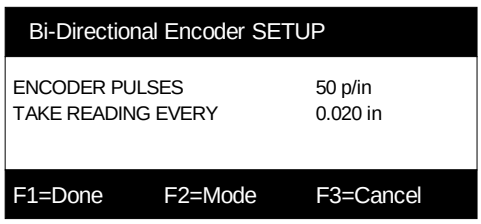
The configuration for the Epoch III and scanner is simple. First, secure the selected transducer with attached cable in the scanner's probe holder using the two tightening screws. Connect the transducer cable into the BNC or LEMO connector on the Epoch III as shown in Figure 9.3. This will provide the ultrasonic information from the transducer to the Epoch. Attach the LEMO connector of the encoder cable into the scanner. The 15 pin connector will then plug into the 15 pin parallel port of the Epoch III. A couplant feed can be connected to the couplant feed port on the scanner which will allow for continuous transducer coupling when used with a water pump or pressurized couplant dispenser.

9.6.3 B-Scan Setup

The procedure for setting up a B-Scan is as follows:

1. Press **[OPTION SELECT]** to bring up the Options Menu.
2. Use the slewing keys, ⊞ or ⊞, to place the highlight bar over the "B-SCAN Setup" selection and press **[ITEM SELECT]**.
3. From the Setup menu, use the **[F2]** key to select the appropriate mode: Bi-directional, Uni-directional, or Manual mode. Notice the dialog box will change for each mode.

9.6.3.1 Bi-Directional Mode



Using the **[ITEM SELECT]** key, position the highlight box over "ENCODER PULSES ___ p/in (p/mm)". This value is associated with the specifications of your particular encoder and is only adjusted if a different encoder is being used. The default setting is 50 pulses/inch (2 p/mm) which represents the specification of the encoder offered by Panametrics-NDT™ with the B-Scan kit.

To adjust the value, use the ⊞ or ⊞ slewing keys and select the correct number of encoder pulses per inch (mm) specific to the encoder being used. Consult the encoder specification to determine the appropriate encoder pulses value for your encoder. When finished, press the **[ITEM SELECT]** key to highlight "TAKE READING EVERY __.___ in (mm)". Again, use the ⊞ and ⊞ slewing keys to enter the desired resolution.

Note: The desired resolution is based on the encoder resolution in pulses per inch/mm. Therefore, desired resolution will be limited to increments of the encoder resolution that is being used. For example, if the encoder resolution is 50 pulses/inch (2 pulses/mm), the best resolution possible would be 0.020 inch (0.5mm). A sample English and Metric unit calculation follows:

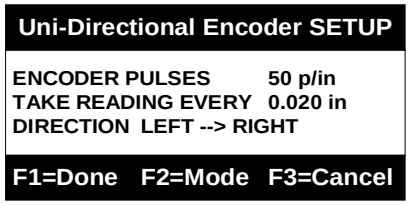
$$\frac{1.0 \text{ inch}}{50 \text{ pulses/inch}} = 0.020 \text{ inch} \qquad \frac{1.0\text{mm}}{2 \text{ pulses/mm}} = 0.5\text{mm}$$

Each pulse from the encoder is capable of taking readings in increments of 0.020 in (0.5mm). It is possible to take a reading every other pulse, every third pulse, every fourth pulse, etc. Therefore, the resolution can be changed in increments as follows:

0.020 inch (0.5 mm) - (Take reading every 1 pulse)
0.040 inch (1.0 mm) - (Take reading every 2 pulses)
0.060 inch (1.5 mm) - (Take reading every 3 pulses)
0.080 inch (2.0 mm) - (Take reading every 4 pulses)
0.100 inch (2.5 mm) - (Take reading every 5 pulses) etc....

Once you have selected the appropriate settings for encoder pulses and resolution, press **[F1]** to exit the setup menu. Press **[OPTION SELECT]** to return to the A-Scan display. If at any time you decide to exit the setup menu without saving the changes you have just made, press **[F3]** to cancel the changes and exit the setup menu.

9.6.3.2 Uni-Directional Mode



The setup for the Uni-Directional mode is nearly identical to the Bi-Directional mode. After selecting the Uni-Directional mode using the **[F2]** key, use the **[ITEM SELECT]** key to position the highlight box over "ENCODER PULSES ___ p/in (p/mm)". To adjust the value, use the and slewing keys and select the correct number of encoder pulses per inch (mm) specific to the encoder being used. Consult the encoder specification to determine the appropriate value for your encoder. When finished, press the **[ITEM SELECT]** key once again to highlight "TAKE READING EVERY __.___ in (mm)". Again, use the and slewing keys to enter the desired resolution. (See note above for entering the proper resolution.) Finally, press **[ITEM SELECT]** a third time to select "DIRECTION LEFT —> RIGHT". Using the and slewing keys will change the direction of the arrows as follows:

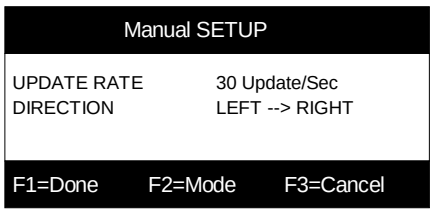
LEFT —> RIGHT
LEFT <— RIGHT

This determines the direction which the data will be updated on the Epoch III screen. Choosing LEFT —> RIGHT will cause the data to start at the left side of the screen and scroll to the right.

Once you have selected the appropriate settings for Encoder Pulses, Resolution, and Direction, press **[F1]** to exit the setup menu. Press **[OPTION SELECT]** to return to the A-Scan display.

If at any time you decide to exit the setup menu without saving the changes you have just made, press **[F3]** to cancel the changes and exit the setup menu.

9.6.3.3 Manual Mode



Once you have selected the Manual mode using the **[F2]** key, use the **[ITEM SELECT]** key to position the highlight box over "UPDATE RATE Update/Sec". This value can be adjusted from 1 to 60. This will control the rate at which the Epoch III will take readings and in effect control the rate of the scan. Entering a value of 60 Updates/Sec will allow the Epoch III B-Scan to capture 60 readings every second. This will also determine the minimum scan speed for the desired resolution. For example to achieve a scan speed of 6 inches per second with a desired resolution (field of scan) of 0.100 inch, the value would need to be set at 60 Updates/Sec.

60 Updates/Sec X 0.100 inch = Max scan speed of 6 inches/second
30 Updates/Sec X 0.100 inch = Max scan speed of 3 inches/second

Finally, press **[ITEM SELECT]** a second time to select "DIRECTION LEFT —> RIGHT". Using the and slewing keys will change the direction of the arrows as follows:

LEFT —> RIGHT
LEFT <— RIGHT

This determines the direction which the data will be updated on the Epoch III screen. Choosing LEFT —> RIGHT will cause the data to start at the left of the screen and scroll to the right.

Once you have selected the appropriate settings for Updates/Sec and Direction, press **[F1]** to exit the setup menu. Press **[OPTION SELECT]** to return to the A-Scan display.

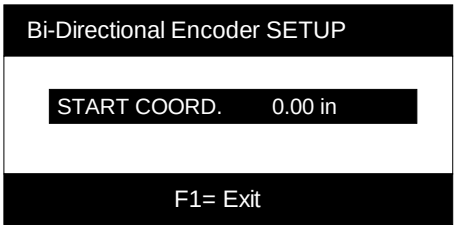
If at any time you decide to exit the setup menu without saving the changes you have just made, press **[F3]** to cancel the changes and exit the setup menu.

9.6.4 B-Scan Operation:

Before beginning to collect data, the Epoch III A-Scan should be set up as follows:

1. Calibrate the Epoch III for the appropriate transducer and material. See Section 4 for proper calibration procedures.
2. Position GATE 1 using **[GATE START]**, **[GATE WIDTH]**, and **[GATE LEVEL]** so that the start of the gate is positioned prior to the minimum expected thickness. Likewise, the end of the gate should be positioned after the maximum expected reading. An echo must break the gate for the Epoch III to detect it and display a B-Scan data point.

   Upon entering the B-Scan mode, the GATE START and GATE END positions will determine the vertical scale of the B-Scan. For best resolution, the gate should be positioned as accurately as possible near the minimum and maximum values expected. Use a slight buffer to include potential unexpected values. When entering the B-Scan mode, the Epoch III will automatically zoom the gate and expand the range until the gate represents full screen.
3. To enter B-Scan, from the A-Scan mode press **[2nd F]**, **[ZOOM]**. If the Bi-Directional or Uni-Directional Mode has been previously selected, the user will be prompted to enter a START COORDINATE.



Use the and slewing keys to enter the appropriate value for the starting point of your inspection. This will represent the first Distance Traveled (DT) value of the B-Scan. For example, if you are beginning the scan at the end of a pipe or plate, you may wish to enter a value of zero. If beginning a scan a certain distance from the end of the test piece, an appropriate value can be entered.

Note: You may wish to mark the location on your material to indicate where you have started the inspection for later reference.

Once you have entered the appropriate START COORDINATE, press **[F1]**. You will now be in the B-Scan mode. The following screen will be displayed:

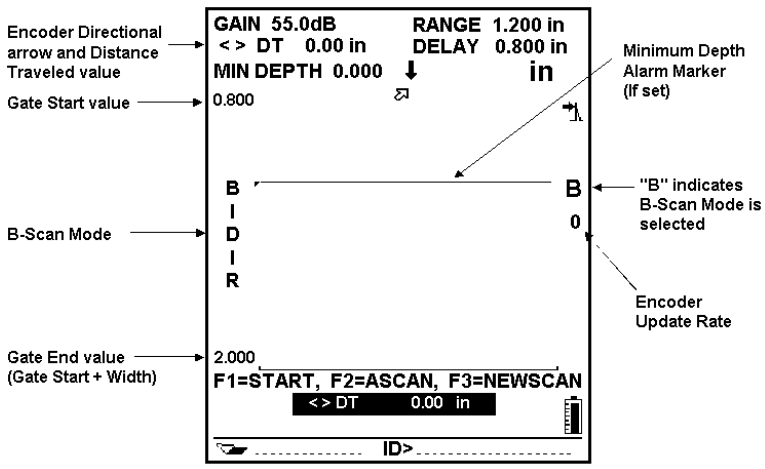


Figure 9.4: Bi-Directional B-Scan Start Screen

The selected mode will be indicated along the left edge of the B-Scan. If this is not the proper mode, exit the B-Scan by pressing **[2nd F]**, **[ZOOM]** and refer to Section 9.6.3 (B-SCAN SETUP).

You are now ready to begin collecting data. Notice the following prompts will be displayed just beneath the Waveform :

F1 = START, F2 = ASCAN, F3 = NEWSCAN

To begin collecting data, press **[F1]**. As the scanner is moved, data will be collected and displayed as a cross sectional image of the test material. The number of data points is based on the movement of the encoder wheel in increments of the resolution entered in the setup screen. The Bi-Directional Mode allows the scanner to be moved backwards. B-Scan data

points are updated. This is especially useful when verifying thin material areas where an alarm condition exists (Refer to Figure 9.5).

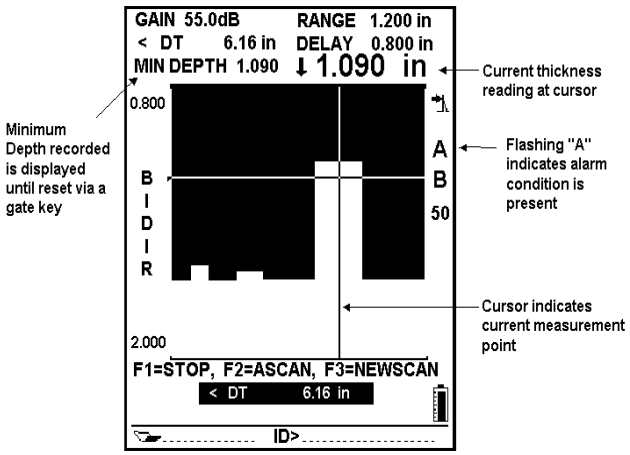


Figure 9.5: Collecting B-Scan Data

While collecting data, the information will be temporarily stored in a memory buffer. The Epoch III is capable of storing up to 60,000 B-Scan data points (thickness readings) before the buffer is full. In the Bi-Directional mode, the buffer can store 50,000 readings in the forward direction and up to 10,000 readings in the backwards direction. When the buffer becomes full, the scan will stop. The user will be prompted to save the scan or start a new one. To prevent the loss of encoded data, the DT reading will flash as a warning when the buffer is within 500 readings of being full.

While in the collect mode, the following prompt will be displayed:

F1 = STOP, F2 = ASCAN, F3 = NEWSCAN

Press **[F1]** to stop the collection of B-Scan data. Consecutive presses of **[F1]** will toggle between Start and Stop.

Press **[F2]** to view the A-Scan image while simultaneously collecting B-Scan thickness readings. This is especially useful to confirm unusual readings or a loss of signal. Consecutive presses of the **[F2]** key will toggle between the A-Scan and B-Scan.

You will notice that many of the standard functions have been disabled while in B-Scan mode. However, you may adjust GAIN directly while viewing the A-Scan. Once doing so, you must press **[ITEM SELECT]** to display the prompt for returning to B-Scan mode. Again, **[F2]** will toggle between the A-Scan and B-Scan.

Press **[F3]** will initiate a new scan. A new scan will clear any information in the memory buffer. Be sure to save the B-Scan before starting a new scan if desired (See Section 9.6.8). After **[F3]** is pressed, the user will be prompted to assure if this is the correct course of action.

9.6.5 Reviewing Depth and Distance Traveled Information

It is possible to stop the B-Scan and review depth information and correlating distance traveled values. At any time during the scan, press **[F1]** to stop the B-Scan. A marker arrow will appear in the place of the cursor on the display. This marker can be moved along the scan using the ⊞ and ⊞ slewing keys. In Manual Mode, the depth recorded at each data point will be displayed. In one of the encoded modes, the thickness reading along with the DT value at that point will be shown. (Refer to Figure 9.6).

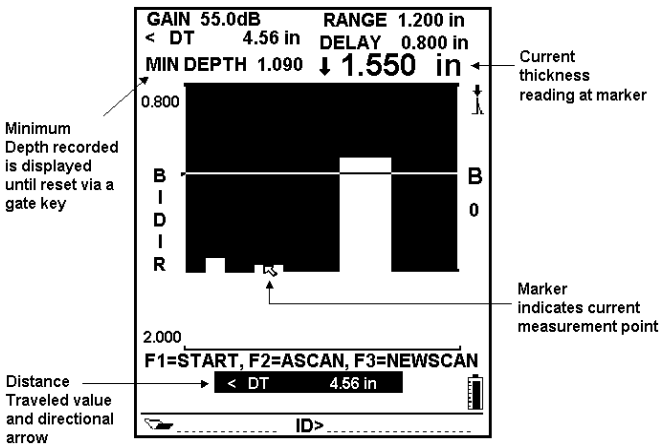


Figure 9.6: Collecting B-Scan Data

Press **[F1]** again to restart the scan. The scan will resume at the cursor's last position.

9.6.6 Minimum Depth Alarm

The Epoch III is equipped with a minimum depth alarm which will be triggered whenever the current thickness reading falls below an operator defined level. The minimum depth alarm will appear as a cursor on Gate 1 in single gate mode or on Gate 2 in Echo-to-Echo mode. The alarm level will be displayed as a horizontal line across the B-Scan (Refer to Figures 9.4 and 9.5). The alarm will be noted by a flashing "A" on the display and a continuous audible tone.

For further information on setup of the minimum depth alarm, see Section 5.8.2, Setting And Using The Minimum Depth Alarm.

Note: The minimum depth alarm may only be activated or modified in the A-Scan mode and cannot be changed while in B-Scan mode.

9.6.7 Scan Speed Alarm

When acquiring B-Scan data in one of the encoded modes, an alarm will be triggered if the scanner is moved too fast for the Epoch III to acquire and display data. The encoder's update rate is displayed on the right side of the screen when operating in the B-Scan Mode. If this value exceeds 60 updates per second, an alarm condition will be noted by an audible beep along with the flashing of the update rate. Encoded Distance Traveled (DT) data will be kept in sync with the scanner, but no data will be drawn on the screen. The Bi-Directional Mode allows the scanner to be moved in the opposite direction at a slower speed to redraw these thickness values.

Note: The greater the resolution desired, the slower the scanner can be moved to avoid missing data points. The resolution can be adjusted in the B-Scan setup screen.

9.6.8 Floating Gate

The Floating Gate option is used to track the peak echo amplitude at either the -6dB or -12dB point of the echo. By utilizing the floating gate, it will provide a more consistent and accurate thickness reading particularly when using the edge depth mode.

This feature can be used in either peak depth or edge depth modes. In edge depth mode, the floating gate will track the highest amplitude echo breaking the gate, but will take the measurement from the left most echo breaking the gate.

When Gate Level is selected the following prompt will be displayed below the Waveform:

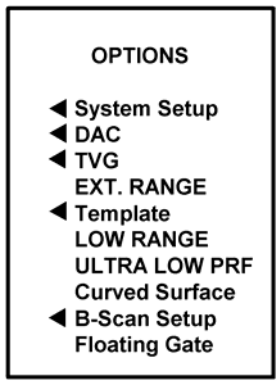
F1 = Gate 1/Gate 2 F2 = -6dB/-12dB F3 = Manual

This will allow the ability to toggle between Gate 1 and Gate 2 selection, -6 and -12dB selection, and standard manual gate level mode in either A-Scan mode or while viewing the A-Scan from B-Scan mode.

Note: While viewing the A-Scan from B-Scan mode, activating the Floating Gate will cause the above Floating Gate prompt to be displayed. To return back to the B-Scan screen, pressing **[ITEM SELECT]** will cause the following B-Scan prompt to return to the screen:

F1 = START, F2 = B-SCAN, F3 = NEWSCAN

In the Options screen, a box will indicate the Floating Gate is available as shown below:



The Floating Gate option is available on both Gate 1 and Gate 2.

In the split screen mode, under the Gate Level parameter, the display will read either -6dB, -12dB, or the current gate level (in manual mode). When the calibration is saved while in Floating Gate to monitor for sever wall loss.

9.6.9 Echo to Echo Detection

Future development.

9.6.10 Saving B-Scan Data

With the addition of the Epoch III internal memory board supplied with the B-Scan option, it is possible to store up to 200,000 B-Scan data points. The only restriction is the maximum size of the active memory buffer (Refer to Section 9.6.5). Therefore, not all 200,000 readings can be collected at one time. Instead, individual files of up to 60,000 readings can be created.

Storing the B-Scan data is similar to creating standard files in the Epoch III Database. Refer to Section 8 for specific Datalogger and Data communications features.

To store a file, you must first select the file you wish to store the data in. Press **[2nd F]**, **[DISPLAY/STATUS]**, to enter the memory screen. Use the and slewing keys to select an existing or new file. Return to the B-Scan display by pressing **[DISPLAY/STATUS]**. Press the **[ID]** key and enter an appropriate identifier. B-Scans can be saved in the Start or Stop Mode. To save the entire collected B-Scan currently occupying the memory buffer, press **[2nd F]**, **[SAVE]**. To store a single screen of the B-Scan data which is currently being viewed, press **[SAVE]**.

In addition, it is also possible to store an associated A-Scan while in B-Scan mode for verification of data. While viewing the A-Scan, simply press **[2nd F]**, **[SAVE]** and the A-Scan will be stored.

9.6.11 Viewing and Recalling Stored B-Scans

Stored B-Scans along with corresponding setup parameters can be viewed in the memory screen. If more than 200 readings have been collected and saved, the Epoch III will display a compressed image of the entire scan in the memory screen. This data will automatically be uncompressed when the data is recalled to the live screen. Use the and slewing keys to move the marker along the scan and review thickness values. If the scan was done in an encoded mode, relative Distance Traveled (DT) values will correlate to the thickness measurements.

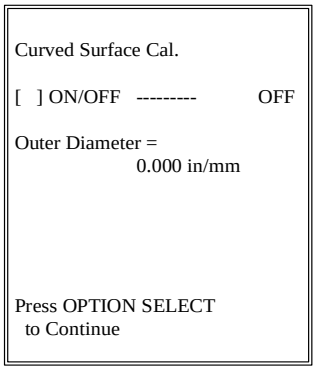
Press **[F1]** to re-start the scan at the cursor's last position when the scan was saved.

Note: It is not advised to re-start a B-scan that was saved as a single screen shot. However, it is possible to use the and slewing keys to move the marker along the scan to review depth and distance traveled.

9.7 Curved Surface Correction Option

The Curved Surface Correction (CSC) option for the Epoch III is used to provide accurate sound path values when inspecting curved surfaces such as pipes. After an operator enters the pipe diameter and thickness, soundpath information will be adjusted accordingly when using an angle beam probe to inspect circumferentially around the curved surface.

1. Press **[OPTION SELECT]**. Using the and slewing keys, highlight "Curved Surface" from the menu and press **[ITEM SELECT]**. The following box will appear:



2. Press **[ITEM SELECT]** to activate CSC. An "X" will appear in the box to signify the option is active. A cursor will appear over the Outer Diameter value. Use the and slewing keys to enter the desired diameter. Press **[OPTION SELECT]** to return to the live A-Scan. A "CSC" prompt will be displayed above the A-Scan whenever the Epoch III is in Curved Surface Correction Mode.

3. Calibrate the Epoch III and be sure to enter the appropriate shear wave angle. Correct soundpath information will be displayed when an echo breaks a gate.

Note: The CSC option is linked to the Epoch III memory. If a calibration or Waveform is saved in CSC mode, the Epoch III will be in CSC mode when the that data set is recalled. A "c" will also be displayed in the memory screen after the ID to signify the calibration or Waveform was saved in CSC mode.

To exit CSC mode, press **[OPTION SELECT]** and then highlight "Curved Surface". Press **[ITEM SELECT]** to bring up the CSC setup menu. Press **[ITEM SELECT]** to disable the option and remove the "X" from the box. Press **[OPTION SELECT]** to return to the live A-Scan.

9.8 DGS Option

The DGS option for the Epoch III is a flaw sizing technique that evaluates echo signals using a DGS Diagram. The DGS Diagram consists of a set of known curves based on a reference reflector's echo pattern on a standardized calibration block. The diagram plots reflector echo amplitude versus the reflector's relative size/distance from the transducer. Various amplitude corrections are made to the DGS curve, taking into account slight differences in probes, test material, surface smoothness, etc. These corrections, along with Registration and Warning levels selected by the operator, are then used to draw a valid DGS curve on the EPOCH III screen.

The DGS option for the EPOCH III consists of software programmed into the actual unit, along with a Windows based Calibration Interface Program. Probe calibrations are set up utilizing the Interface Program and then downloaded to the EPOCH III. Installation of the Interface Program and operating instructions for the DGS option are outlined in this manual.

The following items are necessary for utilizing the DGS option for the EPOCH III:

- EPOCH III unit programmed with the DGS software option
- Windows based EPOCH III DGS Calibration Interface Program
- 9-Pin to 9-Pin RS-232 serial communication cable
- Calibration test block with test data specifications
- Appropriate transducer and transducer cable suitable for DGS method

9.8.1 Installing the DGS Calibration Interface Program on a PC

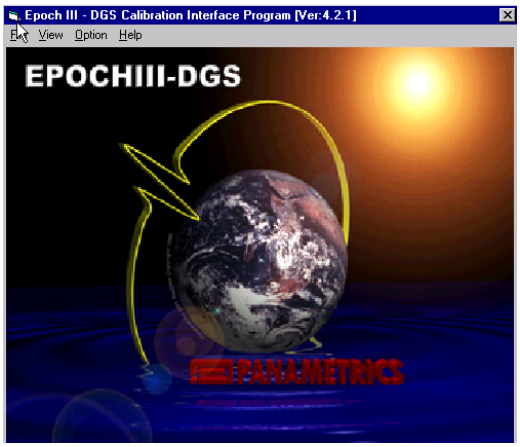
The DGS Interface is compatible with Windows 95, Windows 98, and Windows NT. To install the Interface Program onto a computer's hard drive:

1. Enter Windows.
2. Install the DGS Interface CD-ROM into the CD-ROM drive of the computer.

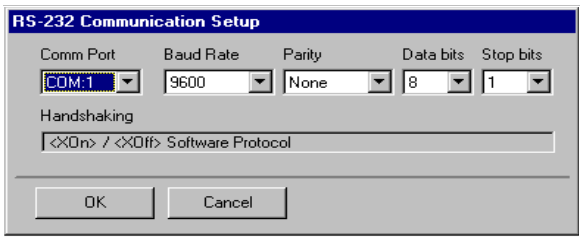
3. Click on “START” at the bottom left corner of the computer screen.
4. Select “RUN”.
5. Type: D:\Setup.exe and click **[OK]**. (Note: individual CD-ROM drive directory names may vary.)
6. Follow instructions that appear on the screen to complete the installation process.
7. Remove the CD-ROM and store it in a safe place as a backup.

9.8.2 RS-232 Communication

The communication protocols in the Interface Program must be setup to allow a transfer of data back and forth to the EPOCH III. Open the DGS Interface Program by clicking on **[START]** and then **[EPOCH III - DGS Calibration IP]**. The following screen will appear:



Select **FILE** from the menu bar and click on **RS-232 Setup**. The first time you enter this screen the program defaults will be selected. The setting for the Baud Rate, Parity, Data Bits, and Stop Bits should already match the EPOCH III settings. The Comm Port number may have to be adjusted to match the PC. Once you select **[OK]** the setup will be saved for future communications.



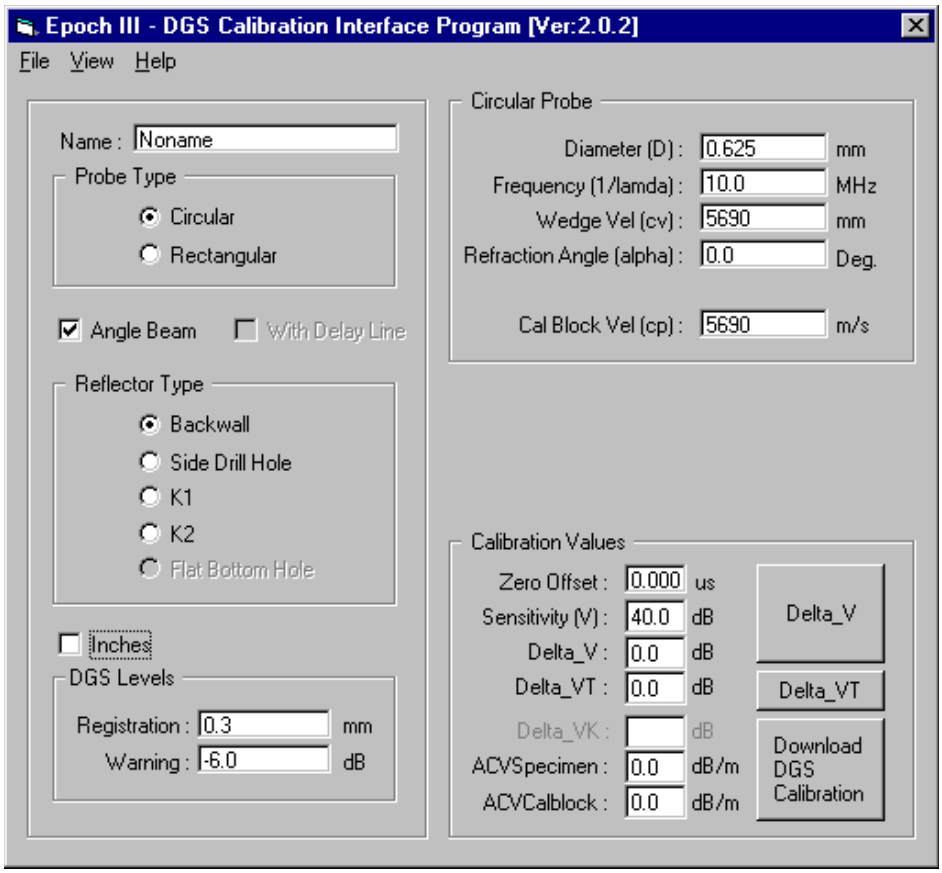
9.8.2.1 Setting Initial EPOCH III Parameters

- Turn on the EPOCH III and go to the live screen
- Set ANGLE to zero (0)

- Select PEAK MODE
- Turn off all other options (DAC, TVG, etc.)

9.8.3 Creating a New DGS Calibration in the Interface Program

From the main screen of the Interface Program select **FILE** from the menu bar and click on **NEW**. A calibration setup screen will appear similar to the one shown below.



9.8.3.1 Entering Probe Characteristics

Enter appropriate data in the spaces allotted to satisfy the probe characteristic requirements.

1. Under the “Name:” heading enter an appropriate file name (up to eight [8] characters).
2. Select either “Circular” or “Rectangular” Probe Type depending on the transducer being used for calibration.
3. Select “Angle Beam” if using an angle beam probe or “With Delay Line” if using a delay line probe for calibration.

4. The Interface Program defaults to metrics units. Select “inches” to display all settings in English units. This setting should match the EPOCH III displayed measurement units.

5. Enter the following probe characteristics under the “Circular Probe” or “Rectangular Probe” heading depending on the type of probe previously selected.

   For a Circular Probe:

   - Diameter = Diameter of transducer as labeled
   - Frequency = Frequency of transducer as labeled
   - Wedge Vel = Acoustic Wedge Velocity (enter value if “With Delay Line” or “Angle Beam” is selected)
   - Refraction Angle = Sound Refraction Angle in material (enter value if “Angle Beam” is selected)
   - Cal Block Vel = Acoustic Calibration Block Velocity

   For a Rectangular Probe:

   - Side A = The smaller length of the actual crystal. The software will compute the effective length automatically.
   - Side B = The larger length of the actual crystal. The software will compute the effective length automatically.
   - Frequency = Frequency of transducer as labeled
   - Wedge Vel = Acoustic Wedge Velocity (enter value if “With Delay Line” or “Angle Beam” is selected)
   - Refraction Angle = Acoustic Refraction Angle in material (enter value if “Angle Beam” is selected)
   - Cal Block Vel = Acoustic Calibration Block Velocity

9.8.3.2 Entering Registration and Warning Levels

Enter a Registration Level under the “Registration:” heading. This level is the operator selected critical flaw size diameter in millimeters or inches.

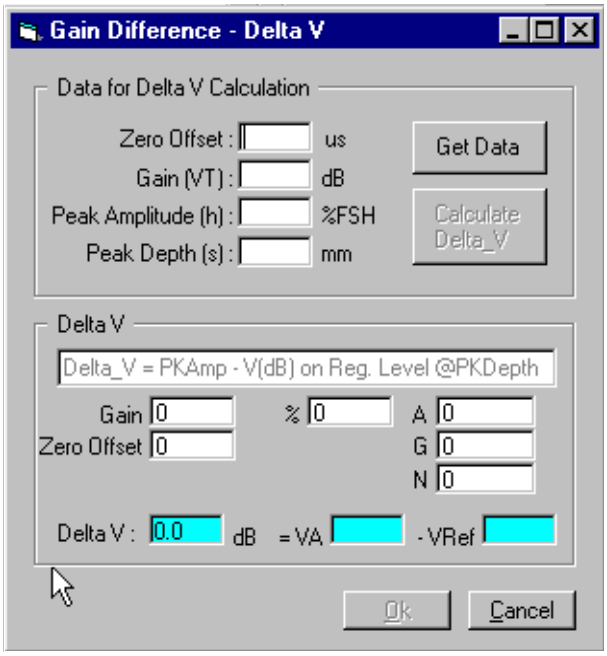
Enter a Warning Level under the “Warning:” heading. This level is always a negative value in decibels (dB). The value represents the decibel level below the Registration Level curve where the Warning Level curve will be drawn on the EPOCH III screen.

Entering Calibration Values (Delta_V): Delta_V is a gain correction value. This value is the gain difference between the measured value (off the calibration block) and the theoretical DGS curve drawn only on transducer parameters. Follow the procedure below to calculate Delta_V:

1. Couple Probe to calibration block. Use a large enough range to display the backwall echo from the backwall/hole reflector.

2. Position GATE 1 so that it is over the reflector echo.

3. Adjust the instrument Gain so that the signal is between 80-90% full screen height.
4. Click on the **[Delta_V]** icon in the Interface Program. The following screen will appear:



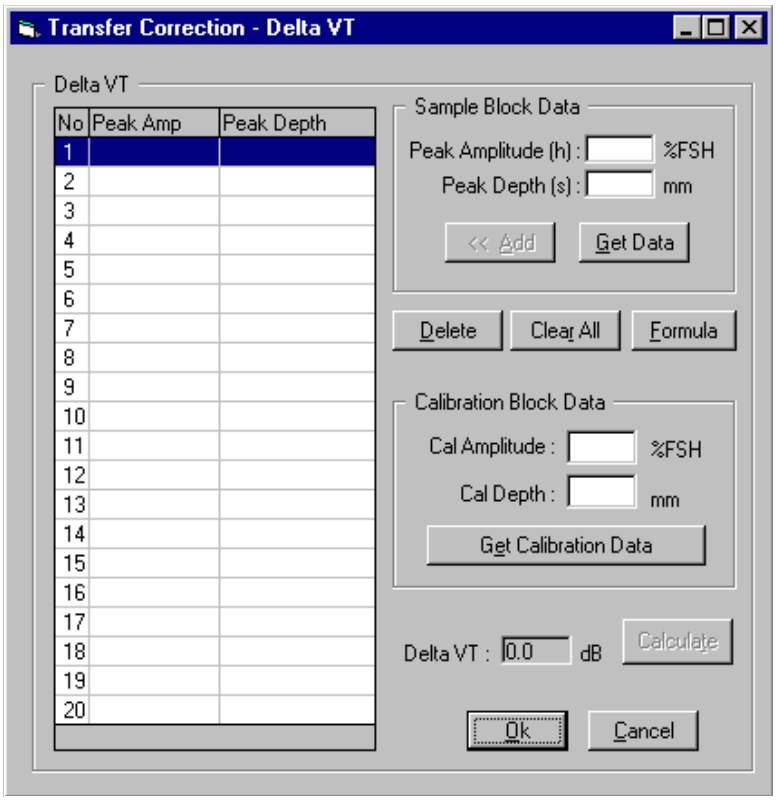
5. Click on the **[Get Data]** icon. The EPOCH III's current Zero Offset, Gain, Peak Amplitude, and Peak Depth will be transferred to the Interface Program and displayed in the appropriate spaces.
6. Click on the **[Calculate Delta_V]** icon to calculate Delta_V.
7. Click **[OK]** to return to the main screen where the calculated Delta_V figure will be displayed.

Entering Calibration Values (Delta_VT): Delta_VT is another gain correction value, that shows the gain difference of the reflector echo between the calibration block and test sample. The procedure to calculate Delta_VT is a 2-step process involving coupling to both the calibration block and then the actual test sample. The procedure is outlined below:

Step 1 - Calibration Block Data

1. Couple Probe to calibration block. Use a large enough range to display the backwall echo from the backwall/hole reflector.
2. Position GATE 1 so that it is over the reflector echo.
3. Move the transducer back and forth along the block until the signal peaks. The EPOCH III's "Peak Memory" feature will aid in this step.
4. Adjust the instrument Gain so that the signal is between 80-90% full screen height.

5. Click on the “Delta_VT” icon in the Interface Program. The following screen will appear:



6. Click on the **[Get Calibration Data]** icon. The EPOCH III’s current Amplitude and Depth will be transferred to the Interface Program and displayed in the appropriate spaces.

Step 2 - Sample Block Data

1. Couple Probe to the actual test sample. Use a large enough range to display the backwall echo from the backwall/hole reflector.
2. Position GATE 1 so that it is over the reflector echo.
3. Move the transducer back and forth along the block until the signal peaks.
4. Adjust instrument Gain so that the signal is between 80-90% full screen height.
5. Click on the **[Get Data]** icon. The EPOCH III’s current Peak Amplitude and Peak Depth will be transferred to the Interface Program and displayed in the appropriate spaces. Click the **[Add]** icon to add these values to the Delta_VT list. Alternate back and forth by clicking **[Get Data]** and **[Add]** to record a total of 20 readings in the Delta_VT list. The **[Delete]** and **[Clear All]** icons can be used should a mistake be made.

6. It is necessary to take 20 readings during this step to take into account slight variances in figures due to coupling pressure, etc. The Interface Program will then average the readings to produce the final Delta_VT value.
7. After 20 readings are recorded, click on **[Calculate]** to display the Delta_VT value. If less than 20 values have been recorded, a message will prompt the user to either accept the total number recorded or cancel to conduct more readings. The program will average how ever many values have been recorded.
8. Click **[OK]** to return to the main screen where the calculated Delta_VT figure will be displayed.

9.8.3.3 Entering Calibration Values (Delta_VK)

Delta_VK is the calibration block correction value. The value is the gain difference between a flat reflector and a curved reflector. A gain loss from a flat reflector to a curved reflector is entered as a positive value. If the operator is using a K1 or K2 type calibration block, it is necessary to enter a Delta_VK value. This value is usually obtained from the calibration block manufacturer. Refer to the block's specification sheets or the manufacturer for this information. Enter the value in the space provided in the Interface Program.

9.8.3.4 Entering Calibration Values (ACVSpecimen)

ACVSpecimen refers to the "Attenuation Correction Value in the Test Specimen (sample)". This value represents the loss in dB/length due to attenuation in the specimen and is usually obtained from a chart. Refer to the block's specification sheet or the manufacturer for this information. Enter the value in the space provided in the Interface Program.

9.8.3.5 Entering Calibration Values (ACVCalblock)

ACVCalblock refers to the "Attenuation Correction Value in the Calibration Block". The value shows the loss in dB/meter due to attenuation in the calibration block and is typically obtained from a chart. Refer to the block's specification sheet or the manufacturer for this information. Enter the value in the space provided in the Interface Program.

9.8.4 DGS BI-Directional Functions

9.8.4.1 Downloading a DGS Calibration from the PC to the EPOCH III

After completing the procedure outlined in Section 4.1 – Creating a New DGS Calibration in the Interface Program, the calibration can be downloaded to the EPOCH III to draw the valid DGS curve.

Confirm that the Interface Program communication parameters have been properly set as outlined in Section 3.1.

1. Click on the **[Download DGS Calibration]** icon.

2. Click on the **[Send]** icon to initiate the download. The calibration will be transferred to the EPOCH III and the valid DGS curve will be displayed on the screen.
3. Click **[OK]** after the download is complete.

9.8.4.2 Utilizing DGS Curves in the EPOCH III

After a DGS calibration is downloaded to the EPOCH III, the valid DGS curve will be drawn on the screen. It may be necessary to adjust the range to see the curve. Some functions are locked when the DGS option is activated. The following keys and second function keys and are active when the DGS option is on:

[ON/OFF]	[GATE START]
(2) Slewing Keys	[GATE WIDTH]
[REF]	[GATE LEVEL]
[RANGE]	[SAVE]
[ITEM SELECT]	[WAVE]
[FREEZE]	[ALARM]
[2nd F]	[MEMORY]
[GATE 2]	[PRINT/SEND]
[DISPLAY/STATUS]	

** All Datalogger Keys are also active*

A sample EPOCH III screen with a DGS curve is shown in Figure 9.7 below.

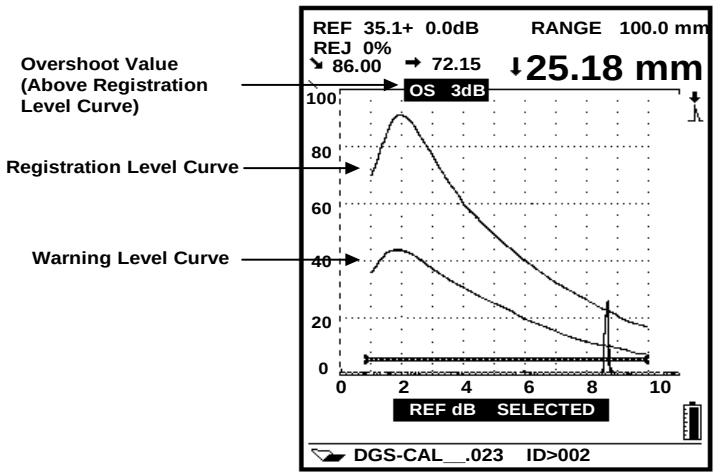


Figure 9.7: DGS Curve

The top curve is the “Registration Level Curve” that is produced from the Registration Value and other information entered in the EPOCH III DGS Interface Program. The curve

below is the “Warning Level Curve”. The Warning Level Curve is lower by the dB value that is also entered in the DGS Interface Program.

The “OS” value is the “Overshoot” value above the Registration Level Curve. This curve lists the dB value that the echo exceeds the Registration Level Curve. This area will remain blank when no echo is above the Registration Level Curve.

Important: It is necessary to position Gate 1 so that it covers the entire region of the DGS curves. Only an echo in the Gate 1 region will provide an Overshoot Value and flaw location information. (The echo does not necessary have to break Gate 1, but must simply be in the region.)

9.8.4.3 Saving and Recalling DGS Curves in the EPOCH III

Saving a DGS calibration and curve in the EPOCH III Datalogger is done the same way as a normal A-Scan. Simply press **[2nd F]**, **[SAVE]** to save the calibration complete with all DGS parameters downloaded from the Interface Program.

Recalling a DGS calibration and curve from the EPOCH III Datalogger is also done the same way as a normal A-Scan.

1. Press **[2nd F]**, **[MEMORY]** to enter the memory screen.
2. Use the slewing keys to select a directory at the bottom of the screen.
3. Press **[ITEM SELECT]** to enter the directory.
4. Use the slewing keys to scroll down and view the contents of the directory.
5. To recall a calibration, scroll so that the A-Scan is visible on the screen, then press **[F3]**. The DGS calibration and curve will be recalled to the live screen.

The DGS Parameter Setup will also be shown for operator verification (See Figure 5.2). These parameters can also be modified at this point. For example, in Figure 5.2, the Registration Level may be changed from 1.00mm to 2.00mm. This process is accomplished by using the **[ITEM SELECT]** key to select the desired parameter, then using the slewing keys to change the value. Press **[F1]** when done to recall the calibration.

Note: See Section 8 of the EPOCH III operating manual for more information on Datalogger Functions.

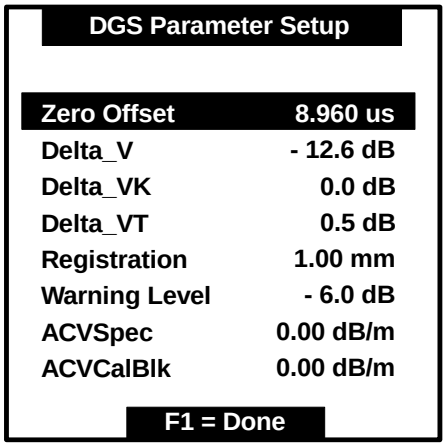
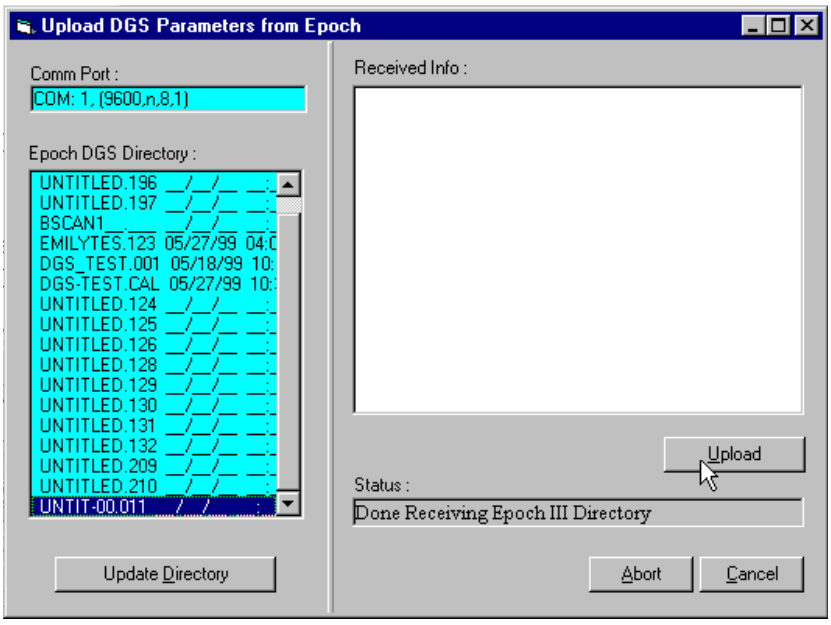


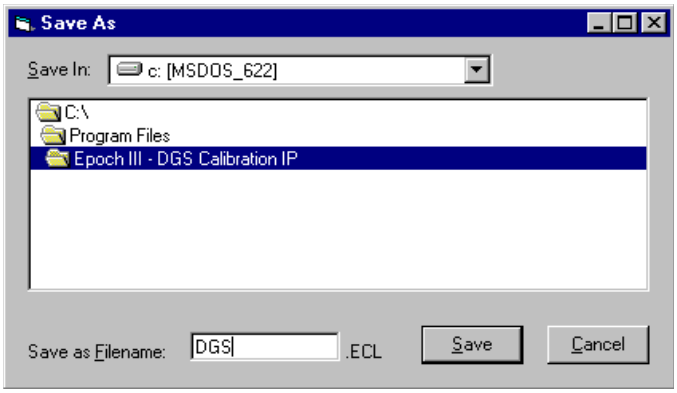
Figure 9.8: DGS Parameter Setup Screen Upon Recall

9.8.4.4 Uploading and Saving a DGS Calibration Curve from the EPOCH III to the PC

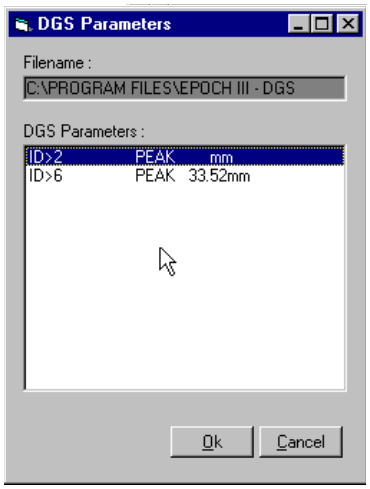
Open the EPOCH III DGS Interface Program. Click on **File** then **Upload From EPOCH**. The following screen will be displayed:



Click on the directory you wish to upload, then click on the **[Upload]** icon. After the transfer of information, the user will be prompted to enter a filename to save the data. Enter a filename up to eight (8) characters, then click **[Save]**.



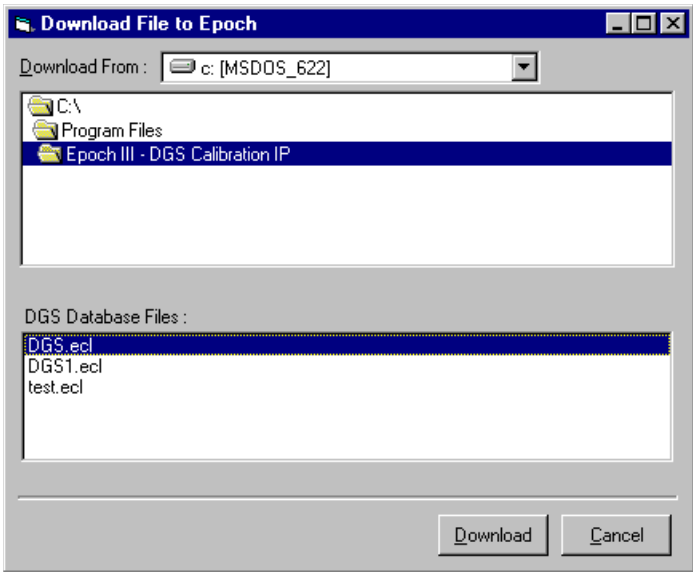
9.8.4.5 Opening a DGS Calibration in the Interface Program



A calibration can be opened in the Interface Program after it is uploaded from the EPOCH III. The DGS curve is not visible, but the DGS parameters can be verified or adjusted as necessary. Click **File**, then **Open**. Select the file to be opened, then click **[OK]**. If multiple IDs have been saved in the file, a prompt box will be displayed asking the user to select the appropriate ID to open.

9.8.4.6 Downloading a Saved DGS Calibration from the Interface Program to the EPOCH III

Open the EPOCH III DGS Interface Program. Click on **File**, then **Download to EPOCH**. The following screen will be displayed:



Select the DGS file to download, then click on the **[Download]** icon. Click **[OK]** after the download is complete.

9.8.4.7 Turning Off the DGS Option

1. Press the **[Option Select]** key.
2. Use to slewing keys to highlight the DGS option.
3. Press **[Item Select]**.
4. Use the slewing keys to highlight the OFF option.
5. Press the **[Item Select]** key, and then **[Option Select]** to exit.

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10 SPECIFICATIONS

DISPLAY	256 column by 320 row flat panel electroluminescent display with large thickness/soundpath display. “Split-screen” allows simultaneous viewing of Waveform and setup data. Selectable “filled” or outline Waveform trace.
GRATICULE	Electronically generated 2.625" x 2.375" (67 x 60mm). No parallax error. No changes in brightness due to repetition rate changes.
DISPLAY UPDATE RATE	Minimum 60Hz under all test conditions.
SENSITIVITY	100.0dB max. and reference level sensitivity feature with 6dB or 0.1dB selectable resolution.
SELF CALIBRATION	Continuous, automatic self-calibration compensates pulse amplitude and receiver sensitivity for temperature and aging effects.
REJECT	Absolutely linear from 0% to 80% full scale in 1% increments.
UNITS	English or Metric.
MATERIAL VELOCITY	0.025 to 0.6000 in/μSec (635 to 15240 m/S). Switchable between two stored velocity settings.
ZERO OFFSET	0 to 350μSec.
RANGE	0.038 - 200 in (1 - 5000mm) standard range at the velocity of longitudinal waves in steel. Extended range option of 400 in (10,000mm); 10 fixed settings and continuously variable.
DISTANCE READOUT	Provides single echo or echo-to-echo thickness readings (in large numerals) or soundpath, surface and depth display for angle beam testing. Measures to either peak or leading edge of gated signal.
REFRACTED ANGLE	Fixed settings of 0^o, 30^o, 45^o, 60^o, 70^o, or variable from 10^o to 85^o in. 0.1^o resolution.
GATE START	Variable over entire displayed range.

GATE WIDTH	Variable from Gate Start position to the maximum displayed range.
GATE LEVEL	“Off” or “On” with level adjustable from 2% to 95% of full screen in both rectified and RF display modes.
ZOOM	Expands gated portion of display to full graticule width.
PEAK MEMORY	Accumulates and holds peak of A-Scan with live Waveform.
SCREEN FREEZE	Freezes and holds Waveform and soundpath display.
PULSER TYPE	Shock excitation type. Amplitude of 100V, 200V, and 400V (± 5% Max.)
PULSE ENERGY	Selectable: Low, Medium, or High.
DAMPING	Selectable settings of 50, 150, or 400 ohms.
RECTIFICATION	Full wave, half wave positive or negative, and unrectified RF settings.
ANALOG BANDWIDTH	Broadband, 0.4 - 17.5MHz at -6dB.
FILTER	Selectable: Standard (0.4 - 16.5MHz) at -6dB or High Pass (1.4MHz - 17.5MHz) at -6dB
TEST MODES	Pulse Echo, Dual, or Through Transmission.
ALARMS	Selectable threshold positive/negative or minimum depth modes.
MEMORY	Storage of up to 130 Waveforms with calibration data or 3,000 thickness readings with alphanumeric identifiers.
IDENTIFIERS	8 character alphanumeric file names and 16 character alphanumeric location codes. Memo Mode allows entry of comments.
OPERATING TEMPERATURE	-25^{o}C to 70^{o}C.
STORAGE TEMPERATURE	With Battery -20^{o}C to 50^{o}C.Without Battery -65^{o}C to 85^{o}C.
POWER REQUIREMENTS	AC Mains; 85-264VAC, 47-66Hz, 30W max.

BATTERY	Lead-lead dioxide.
BATTERY OPERATING TIME	8 hrs. with 12V tray or 12V belt-mount pack, 4 hrs. with 6V tray (typical @25^{o}C).
BATTERY STATUS	Continuously displayed, low battery warning display when battery life falls below a half hour.
TRANSDUCER CABLE CONNECTORS	BNC or Number 1 Lemo.
KEYPAD	English or International Symbols.
LANGUAGES	English, French, German, selectable by keypad. Other languages may be available.
RS-232C COMMUNICATIONS PORT	Serial communications port allows interfacing with IBM compatible computers and Epson FX 80 compatible dot matrix printers.
HIGH SPEED DATA PORT	Provides parallel interface with printers.
DIMENSIONS	Length: 11.4" (289mm) Width: 6.1" (156mm) at keypad, 7" (177mm) at display Depth: Min 1.9" (48mm) at keypad with belt-mount battery, Max 3.8" (95mm) at display and 12V battery tray
WEIGHT	With 12V belt-mount battery: 2.6 lbs (1.2 Kg) With 6V battery tray: 4.9 lbs (2.2 Kg) With 12V battery tray: 6.3 lbs. (2.9Kg)

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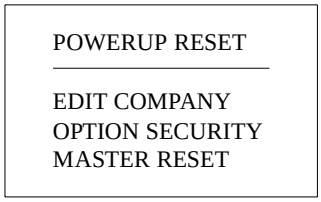
APPENDIX I–INSTRUMENT RESETS

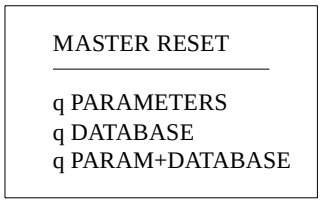
It is sometimes desirable to reset the EPOCH III's parameters or Database to factory default settings. This accomplished in the following manner.

MANUAL RESET

To perform a reset, turn the EPOCH III off. Press and hold the **[MEMO]** key and turn the EPOCH III back on. Once the display is illuminated, you may stop pressing the **[MEMO]** key. The following menu will appear:



Use the ◄► and ◄► slewing keys to position the highlight bar over the MASTER RESET selection and press **[ITEM SELECT]**. The Master Reset Menu will appear as shown below:



To reset only the EPOCH III's parameters, choose "Parameter" reset by positioning the highlight bar over the selection and pressing **[ITEM SELECT]**. Press **[OPTION SELECT]** to carry out the reset.

To reset only the EPOCH III's Database and power-up screen information, choose "Database" reset by positioning the highlight bar over the selection and pressing **[ITEM SELECT]**. Press **[OPTION SELECT]** to carry out the reset. **WARNING: CARRYING OUT A DATABASE RESET WILL ERASE ALL STORED DATA.**

To simultaneously reset both the EPOCH III's parameters and Database, choose "Param + Database" reset by positioning the highlight bar over the selection and pressing **[ITEM SELECT]**. Press **[OPTION SELECT]** to carry out the reset.

Note: To deselect an item and avoid doing the corresponding reset, press **[ITEM SELECT]** a second time. To exit the Master Reset menu

without carrying out any resets, make sure that none of the menu items are selected, and press **[OPTION SELECT]**.

AUTOMATIC RESETS

During the initial self-test routine, the EPOCH III checks the integrity of both the instrument set-up parameters as well as the Database. If either has been corrupted, the Master Reset menu automatically appears. The portion of the instrument that must be reset will automatically be highlighted and cannot be deselected. If desired, it is also possible to reset the other portion of the instrument code by making the appropriate selection and pressing the **[OPTION SELECT]** key.

APPENDIX II–SPARE PARTS LIST

The following list contains recommended spare parts for your EPOCH III. These are not necessarily items which are subject to failure, but you may want to stock a few of these items (such as batteries) to minimize down-time.

PART NUMBER	DESCRIPTION
23BAT-12	8 hour battery pack, 12 Volt, lead-lead dioxide (gel type) batteries. (This item may be included with the purchase of the EPOCH III.)
23BAT-6	4 hour battery pack, 6 Volt, lead-lead dioxide (gel type) batteries. (This item may be included with the purchase of the EPOCH III.)
23BAT-12E	8 hour external battery pack, 12 Volt, lead-lead dioxide (gel type) batteries. (This item may be included with the purchase of the EPOCH III.) Including: - 23BAT - 12AUX battery - Protective pouch and coil cord assembly - 23UB utility belt
23BAT-12AUX	Replacement battery for 8 hour external battery pack, 12 Volt, lead-lead dioxide (gel type) batteries.
23CAM	Multi-rate charger adapter for EPOCH III (90-260VAC, RMS, 0.8 A max, 47-63Hz). (This item is included with the purchase of an EPOCH III.) If ordering as a replacement, please specify power cord type.
23SS	Replacement sunshade for EPOCH III. (This item is included with the purchase of an EPOCH III.)
23PS	Pipe stand for EPOCH III.
23UB	Utility belt, web belt with metal eyelets for carrying 23BAT-12E, external battery pack.
23SC	Heavy duty, hard shell shipping case for EPOCH III.
21PR	Portable printer, Saki, with 120V charger/adapter; includes 21C/25MPR-6 interface cable.
21PRE	Portable printer, Seiko, with 240V charger/adapter; includes 21C/25MPR-6 interface cable.
21PP	Thermal printer paper for Seiko printers, 21PR and 21PRE (box of 5 rolls).
21C/25MPR-6	Printer cable - EPOCH II, IIB, III, or IIIB to 21PR or 21PRE Seiko Printer.

PART NUMBER	DESCRIPTION
21C/9FAT-6	Interface cable to AT-type PC, 6 feet, 9 pin female connector for EPOCH II, IIB, III, IIIB.
23MAN	EPOCH III operating manual
23IP	EPOCH III Windows-based, computer interface program includes 3-1/2" disks and manual.
23CAL-NIST	Calibration data report for EPOCH III, traceable to National Institute of Standards and Technology (NIST). Includes horizontal linearity data and detailed vertical linearity data. (This item included with purchase of EPOCH III.)
P65CAL-ASTM	Certification of horizontal and vertical linearity according to ASTM E-317
23K8000	Distance Amplitude Correction Curve Option with DAC alarm software
23K4000	Time Varied Gain Option
23K1000	Extended Range Option
23K200	Report Template Option
23K20	Ultra Low PRF Option
23PCC	Soft Protective Carrying Pouch

APPENDIX III–RS-232

REMOTE CONTROL

The instrument can be remotely controlled via the RS-232 communication interface. The instrument can be fully controlled in remote mode. The only parameters that cannot be altered remotely are changing the RS-232 communication parameters.

This section describes the basic functionality of RS-232 along with the description and examples.

PROGRAM MESSAGE FORM

The instrument is controlled remotely with program messages which consist of one or several commands, separated by semicolons < ; > and ended by a terminator:

<command/query>; . . . . .;<command/query> <terminator>

The instrument decodes the incoming program message after receiving a terminator. Upper and/or lower case characters can be used for program messages. The commands are processed in the order in which they are transmitted.

Examples

VEL 0.2332 in/us; ANGLE 45.0 Degrees; RANGE?

This program message consists of two commands, followed by a query. The terminator is not shown since it is usually added by the interface driver routine which writes to RS-232. The commands instructs the instrument to set the Velocity value to @0.2332 in/us, set the Angle value to 45.0 degrees, and then query for the Range value.

COMMAND/QUERYFORM

Command and query consists of header <header> which is either followed by one or more parameters <data> separated by space or query question mark <?> :

<header> <SP> <data> <SP> <data>

or

<header> < ? >

Where <SP> is space character. (ASCII space character, decimal value 32).

Example	VEL 0.2332 in/µs	This command instructs the instrument to set the velocity value to 0.2332 in units in/µs. Again the terminator is not shown.
	RANGE?	This command queries the instrument for the Range value. Again the terminator is not shown.

HEADER

The header contains the mnemonic of the function to be selected for changing the value or query the function. All the command/query headers have a long form for easy and short form for better transfer speed. Both the forms can be used interchangeably.

Example	RANGE? or RE?	This long form of Range and the short from of Range (RE) are fully equivalent. The terminator is not shown.

DATA

Command/query is followed by the data value. All the data values are ASCII characters. ASCII data can have upper and lower case Characters, Numeric, String, Block Data or Symbols.

Character Data

Character data are words for the indication of the specific action.

PULSER LOW	The character data value is “LOW” indicates the instrument to select the PULSER value to be LOW.

Numeric Data

The numeric data can be entered as integers or fractions. Exponential representation is not supported.

VEL 0.2332 in/us	The numeric data value is “0.2332” indicating the instrument to set the VELOCITY value to 0.2332 in/us. Note: the second data “in/us” is the character data value.

REJ 10 % The numeric data value is “10” indicating the instrument to set the REJECT value to 10 %. Note: the second data “%” is the character data value.

String Data

The string data enables the transfer of a string of characters as a single parameters. The string data is enclosed between single or double quotes.

MESSAGE ‘Updating Parameters’

The string data value is ‘Updating Parameters’ and the header is MESSAGE indicating the instrument to display the message on the screen.

Block Data

The Block data are binary data value coded in hexa-decimal ASCII. The 4-bit nibbles are translated into the digits 0,...9, A,...F and transmitted as ASCII characters. They are only used for the transfer of Waveforms, DAC curves or TVG values.

RESPONSE MESSAGE FORM

The instrument send response message for each query. The format of the message is same as the program message. They can be sent back to the instrument in the form in which they are received as valid commands. The query are processed in the order in which they are transmitted to the instrument.

Response to Waveform, DAC curves or TVG values constitute a special kind of response message.

RS-232 response message, has < CR > < LF > as the terminators.

Example

VEL?	This command queries the instrument for VELOCITY value.
VEL 0.2332 in/μ	The response to the VEL? query. This response can be sent back to the instrument to set the VELOCITY value to 0.2332 in/μs. The terminators are not shown.

COMMAND TERMINATORS

The valid command terminators are as follows:

< ; > Semicolon character (ASCII semicolon character, decimal value 59).

The command terminator is used between the several commands, and ended by a message terminator.

Examples

VEL 0.2332 in/µs; ANGLE 45.0 Degrees; RANGE?

This program message consists of two commands, followed by a query. The command terminator < ; > is used to separate the commands. The message terminator is not shown since it is usually added by the interface driver routine which writes to RS-232. The commands instructs the instrument to set the Velocity value to 0.2332 in/µs, set the Angle value to 45.0 degrees, and then query for the Range value all in one message.

MESSAGE TERMINATORS

The valid message terminators are as follows:

< CR >	Carriage return character (ASCII carriage return character, decimal value 13).
< CR > < LF >	Carriage return along with the Line-feed character. (ASCII line-feed character, decimal value 10). The message terminator are added at the end of the message transmitted to the instrument from the host.

The message sent by the instrument over RS-232 are terminated by <CR > < LF >.

PIN ASSIGNMENTS

The RS-232 pin assignments are as follows for the 9-pin Male connector on the top panel:

Pin #	Description	
2	RXD	Received data to the EPOCH.
3	TXD	Transmitted data from the EPOCH.
4	DTR	Data Terminal Ready from the EPOCH. Used in hardware handshake. DTR = TRUE when the EPOCH is able to receive characters. DTR=FALSE when the EPOCH is unable to receive characters. If the software Xon/Xoff handshake is

			selected then DTR is always TRUE.
	6	DSR	Data Set Ready to the EPOCH. Used in hardware handshake. When DSR = TRUE, the EPOCH can transmit, when DSR = FALSE, transmission stops. If the software Xon/Xoff handshake is selected then DSR is ignored.
	5	GND	Signal Ground.

Note: The following pins are dedicated for *other use* on the 9-pin connector , they are not part of RS-232 connection:

1	+5 V	Supply +5 Volts.
7	SYNC IN	External Sync in signal.
8	END MEAS	End of measurement out signal.
9	ALARM	Alarm out signal.

CONFIGURATION

The RS-232 is configured as full duplex, which means that the EPOCH and the controller both can send and receive messages at the same time.

The RS-232 baud-rate, parity, character length and number of stop bits can only be changed on the EPOCH. There is no remote command to the RS-232 settings.

After Master Reset on the EPOCH, the default RS-232 setting are as follows:

Baud-rate: 9600
Character length: 8
No of Stop bits: 1
Parity: none

HANDSHAKE CONTROL

When the EPOCH input buffer becomes almost full, the EPOCH sends a handshake signal to the host telling it to stop transmitting. When the buffer has enough room to receive more characters another handshake signal will be sent.

In the Hardware handshake, DSR and DTR hardware signals are used. The DTR will go FALSE to tell the host to stop transmitting. DTR will go TRUE to tell the host to resume transmitting. The flow of characters coming from the EPOCH can be controlled by host by making the DSR go FALSE telling EPOCH to stop transmitting. DSR will go TRUE to tell the EPOCH to resume transmitting.

In the Software handshake, the <XON>/<XOFF> characters are used. The hardware signal DSR is ignored and DTR is always TRUE. The CTRL-S (or <XOFF>) character is sent from the EPOCH to tell the host to stop transmitting and the CTRL-Q (or <XON>) character is sent from the EPOCH to tell the host to resume transmitting. The flow of characters coming from the EPOCH can be controlled by the host by sending CTRL-S (or <XOFF>) to the EPOCH telling it to stop transmitting and the CTRL-Q (or <XON>) to resume transmitting.

RS-232 OPERATION

This section of the manual lists all the commands and queries recognized by the Panametrics-NDT™ Flaw Detector Model 2300.

The commands are divided into four categories on the basis of their functionality.

1) Parameters Commands: These commands are the most important commands. The operational parameters of the instrument like velocity, Range, Pulser etc. fall on this category. You can query as well as change these parameters using the commands under this group.

2) Measurement Commands: These commands can be used either to select the measurement modes like ‘peak depth, ‘edge depth’ or to query the depth and amplitude measurement readings.

3) Database Commands: You can query directory, upload or download the files, query the size of the files and do other memory related tasks using these commands. These commands always start with the characters EP (a short form of Epoch3). For example, EPDIR, EPFILE.

4) Miscellaneous Commands: All other remaining commands belong to this group. Some examples of the commands in this group include setting the beeper on, changing the display of the instrument etc.

All the commands within the group are listed in alphabetical order. Below each command it is indicated whether it denotes a command only, command and query, or query only. The description of each command starts with a explanation of the function performed by it, the syntax and where applicable, the syntax of the query, followed by short example showing typical use of the command.

COMMAND EXECUTION

The instrument decodes the incoming program message after receiving the message terminator. The commands are processed in the order in which they are received by the instrument.

COMMAND NOTATION

The following notation is used in the description of the individual commands:

< > Angular brackets enclose words that are used as placeholders. e.g: The data parameter of a command.

:= A colon followed by an equal sign separates a placeholder from the description of the type and range of values that may be used in a command instead of the placeholder.

{ } Braces enclose a list of choices from which one must be selected.

LANGUAGE SUPPORT

Each command has short as well as long form. The short form command is of two characters and should be capital letters only, where as the long form command can be of any size. The following notation is used in the description of the individual commands:

< > Angular brackets enclose words that are used as placeholders. e.g: The data parameter of a command.

:= A colon followed by an equal sign separates a placeholder from the description of the type and range of values that may be used in a command instead of the placeholder.

{ } Braces enclose a list of choices from which one must be selected.

ANGLE
Command/Query

The ANGLE command controls the refracted angle when performing angle beam inspections. The values could be between 0.0 to 85.0 degrees in 0.1 degrees increments may be specified. The most commonly used values are 0.0, 30.0, 45.0, 60.0, 70.0 degrees.

The ANGLE? query returns the current Angle value in the instrument.

Command Syntax

ANGLE <angle>
AE=<angle>

<angle> := { 0.0, ... 85.0 }

Query Syntax

ANGLE?
AE?

Response Format

ANGLE <angle>
~'~' character means degrees.

Example

The following command sets the angle value to 32.5 Degrees
ANGLE 32.5

This space is for user's notes:

DAMPING
Command/Query

The DAMPING command selects the damping value. The values of 50, 150, 400 Ohms may be specified. The 50 Ohms setting will increase the damping of the system and improve axial resolution while the higher settings (150 or 400 Ohms) decrease the damping and improve penetrating power.

The DAMPING? query command returns the current damping value in the instrument.

Command Syntax

DAMPING <damping> !
DG=<damping>

<damping> := { 50, 150, 400 }

Query Syntax

DAMPING?
DG?

Response Format

DAMPING <damping> !
'!' character

Example

The following command sets the damping value to 150 Ohms.

DAMPING 150

This space is for user's notes:

GAIN
Command/Query

The GAIN command selects the system sensitivity value. The values of 0.0 to 90.0dB in 0.1dB steps may be specified.

The GAIN? query command returns the current system sensitivity value in the instrument.

Command Syntax	GAIN <gain> dB GN= <gain> <gain> := { 0.0, ... 90.0 }
Query Syntax	GAIN? GN?
Response Format	GAIN <gain> dB
Example	The following command sets the system sensitivity to 60.5dB. GAIN 60.5dB

This space is for user's notes:

GATE 1 ALARM
Command/Query

The GATE 1 ALARM command selects the gate 1 alarm value. The values of OFF, UP, DOWN or the depth alarm value may be specified. When gate 1 alarm value is UP, the alarm is activated when an echo exceeds the threshold established by gate level. When gate 1 alarm value is DOWN, the alarm is activated when there are no echoes breaking the gate. When gate 1 alarm value is OFF, the alarm is not activated. When gate1 alarm is in depth alarm mode and the echo crossing the gate is less than the depth alarm value, the alarm is activated.

The GATE 1 ALARM? query command returns the current gate 1 alarm value in the instrument.

Command Syntax

GATE 1 ALARM <alarm> or <depthalarm>
1A=<alarm> or <depthalarm>

<alarm> := { OFF, UP, DOWN}
Note: UP is represented by the ASCII characters (0x15,0x16,0x17) Down is represented by the ASCII characters (0x18,0x19,0x1A)

<depthalarm> := { GATE1 START, ..., GATE1 START+GATE1 WIDTH}

Query Syntax

GATE 1 ALARM?
1A?

Response Format

GATE 1 ALARM <alarm> or
GATE 1ALARM <depthalarm>

Related commands

GATE 1 START, GATE 1 WIDTH, GATE 1 LEVEL

Example

The following command sets the gate 1 alarm OFF

GATE 1 ALARM OFF

The following command sets the Gate 1 start at 2.000 inches and the gate1 width at 0.500 inches before setting the depth 1 alarm to 2.250 inches.

GATE1 START 2.000 in; GATE1 WIDTH 0.500 in

GATE1 ALARM 2.250 in

GATE 2 ALARM
Command/Query

The GATE 2 ALARM command selects the gate 2 alarm value. The values of OFF, UP, DOWN or the depth alarm value may be specified. When gate 2 alarm value is UP, the alarm is activated when an echo exceeds the threshold established by gate level. When gate 2 alarm value is DOWN, the alarm is activated when there are no echoes breaking the gate. When gate 2 alarm value is OFF, the alarm is not activated. When gate2 alarm is in depth alarm mode and the echo crossing the gate is less than the depth alarm value, the alarm is activated.

The GATE 2 ALARM? query command returns the current gate 2 alarm value in the instrument.

Command Syntax

GATE 2 ALARM <alarm> or <depthalarm>
2A=<alarm> or <depthalarm>

<alarm> := { OFF, UP, DOWN}
Note: UP is represented by the ASCII characters (0x15,0x16,0x17) Down is represented by the ASCII characters (0x18,0x19,0x1A)

<depthalarm> := { GATE2 START, ..., GATE2 START+ GATE2 WIDTH}

Query Syntax

GATE 2 ALARM?

2A?

Response Format

GATE 2 ALARM <alarm> or

GATE 2ALARM <depthalarm>

Related commands

GATE 2 START, GATE 2 WIDTH, GATE 2 LEVEL

Example

The following command sets the gate 2 alarm OFF

GATE 2 ALARM OFF

The following command sets the Gate2 start at 2.000 inches and the gate2 width at 0.500 inches before setting the depth 2 alarm to 2.250 inches.

GATE2 START 2.000 in; GATE2 WIDTH 0.500 in
GATE2 ALARM 2.250 in

GATE 1 LEVEL
Command/Query

The GATE 1 LEVEL command selects the gate 1 level value. The values of some percentage of full screen height between 2 to 95% in 1% steps may be specified.

The GATE 1 LEVEL? query command returns the current gate 1 level value in the instrument.

Command Syntax	GATE 1 LEVEL <level> % 1L=<level> <level> := { 2, ..., 95 }
Query Syntax	GATE 1 LEVEL? 1L?
Response Format	GATE 1 LEVEL <level> %
Related commands	GATE 1 START, GATE 1 WIDTH, GATE 1 ALARM
Example	The following command sets the gate 1 level to 50% of full screen height. GATE 1 LEVEL 50%

This space is for user's notes:

GATE 2 LEVEL
Command/Query

The GATE 2 LEVEL command selects the gate 2 level value. The values of some percentage of full screen height between 2 to 95% in 1% steps may be specified.

The GATE 2 LEVEL? query command returns the current gate 2 level value in the instrument.

Command Syntax	GATE 2 LEVEL <level> % 2L=<level> <level> := { 2, ..., 95 }
Query Syntax	GATE 2 LEVEL? 2L?
Response Format	GATE 2 LEVEL <level> %
Related commands	GATE 2 START, GATE 2 WIDTH, GATE 2 ALARM
Example	The following command sets the gate 2 level to 30% of full screen height. GATE 2 LEVEL 30%

This space is for user's notes:

GATE 1 START
Command/Query

The GATE 1 START command selects the gate 1 start value. The values from MINIMUM RANGE to MAXIMUM RANGE - GATE 1 WIDTH may be specified. The units of the values are the same as the current units of the instrument.

The GATE 1 START? query command returns the current gate 1 start value in the instrument.

Command Syntax

GATE 1 START <start>
1S=<start>

<start> := { MINIMUM RANGE, ..., MAXIMUM RANGE -
GATE 1 WIDTH }

Query Syntax

GATE 1 START?
1S?

Response Format

GATE 1 START <start>

Related commands

GATE 1 LEVEL, GATE 1 WIDTH, GATE 1 ALARM, RANGE, VELOCITY

Example

The following command sets the sound velocity to 0.2320 in/µs and gate 1 start to 2.000.

VELOCITY 0.2320 in/µs; GATE 1 START 2.000

This space is for user's notes:

GATE 2 START Command/Query

The GATE 2 START command selects the gate 2 start value. The values from GATE 1 START + 1 to MAXIMUM RANGE - GATE 2 WIDTH may be specified. The units of the values are the same as the current units of the instrument.

The GATE 2 START? query command returns the current gate 2 start value in the instrument.

Command Syntax	GATE 2 START <start> 2S=<start> <start> := { MINIMUM RANGE, ..., MAXIMUM RANGE - GATE 2 WIDTH }
Query Syntax	GATE 2 START? 2S?
Response Format	GATE 2 START <start>
Related commands	GATE 2 LEVEL, GATE 2 WIDTH, GATE 2 ALARM, RANGE, GATE 1 START, VELOCITY
Example	The following command sets the sound velocity to 0.2320 in/µs and gate 2 start to 2.000 in. VELOCITY 0.2320 in/µs; GATE 2 START 2.000

This space is for user's notes:

GATE 1 WIDTH
Command/Query

The GATE 1 WIDTH command selects the gate 1 width value. The value from 0.0 inches to MAXIMUM RANGE - GATE 1 START inches may be specified.

The GATE 1 WIDTH? query command returns the current gate 1 width value in the instrument.

Command Syntax	GATE 1 WIDTH <width> 1W=<width> <width> := { 0.0, ..., MAXIMUM RANGE - GATE 1 START }
Query Syntax	GATE 1 WIDTH? 1W?
Response Format	GATE 1 WIDTH <width>
Related commands	GATE 1 LEVEL, GATE 1 START, GATE 1 ALARM, RANGE, VELOCITY
Example	The following command sets the sound velocity to 0.2320 in/μs and gate 1 width to 2.000 in. VELOCITY 0.2320 in/μs; GATE 1 WIDTH 2.000

This space is for user's notes:

GATE 2 WIDTH
Command/Query

The GATE 2 WIDTH command selects the gate 2 width value. The value from 0.00 inches to MAXIMUM RANGE - GATE 2 START inches may be specified.

The GATE 2 WIDTH? query command returns the current gate 2 width value in the instrument.

Command Syntax	GATE 2 WIDTH <width> 2W=<width> <width> := { 0.0, ..., MAXIMUM RANGE - GATE 2 START }
Query Syntax	GATE 2 WIDTH? 2W?
Response Format	GATE 2 WIDTH <width>
Related commands	GATE 2 LEVEL, GATE 2 START, GATE 2 ALARM, RANGE, VELOCITY
Example	The following command sets the sound velocity to 0.2320 in/µs and gate 2 width to 2.000 in. VELOCITY 0.2320 in/µs; GATE 2 WIDTH 2.000

This space is for user's notes:

FILTER
Command/Query

The FILTER command is used to select high pass filter.The FILTER? query command returns the current high pass filter.

Command Syntax	FILTER<filter> FR<filter> FILTER = <filter> FR = <filter> <filter> :={STD,HP}
Query Syntax	FILTER? FR?
Response Format	FILTER <filter>
Example	Command: FILTER? Response: FILTER STD

This space is for user's notes:

MODE
Command/Query

The MODE command selects the pulser mode. The value of PULSE-ECHO, DUAL, THROUGH may be specified. The Pulse-Echo mode is used for single element transducers. The Dual mode ("pitch and catch") should be used for dual transducers. The Through transmission mode is used when two separate transducers are used on opposite sides of the test piece. In the Dual mode the instrument accounts for a two-way travel time by dividing the transit time, where as in Through mode it is not necessary.

The MODE? query returns the current pulser mode value in the instrument.

Command Syntax	PULSE-ECHO MODE DUAL MODE THROUGH MODE
Query Syntax	MODE? MD?
Response Format	PULSE-ECHO MODE DUAL MODE THROUGH MODE
Example	The following command selects the pulse-echo mode PULSE-ECHO MODE

This space is for user's notes:

PULSER
Command/Query

The PULSER command selects the pulser energy setting. The value of LOW, MED, HIGH may be specified.

The PULSER? query returns the current pulser energy value in the instrument.

Command Syntax	PULSER <pulser> PR=<pulser> <pulser> := { LOW, MED, HIGH }
Query Syntax	PULSER? PR?
Response Format	PULSER <pulser>
Example	The following command sets the pulser energy to MEDium. PULSER MED

This space is for user's notes:

RANGE
Command/Query

The RANGE command selects the range setting. The value of MINIMUM RANGE to MAXIMUM RANGE of 20.00 inches/div may be specified. Make sure the instrument is in the units you want. If the units in the instrument and command does not match, the command will return error.

The RANGE? query returns the current range value in the instrument.

Command Syntax

RANGE <range> <units> / <scale>
RE=<range> <units> / <scale>

<range> := { MINIMUM RANGE, ..., 20.00 } IN/DIV

<range> := { MINIMUM RANGE, ..., 200.0 } IN

<units> := { IN, MM }

<scale> := { DIV}

Query Syntax

RANGE?
RN?

Response Format

RANGE <range> <units> / <scale>

Example

The following command sets the range value to 1.200 in/div.

RANGE 1.200 IN / DIV

This space is for user's notes:

RECTIFY
Command/Query

The RECTIFY command selects the Waveform rectify mode. The value of HALF-WAVE+, HALFWAVE-, FULLWAVE or RF WAVEFORM may be specified. The Rectify mode is used for selection of four different display mode of the acquired data. The RECTIFY HALFWAVE+ display only the positive halfwave of the acquired Waveform. The RECTIFY HALFWAVE- will display only the negative half wave of the acquired Waveform. The RECTIFY FULLWAVE will display both the halfwave of the acquired Waveform. The RF Waveform mode displays the acquired Waveform as RF WAVE-FORM.

The RECTIFY? query returns the current rectify mode value in the instrument.

Command Syntax

FULLWAVE	RECTIFY
HALFWAVE+	RECTIFY
HALFWAVE-	RECTIFY
RF WAVEFORM	
RECTIFY?	
RY?	
FULLWAVE	RECTIFY?
HALFWAVE+	RECTIFY?
HALFWAVE-	RECTIFY?
RF WAVEFORM?	

Response Format

FULLWAVE	RECTIFY
HALFWAVE+	RECTIFY
HALFWAVE-	RECTIFY
RF WAVEFORM	

Example

The following command selects the FULLWAVE rectify display modeFULLWAVE RECTIFY
The following command selects the RF Waveform display modeRF WAVEFORM

This space is for user's notes:

REJECT
Command/Query

The REJECT command selects the reject level. The value of 0 to 80 % of full scale with 1% resolution may be specified. The reject is completely linear. The reject level eliminate unwanted low-level signals from the display.

The REJECT? query returns the current reject value in the instrument.

Command Syntax

REJECT <reject> %
RT=<reject> %

<reject> := { 0, ..., 80 }

Query Syntax

REJECT?
RT?

Response Format

REJECT <reject> %

Example

The following command sets the reject value to 10 %

REJECT 10 %

This space is for user's notes:

REFerence
Command/Query

The REFerence command selects the system sensitivity to establish a reference gain level. The values of 0.0 to 90.0dB in 0.1dB steps may be specified. Note: The resulting sensitivity will be the GAIN + REFerence level.

The REF? query command returns the current system sensitivity value in the instrument as GAIN + REFerence level.

Command Syntax

REF <gain> +<reference>dB
RG=<gain> + <reference>

<gain> := { 0.0, ..., 100.0 }
<reference> := {0.0, ..., 100.0}

Note

<gain> + <reference>is always less than or equal to 100.0dB

Query Syntax

REF?
RG?

Response Format

REF <gain> +<reference>dB

Example

The following command sets the reference level to 6.0dB with Gain of 12.0dB.

REF 12.0 + 6.0dB

This space is for user's notes:

STATUS
Query

Many times instead of inquiring each status parameters like angle, range, velocity etc. individually, you may like to inquire all the status parameters at one time. That is what this STATUS command does. Note that this is only a query command.

Command Syntax

STATUS?
SS?

Response Format

REF xx.x+xx.xdB
REJECT xx%
RANGE xx.xxx in
VEL x.xxxx in/us
ZERO x.xxx us
ANGLE xx.x
THICK x.xxx in
FULLWAVE RECTIFY
PULSER LOW
DAMPING xxx !
PULSE-ECHO MODE
GATE1START xxx.xxx in
GATE1WIDTH xxx.xxxin
GATE1LEVEL xx%
GATE1ALRM <alarm>
GATE2START xxx.xxx in
GATE2WIDTH xxx.xxxin
GATE2LEVEL xx%
GATE2ALRM <alarm>

This space is for user's notes:

THICKness Command/Query

The THICKness command selects the nominal thickness value. The material thickness value is used to calculate the depth of a reflector beyond the first leg, out to four legs. The values 0.000 to 20.00 inches or 0.000 to 635.00 mm. may be specified. Make sure that the instrument is in the correct units.

The THICK? query command returns the nominal thickness value in the instrument.

Command Syntax	THICK <thickness> TS=<thickness>
Query Syntax	THICK? TS?
Response Format	THICK <thickness>
Example	The following command sets the nominal thickness value to 1.000 inches. THICK 1.000

This space is for user's notes:

VELocity
Command/Query

The VELocity command selects the sound velocity value. The values of 0.0250 to 0.6000 inches/us may be specified in steps of 0.0001 inch/us.

The VEL? query command returns the sound velocity value in the instrument.

Command Syntax

VEL <velocity>
VY=<velocity>

<velocity> := { 0.0250, ..., 0.6000 }

Query Syntax

VEL?
VY?

Response Format

VEL <velocity>
<units><units> := { in/μs, m/s }

Example

The following command sets the sound velocity to 0.2320 in/μs.

VEL 0.2320 in/μs

This space is for user's notes:

ZERO
Command/Query

The ZERO command selects the zero offset time value. The zero offset value is unique for each transducer and is determined during the calibration process. The zero offset value is used to compensate for the time delay between the firing of the initial pulse and the entry of the sound beam into the material. The values of 0.0 to 200.0 usec may be specified.

The ZERO? query command returns the zero offset value in the instrument.

Command Syntax

ZERO <zero>µs
ZR=<zero>

<zero> := { 0.000, ..., 200.0 }

Query Syntax

ZERO?
ZR?

Response Format

ZERO <zero> µs

Example

The following command sets the zero offset value to 174.2µs.

ZERO 174.2µs

This space is for user's notes:

DATABASE COMMANDS

epFILE
Command/Query

The epFile is a file operation command. With this command you can read a file, write to a new file, delete a file, select a file, create a new file, query the selected filename and recall the saved calibration and Waveform. You can also control the behavior of the command by selecting proper flags.

Note that the Epoch III allows multiple files with the same filename. When you try to access those files with this command and filename, only the first file with that name will be accessed. In order to access any file, even the files with the same filename, use the command with file index.

Command Syntax

epFILE <filename> <flags>
epFILE<file index><flags>
EL <filename> <flags>
EL<file index><flags>

<filename> := { DOS compatible filename, 8 characters before, and 3 and 3 characters after decimal point. }
<file index>:= {index number as shown in directory list in the Epoch III}

<flags> := { /r, /w, /s, /d, -a, -i, -d, -u, -m,-w, -s, -n}

where /r = READ with available choices
-a = All information is included
-i = ID information included
-d = Depth information included
-u = Units included
-m = Memo included
-w = Waveform included
-s = Status included

/w = WRITE
Write to the memory. The file packet will follow after this command. The file packet is similar to the packet obtained from ‘READ command.

/d = DELETE
Delete the given file from memory.

/s = SELECT
Select the given file in memory.

/c = CREATE
Create a new file with given filename.

/e = RECALL
-l <xxx> = Line number
-n <xxxxxxxxxxxxxxxx> = Id number with at most 16
characters\
Recall the Waveform and setup from the memory at the given line number or given id number.

Query Syntax

To Query the current filename
epFILE?
EL?

Return Format

epFILE <Filename>

Example

Suppose the name of the third file in the Epoch III is ‘untitled.104’. In order to read the file, use any of the following commands:

epFile untitled.104 /r -a
epfile 3 /r -a

See Also

epDIR, epFSIZE

This space is for user’s notes:

epDIRectory Query

This command uploads the Epoch III directory over RS232. The Directory information consists of DOS compatible filename, date and time. Each Directory string is 40 characters long. The first string of the directory listing is a header, which has the starting word ‘DIR_BEGIN followed by the size of the directory. The last string of the listing is a word ‘OK which conveys the end of the directory listing.

Command Syntax

epDIR
ER

Response Format

DIR_BEGIN <DirectorySize> <CR><LF>
FILE: xxxxxxxx.xxx xx/xx/xx xx:xx <CR><LF>
FILE: xxxxxxxx.xxx xx/xx/xx xx:xx <CR><LF>

FILE: xxxxxxxx.xxx xx/xx/xx xx:xx <CR><LF>
OK <CR><LF>

See Also

epFILE, epFSIZE

This space is used for user’s notes:

epDSIZE
Query

The epDSize command is used to inquire the size of the directory. If there is no file in the directory, the returned value will be zero.

Query Syntax	epDSIZE?
	ED?
Response Format	epDSIZE xx
See Also	epFSIZE, epFILE, epDIR

This space is used for user's notes:

epFSIZE Command

The epFSize command is used to inquire the size of the file. The maximum possible size of the file is about 128 kilo bytes. Note that the file size is returned in hex format.

Command Syntax	epFSIZE <filename> EF<filename>
Response Format	epFSIZE xxxxxxxxh
See Also	epFILE, epDIR, epDSIZE

This space is used for user's notes:

MEASUREMENT COMMANDS

Amplitude Measurement Commands

CURRENT
Command/Query

The CURRENT command selects the Amplitude Measurement mode. The 'CURRENT' refers to the "real time" amplitude of the peak signal within the gate.

The CURRENT? query command returns the current amplitude value in the instrument. The returned value is from 0% to 100%.

Command Syntax	CURRENT CT
Query Syntax	CURRENT? CT?
Response Format	CURRENT xxx%
Example	The following command sets the instrument to Amplitude Measurement mode, and queries the Current Amplitude. CURRENT;CURRENT?

This space is used for user's notes:

AMPLITUDE MAX
Command/Query

The AMPLITUDE MAX command selects the Amplitude Measurement mode. The Amplitude Max is the highest amplitude of a signal that has broken the gate threshold.

AMPLITUDE MAX? query command returns the current Maximum Amplitude value in the instrument. The returned value is from 0% to 100%.

Command Syntax	AMPLITUDE MAX AX
Query Syntax	AMPLITUDE MAX? AX?
Response Format	AMPLITUDE MAX xxx%
Example	The following command sets the instrument to Amplitude Measurement mode, and queries the Amplitude Max AMPLITUDE MAX; AMPLITUDE MAX?

This space is used for user's notes:

AMPLITUDE DAC
Command/Query

The AMPLITUDE DAC command selects the Amplitude Measurement mode. The Amplitude DAC is the current amplitude of a signal that has broken the gate threshold relative to the DAC curve at the location. If the DAC function is not active, the command will return error.

AMPLITUDE DAC? query command returns the current DAC Amplitude value in the instrument. Note that the returned amplitude value can be more than 100%, unlike Current Amplitude value.

Command Syntax	AMPLITUDE DAC AD
Query Syntax	**AMPLITUDE DAC?** **AD?**
Response Format	AMPLITUDE DAC xxx%
Example	The following command sets the instrument to Amplitude Measurement mode, and queries the Amplitude DAC. AMPLITUDE DAC; AMPLITUDE DAC?
See Also	DAC ?, DAC = UPLOAD, WAVE = DAC

This space is used for user's notes:

DEPTH MEASUREMENT COMMANDS (ANGLE is 0)

EDGE depth
Command/Query

The EDGE command selects the Edge Depth Measurement mode. The Edge Depth measures depth to the leading edge of the echo within the first gate in normal depth mode and the second gate in echo-to-echo depth mode. Note the difference in response formats in normal and echo-to-echo measurement mode.

EDGE ? query command returns the current Edge Depth value in the instrument.

Command Syntax	EDGE EH
Query Syntax	EDGE? EH?
Response Format	EDGE x.xxx <units> in normal depth mode eEDGE x.xxx <units> in echo-to-echo depth mode <units> := { in, mm }
Example	The first command sets the instrument to Edge Depth mode, and queries the Edge Depth. Where as the second command selects echo-to-echo measurement mode, then selects edge depth and queries the Edge Depth. EDGE ; EDGE? ECHOTOECHO ON; EDGE; EDGE ?
See Also	ECHO, \EDGE

This space is used for user’s notes:

MIN DEPTH
Query

The Min Depth refers to the minimum thickness value for the left most echo breaking the gate threshold.

MINDEPTH? query command returns the Minimum Depth value in the instrument.

Query Syntax

MINDEPTH?
MH?

Response Format

MIN DEPTH x.xxx <units>
<units> := { in, mm }

Example

The following command sets the instrument to Edge Depth measurement mode, and queries the Minimum Depth.

EDGE; MINDEPTH ?

This space is used for user's notes:

PEAK depth
Command/Query

The PEAK command selects the Peak Depth Measurement mode. The Peak Depth measures to the peak of the echo within the first gate in normal and second gate in echo-to-echo measurement mode. Note the difference in response formats in normal and echo-to-echo measurement modes.

PEAK ? query command returns the current Peak Depth value in the instrument.

Command Syntax	PEAK PH
Query Syntax	PEAK ? PH?
Response Format	PEAK x.xxx <units> in normaldepth mode ePEAK x.xxx <units> in echo-to-echo depth mode <units> := { in, mm }
Example	The following first command sets the instrument to Peak Depth mode, and queries the Peak Depth. Where as the second command selects echo-to-echo mode, then peak depth, and queries the Peak Depth. PEAK ; PEAK? ECHOTOECHO ON; PEAK; PEAK?
See Also	ECHO, \PEAK

This space is used for user's notes:

DEPTH MEASUREMENT COMMANDS (ANGLE is greater than 0)

In angular depth measurement, three types of the depth readings can be measured: 1) Sound path (Angular depth) 2) Horizontal depth and 3) Vertical depth. Moreover, these readings can be made either in ‘edge or ‘peak’ mode. So all together, following six commands related to depth are possible when angle is greater than zero.

Description	Full Command	Short Command
Angular edge depth	\EDGE	\E
Horizontal edge depth	>EDGE	>E
Vertical edge depth	|EDGE	|E
Angular peak depth	\PEAK	\P
Horizontal peak depth	>PEAK	>P
Vertical peak depth	|PEAK	|P

\EDGE depth
Command/Query

The \EDGE command selects Edge Depth Measurement mode when angle is greater than zero (0) degrees. The Edge Depth measures depth to the leading edge of the echo within the first gate in normal depth mode and the second gate in echo-to-echo depth mode. Note the difference in response formats in normal and echo-to-echo measurement mode.

\EDGE ? query command returns the current angular depth (sound path) value in the instrument.

Command Syntax	\EDGE \E
Query Syntax	\EDGE ? \E ?
Response Format	\EDGE x.xxx <units> in normal depth mode \eEDGE x.xxx <units> in echo-to-echo depth mode <units> := { in, mm }
Example	The first command sets the instrument to angle 30 degrees. Where as the second command selects Edge Depth mode, and queries the Angular Depth. ANGLE = 30.0 \EDGE; \EDGE?
See Also	ECHO, EDGE

This space is used for user's notes:

\PEAK depth Command/Query

The \PEAK command selects Peak Depth Measurement mode when angle is greater than zero (0) degrees. The Peak Depth measures depth to the peak of the echo within the first gate in normal depth mode and the second gate in echo-to-echo depth mode. Note the difference in response formats in normal and echo-to-echo measurement mode.

\PEAK ? query command returns the current angular depth (sound path) value in the instrument.

Command Syntax

\PEAK
\P

Query Syntax

\PEAK ?
\P?

Response Format

\PEAK x.xxx <units> in normal depth mode
\ePEAK x.xxx <units> in echo-to-echo depth mode
<units> := { in, mm }

Example

The first commands sets the instrument to angle 30 degrees, than selects Peak Depth mode, and queries the Angular Depth.

ANGLE = 30.0
\PEAK; \PEAK?

See Also

ECHO, PEAK

This space is used for user's notes:

>EDGE depth
Command/Query

The >EDGE command selects Edge Depth Measurement mode when angle is greater than zero (0) degrees. The Edge Depth measures depth to the leading edge of the echo within the first gate in normal depth mode and the second gate in echo-to-echo depth mode. Note the difference in response formats in normal and echo-to-echo measurement mode. The Horizontal Depth is calculated from the angular depth with the equation:

Horizontal Depth = Angular Depth * sin(Angle)

>EDGE ? query command returns the current horizontal depth value in the instrument.

Command Syntax	>EDGE >E
Query Syntax	>EDGE ? E?
Response Format	>EDGE x.xxx <units> in normal depth mode >eEDGE x.xxx <units> in echo-to-echo depth mode <units> := { in, mm }
Example	The first command sets the instrument to angle 30 degrees. Where as the second command selects Edge Depth mode, and queries the Horizontal Depth. ANGLE = 30.0 Degrees EDGE; >EDGE?
See Also	ECHO, EDGE

This space is used for user's notes:

>PEAK depth
Command/Query

The >PEAK command selects Peak Depth Measurement mode when angle is greater than zero (0) degrees. The Peak Depth measures depth to the peak of the echo within the first gate in normal depth mode and the second gate in echo-to-echo depth mode. Note the difference in response formats in normal and echo-to-echo measurement mode. The Horizontal Depth is calculated from the angular depth with the equation:

Horizontal Depth = Angular Depth * sin(Angle)

>PEAK ? query command returns the current horizontal depth value in the instrument.

Command Syntax	>PEAK >P
Query Syntax	>PEAK ? >P?
Response Format	>PEAK x.xxx <units> in normal depth mode >ePEAK x.xxx <units> in echo-to-echo depth mode <units> := { in, mm }
Example	The first commands sets the instrument to angle 30 degrees. Where as the second command selects Peak Depth mode, and queries the Horizontal Depth. ANGLE = 30.0 Degrees >PEAK; >PEAK?
See Also	ECHO, PEAK

This space is used for user's notes:

|EDGE depth
Command/Query

The |EDGE command selects Edge Depth Measurement mode when angle is greater than zero (0) degrees. The Edge Depth measures depth to the leading edge of the echo within the first gate in normal depth mode and the second gate in echo-to-echo depth mode. Note the difference in response formats in normal and echo-to-echo measurement mode. The Vertical Depth is calculated from the angular depth with the equation:

Vertical Depth = Angular depth * cos(Angle)

|EDGE ? query command returns the current horizontal depth value in the instrument.

Command Syntax

|EDGE
|E

Query Syntax

|EDGE ?
|E?

Response Format

|EDGE x.xxx <units> in normal depth mode
|eEDGE x.xxx <units> in echo-to-echo depth mode
<units> := { in, mm }

Example

The first command sets the instrument to angle 30 degrees. Where as the second command selects Edge Depth mode, and queries the Vertical Depth.

ANGLE = 30.0 Degrees
|EDGE; |EDGE?

See Also

ECHO, EDGE

This space is used for user’s notes:

|PEAK depth
Command/Query

The |PEAK command selects Peak Depth Measurement mode when angle is greater than zero (0) degrees. The Peak Depth measures depth to the peak of the echo within the first gate in normal depth mode and the second gate in echo-to-echo depth mode. Note the difference in response formats in normal and echo-to-echo measurement mode. The Vertical Depth is calculated from the angular depth with the equation:

Vertical Depth = Angular depth * cos(Angle)

|PEAK ? query command returns the current horizontal depth value in the instrument.

Command Syntax

|PEAK
VH

Query Syntax

|PEAK ?
VH ?

Response Format

|PEAK x.xxx <units> in normal depth mode
|ePEAK x.xxx <units> in echo-to-echo depth mode
<units> := { in, mm }

Example

The first command sets the instrument to angle 30 degrees, the second command selects Peak Depth mode, and queries the Vertical Depth.

ANGLE = 30.0 Degrees
|PEAK; |PEAK?

See Also

ECHO, PEAK

This space is used for user's notes:

Sending Continuous Depth Reading

In order to get the certain number of measurement readings through the serial port after each acquisition, send the following serial query command to the Epoch III. The query command is the same as the 'normal' serial command to query the single measurement reading, except that now you need to add a hex number after the '?' to indicate the number of measurement readings you want the Epoch III to send. In the single measurement query command, the reply will be the full measurement string, whereas the reply for the other will be the measurement readings only.

The following table summarizes the differences:

Description	Single Measurement Reading	Multiple Measurement Reading
Query command format	<Command>?	<Command>?<xxxxxxxx (in hex)>
Example 1	PEAK? PEAK 1.200 in	PEAK? 1A PEAK? 1FFF PEAK? 1000 1.200
Example 2	\PEAK?;>PEAK?;|PEAK? \PEAK 1.200 in >PEAK 0.600 in |PEAK 1.039 in	/PEAK?200;>PEAK?200;|PEAK?200 1.200;0.600;1.039
Example 3	AX?CT? Amplitude Max 50% Current 30%	AX?100;CT? 50;30

Notes:

1. The number after the question mark (?) is in hex format. Any hex numbers from 'x' to 'xxxxxxxx' is accepted. For example, FF or 0FF or 000000FF gives the same result, but the number should not exceed 8 digits.
2. The upper limit is the hex number '7FFFFFFF' (which is 2147483647 in decimal).
3. If you send the new command, it will replace the old command, if there is any, even if it is still sending the measurement readings. The facility can be used to change the command or to stop the old command from sending further measurement readings. In order to stop sending further measurement readings, just send any measurement command with the measure hex number being 0 (i.e. <Command> ?0).

ECHO-TO-ECHO SELECTION COMMAND

ECHOtoecho
Command/Query

The ECHO command is used to select or deselect Echo-to-echo measurement mode. Once the mode is selected, depth or amplitude measurement commands can be used to obtain depth or amplitude readings.

The ECHO? query returns either ON or OFF depending on whether the instrument is in Echo-to-echo measurement mode or not.

Command Syntax

ECHO <state>
ECHO = <state>
<state> = {ON, OFF}

Query Syntax

ECHO?
EE?

Response Format

ECHO <state>

Example

The following commands sets the instrument to Echo-to-echo mode , with angle equals to zero (0) degree and peak depth measurement mode, and queries peak depth value.

```
ANGLE 0.0; ECHO ON
PEAK; PEAK?
```

This space is used for user's notes:

MISCELLANEOUS COMMANDS

BATtery Query

The BAT query command returns the remaining battery life in minutes.

Query Syntax	BAT? BT?
Response Format	BAT <xxxx> min If the returned value is 1000 minutes, the battery is in charging state.

This space is used for user's notes:

BEEP
Command/Query

The BEEP command is used to select, deselect and inquire the current beep state of the instrument.

Command Syntax	BEEP = <state> BP = <state> <state > := {ON, OFF}
Query Syntax	BEEP? BP?
Response Format	BEEP < state>

This space is used for user's notes:

CALLOCK/ALLLOCK
Command/Query

The CALLOCK and ALLLOCK have similar formats. The CALLOCK locks the calibration of the instrument. In other words all the keys related to calibration of the instrument are locked or made ineffective. Where as in ALLLOCK, all the keys (except the keys related to unlock the ALLLOCK) are locked or made ineffective.

Command Syntax

CALLOCK = <state>
CK=<state>
ALLLOCK = <state>
AK=<state>
<state > := {ON, OFF}

Query Syntax

CALLOCK?
CK?
ALLLOCK?
AK?

Response Format

CALLOCK< state>
ALLLOCK<state>

This space is used for user's notes:

DAC
Command/Query

The DAC command is used 1) to check the status of the DAC and 2) to upload and download DAC points and activate the DAC in the instrument. Note that the maximum number of points allowed is 20. Two types of DAC curves are supported: 1) ASME 2) JIS. The format of DAC packet is given below. In the packet header, the second word suggests the type of the DAC curve, and next word gives the length of the DAC points. The second line, third line and fourth line have amplitude (y) and position (x), and gain multiplier (g) information respectively. Make sure that the second, third and fourth lines have 40 characters each, even though the number of DAC points are less than 20. In order to use the DAC points corresponding to 0dB gain, correct the amplitude value for each point using the following equation: New_Amplitude = (Amplitude *Gain Multipler)/32. In order words the multiplication of Amplitude and Gain (y*g) results the point which is at 30dB level.

DAC _BEGIN <type> <NoOfPts> <CR> <LF>
20 DAC amplitude as 40 characters,, <CR> <LF>
20 DAC position as 40 characters,, <CR> <LF>
20 DAC gain multiplier as 40 characters, <CR> <LF>
OK_DAC <CR> <LF>

where
<type>:= {ASME,, JIS}
<NoOfPts> : = {2 to 20}

Command Syntax
DAC = <Func>
DC=<Func>
<Func> : = {OFF, DOWNLOAD, UPLOAD}

Query Syntax
DAC?
DC?

Response Format
DAC = {ON/OFF}

See Also
WAVE = DAC

DISPLAY
Command/Query

There are three different types of screens in the unit: a) Split screen: Both the Waveform and status parameters are displayed together. b) Full screen: Only the Waveform is displayed. c) Memory screen: Directories and saved data can be viewed in this screen. Out of these three screens, only one screen can be on view at a time on the Epoch3. The DISPLAY command is used to change or select the screens.

The DISPLAY? query returns the current screen on view.

Command Syntax	DISPLAY <screens> DY<screens> DISPLAY = <screens> DY=<screens><screens> = {FULL,SPLIT,MEM}
Query Syntax	DISPLAY? DY?
Response Format	DISPLAY <screens>

This space is used for user's notes:

FILLED Waveform Command/Query

The FILLED command is used to change a Waveform drawing to either filled in our outlined mode whereas FILLED? query command returns ON or OFF depending upon the state Waveform drawing mode.

Command Syntax	FILLED Waveform <state> FM<state> FILLED Waveform = <state> FM = <state> <state> = {ON, OFF}
Query Syntax	FILLEDWaveform?
Response Format	FILLED Waveform <state>

This space is used for user's notes:

FREEZE
Command/Query

The FREEZE command is used to hold or ‘freeze the information on the screen. Once the FREEZE function is activated, no further data will be acquired. This function is ideal for high temperature measurement.

The FREEZE? query returns either ON or OFF depending on whether the Freeze function is activated or not.

Command Syntax	FREEZE<state> FZ<state> FREEZE = <state> FZ=<sate> <state> = {ON, OFF}
Query Syntax	FREEZE?
Response Format	FREEZE <state>

This space is used for user’s notes:

GRID
Command/Query

The GRID command is used to select, deselect and inquire the current grid state of the instrument. You can turn on or off the grid on Waveform display area of the instrument by using this command.

Command Syntax	GRID = <state> GD=<state> <state > := {ON, OFF}
Query Syntax	GRID? GD?
Response Format	GRID < state>

This space is used for user's notes:

ID
Command/Query

The ID command can used to change or update the Id value in the instrument. When you save the Depth reading or the Waveform in the memory, this Id value is also saved along with the Depth reading. Then, Id will be updated either to next pre-stored Id value in the memory or to the next increment value. Note that the width of the Id field is 16 characters.

The ID? query returns current Id value.

Command Syntax	ID = <xxxxxxxxxxxxxxxx>
Query Syntax	ID?
Response Format	ID = <xxxxxxxxxxxxxxxx>
Example	In the following example, the Id value is set first, before saving the depth value to memory. Then inquiries the updated id value. ID = PIPE1024 SAVE ID ID ?
See Also	epFILE <Filename> /s, epFILE <Filename> /c, SAVE = ID, SAVE = WAVE

This space is used for user's notes:

PEAKMEM
Command/Query

The PEAKMEM command is used to select or deselect Peak Memory mode. Setting the instrument to Peak Memory mode, one can obtained the envelope of the Waveform as well as 'live' Waveform at the same time. Note that the Peak Memory cannot be activated in the RF display mode.

The PEAKMEM? query returns either ON or OFF depending on whether the instrument is in Peak Memory mode or not.

Command Syntax

PEAKMEM<state>
PM<state>
PEAKMEM = <state>
PM=<state>
<state> = {ON, OFF }

Query Syntax

PEAKMEM?
PM?

Response Format

PEAKMEM <state>

This space is used for user's notes:

OK
Command/Query

In default setting, the instrument will reply ‘ER’ only for the invalid command. If instrument receives the valid RS232 command, it will execute the command, but it will not returned any reply.

You can set the instrument to return ‘OK’ for valid command (not the valid query command) with the OK command.

OK? query command returns ON or OFF depending on the current setting of RS232.

Command Syntax

OK <state>
<state> = {ON, OFF}

Query Syntax

OK?

Response Format

OK <state>

Example

In the following example, the OK is set to ON. When angle is changed, you will see that the instrument returns OK.

OK = ON
ANGLE 30.0

This space is used for user’s notes:

MASTER RESET Command

The MASTER RESET is very important as well as ‘dangerous’ command, so use it more carefully. Two kinds of reset is possible in the instrument: Parameters and Memory. The resetting the parameters means setting the parameters from the master table stored in the instrument. Once you reset the parameters, you lose the current setting of the instrument. The resetting the memory wipes out the entire memory. All the files stored in the memory will be lost. There is no way to recover the files again.

Command Syntax

MASTERESET = <type>
MR=<type>
<type > := {PARAM, Database}

This space is used for user’s notes:

SAVE Command

The SAVE command stores either the Depth reading only or Depth reading, the Waveform and state of the instrument in to the memory. If the Id is invalid, or there is not enough memory, the command will not be effective.

Command Syntax

SAVE = <type>
SAVE <type>
SD <type>
<type> := { ID, WAVE }

Example

In the following example, the Id value is set to ‘PIPE1024 and new file with name ‘Test_001.dat is created. A depth value is saved into that id.

```
ID = PIPE1024
epFILE TEST_001.DAT /C
SAVE = ID
```

See Also

SAVE = WAVE, epFILE ?, epFILE <Filename> /s, epFILE <Filename> /c

This space is used for user’s notes:

SHUTDOWN
Query

There are three ways the unit can be shut down:

1. Normal shutdown - the user turns off via the on/off key manually.
2. Battery low - when the battery goes low, the unit shuts down automatically.
3. Calibration error and battery low - when the calibration error occurs, a prompt indicating the calibration error number appears requesting a user response to continue. While waiting for the user response, if the battery goes low, the unit shuts down automatically.

   This shutdown state is preserved in the unit and can be queried when the unit is turned on again by using the command below.

Query Syntax

SHUTDOWN = <shutdown>
SN = <shutdown>

<shutdown>:= {1,2,3} where 1: Normal
2. Battery low
3. Calibration error and battery low

This space is used for user's notes:

VERSION
Query

The VERSION command is used to check the version number of the instrument.

Query Syntax	VERSION? VN?
Response Format	VERSION <version >

This space is used for user's notes:

WAVE
Command

The WAVE command is used to upload the Waveform buffer. The Waveform buffer can be of any one of the following types: A-Scan, RF, Peak Memory and DAC. All the buffers have 220 data except RF buffer which has 440 data, 220 max and 220 min. Each data is of 8 bit value, which is converted to 2 ASCII characters before transmitting. First ASCII character is converted from the most significant 4 bits of data, another character from remaining 4 bits. The following list shows decimal data and the corresponding transmitted characters.

Transmitted ASCII Character Values	Transmitted ASCII Characters	Decimal Data	Binary Data	Hex Data
30 30	‘00’	00	0000 0000	00
30 31	‘01’	01	0000 0001	01
30 32	‘02’	02	0000 0010	02
. .	. .	. .	. .	. .
. .	. .	. .	. .	. .
30 39	‘09’	09	0000 1001	09
30 3A	‘0:’	10	0000 1010	0A
30 3B	‘0;’	11	0000 1011	0B
30 3C	‘0<‘	12	0000 1100	0C
30 3D	‘0=’	13	0000 1101	0D
30 3E	‘0>’	14	0000 1110	0E
30 3F	‘0?’	15	0000 1111	0F
31 30	‘10’	16	0001 0000	10
. .	. .	. .	. .	. .
. .	. .	. .	. .	. .
33 32	‘32’	50	0011 0010	32
. .	. .	. .	. .	. .
. .	. .	. .	. .	. .
36 3B	‘6;’	107	0110 1101	6B
. .	. .	. .	. .	. .
. .	. .	. .	. .	. .
3A 3C	‘:<‘	172	1010 1100	AC
. .	. .	. .	. .	. .
. .	. .	. .	. .	. .
3C 37	‘<7’	199	1100 0011	C7

The formula for computing a decimal data given two transmitted characters is shown below:

Let two transmitted characters be CH1 and CH2,
decimal data = (CH1 - 0x30) * 16+(CH2 - 0x30)
Or in 'C' language format
decimal data = (CH1 - '0') <4+(CH2-''0')

Make sure to activate the necessary functionality in the instrument before uploading the buffer. Otherwise, it will return an error. For example, the Peak Memory buffer will not be uploaded if Peak Memory is not activated.

Command Syntax

WAVE = <type>
WV=<type>
<type> = {ASCAN, RF, PEAKMEM, DAC}

Example

In the following example, Full wave rectify mode is selected and Peak Memory functionality is activated before uploading ASCAN Waveform and PEAKMEM Waveform.

```
FULLWAVE RECTIFY
PEAKMEM = ON
WAVE = ASCAN
WAVE = PEAKMEM
```

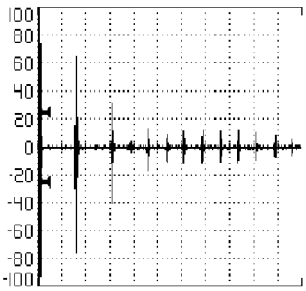
See Also

epFILE <Filename> /r -a

Format

ASCAN Waveform packet (Wave buffer size = 220)

```
ASCAN_Waveform _BEGIN 40 chars... EPOCH III <CR> <LF>
line 1      1-20 ascan data as 40 characters          <CR> <LF>
line 2      21-40 ascan data as 40 characters
:
:
line10      181-200 ascan data as 40 characters       <CR> <LF>
line 11     201-220 ascan data as 40 characters       <CR> <LF>
OK_Waveform _END<CR> <LF>
```



ASCAN_Waveform_BEGIN EPOCH III

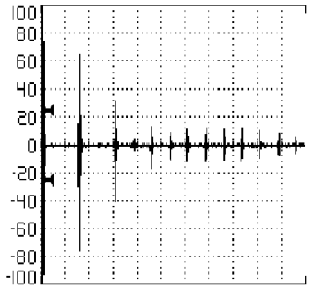
02<8<8;<2006020202020402020202020402040 2
0202020202020404020202 3>962>0<0404020202
0202020204020204040402020404040204020402
021:521:06020204020202020202040202 0:0:04
0202020202020202040202082 40<040402040404
0204040202040214160802040202020202020402
0404180>040204020204040402040404021:1808
0202040204020202020204041:0<040404040404
0204040204040216 1<060204020202040402020 2
0404140604040204020402020204040402 0>1204
0402020202040202040404040<0:040404040402
OK_Waveform_END

Converting to decimal data

2, 200, 200, 188, 32, 6, 2, 2, 2, 2, 4, 2, 2, 2, 2, 2, 2, 4, 2, 4, 2
2, 2, ... , 4, 2, 2, 2
2, 2, ... , 4, 2, 4, 2
2, 26, ... , 2, 10, 10, 4
2, 2, ... , 2, 4, 4, 4
2, 4, ... , 2, 2, 4, 2
4, 4, ... , 2, 26, 24, 8
2, 2, ... , 4, 4, 4, 4
2, 4, ... , 4, 2, 2, 2
4, 4, ... , 2, 14, 18, 4
4, 2, 2, 2, 2, 4, 2, 2, 4, 4, 4, 4, 14, 10, 4, 4, 4, 4, 4, 2

RF Waveform packet (Wave buffer size = 440)

RF_Waveform _BEGIN 40 chars... EPOCH III<CR> <LF>
line 1 1-20 max data as 40 characters <CR> <LF>
line 2 21-40 max data as 40 characters <CR> <LF>
:
:
line 10 181-200 max data as 40 characters <CR> <LF>
line 11 201-220 max data as 40 characters <CR> <LF>
line 12 1-20 min data as 40 characters <CR> <LF>
line 13 21-40 min data as 40 characters <CR> <LF>
line 21 181-200 min data as 40 characters <CR> <LF>
line 13 201-220 min data as 40 characters <CR> <LF>
OK_Waveform _END<CR> <LF>



After uploading

RF_Waveform_BEGIN EPOCHIII
66<8<8;06<6565656565656565656565656565
65666565656565656565666674:67:696665656565
65656565666565656765665656565656566656565
65698470676565656566656665656566566696966
65656565656666656565656726:666565666565
656566656565656;6>676666656565656565665
6666706:66666566656565656565656566656;7065
65656565666565656565666665716:676665666565
65666566656666697166656565656565665666565
66656>67666565656665656565656565676=66
65656565656666665656565656:69656665656665
63000007546162636263636262626363636363
62626363636363636363636245184>5>6362636362
63636363636363626263636363626363263636363
63583:586163626363636363636363626263616061
63636362636363636363636360525>626363636363
636363636363625:5:6063636362636363636263
6362585?6162636363626263636363626263575;5?
63636363636362636263636263595>626363636363
6363636263636362595;6163626363636363626363
62635;6162636363626363636363626362625=5<62
63636263636362636363626362635>60636363636363
OK_Waveform_END
Converting to RF data in max and min pair

(102,99), (200,0), (200,0), (176, 7), (108,84), (101,97), ... ,(101,99), (101,99)
(101,98), (102,98), ... ,(101,99), (101,99)
(101,99), (101,99), ... ,(101,99), (101,99)
(101,99), (105,88), ... ,(105,96), (102,97)
(101,99), (101,99), ... ,(101,99), (101,99)
(101,99), (101,99), ... ,(101,98), (101,98)
(102,98), (102,98), ... ,(112,91), (101,95)
(101,99), (101,99), ... ,(101,99), (101,99)
(101,99), (102,99), ... ,(101,99), (101,99)
(102,98), (101,99), ... ,(109,99), (102,98)
(101,99), (101,99), ... ,(102,99), (101,99)

Converting to RF Signal Amplitude (%) in max and min pair

(2,-1), (100,-100), (100,-100), (76, -93), (8,-16), (1,-3), ... ,(1,-1), (1,-1)
(1,-2), (2,-2), ... ,(1,-1), (1,-1)
(1,-1), (1,-1), ... ,(1,-1), (1,-1)
(1,-1), (5,-12), ... ,(5,-4), (2,-3)
(1,-1), (1,-1), ... ,(1,-1), (1,-1)
(1,-1), (1,-1), ... ,(1,-2), (1,-2)
(2,-2), (2,-2), ... ,(12,-9), (1,-5)
(1,-1), (1,-1), ... ,(1,-1), (1,-1)
(1,-1), (2,-1), ... ,(1,-1), (1,-1)
(2,-2), (1,-1), ... ,(9,-1), (2,-2)
(1,-1), (1,-1), ... ,(2,-1), (1,-1)

PEAKMEM Waveform packet (Wave buffer size = 220)

PEAKMEM_Waveform _BEGIN 40 chars EPOCH III<CR> <LF>
1- 20 peak memory data as 40 characters <CR> <LF>
21-40 peak memory data as 40 characters <CR> <LF>
:
:
181-200 peak memory data as 40 characters <CR> <LF>
201-220 peak memory data as 40 characters <CR> <LF>
OK_Waveform _END<CR> <LF>

Example:

See the example in ASCAN Waveform packet

PEAKMEM Waveform packet (Wave buffer size = 220)
PEAKMEM_Waveform _BEGIN 40 chars EPOCH III <CR> <LF>
Division 1, 20 ascan data as 40 characters, <CR> <LF>
:
:
Division 11, 20 ascan data as 40 characters, <CR> <LF>
OK_Waveform _END<CR> <LF>
DAC Waveform packet (Wave buffer size = 220)
DAC_Waveform _BEGIN 40 chars... EPOCH III <CR> <LF>
Division 1, 20 ascan data as 40 characters, <CR> <LF>
:
:
Division 11, 20 ascan data as 40 characters, <CR> <LF>
OK_Waveform _END<CR> <LF>

RW
Command

The RW command is used to upload the Waveform buffer. The Waveform buffer can be of any of the following types: Ascan, Peak Memory and DAC. All the buffers have 220 data except RF buffer which has 440 data, 220 max, and 220 min. Each data is of 8 bit value, a constant value 28 is added to the data before transmitting. So the transmitted data is the sinusoidal data whose value varies from 28 to 228, centered at 128. The transmitted data is a binary data and not an ASCII data.

Make sure to activate the necessary functionality in the instrument before uploading the buffer. Otherwise, it will return an error. For example, the Peak Memory buffer will not be uploaded if Peak Memory is not activated.

Command Syntax RW = <type>
<type> = {ASCAN, RF, PEAKMEM, DAC}

Response Format <type>,#9000000<# of data><data>...<data><EOT>

Example

Command: RW= ASCAN

Response: ASCAN,#9000000220<data>...<data><EOT>

Command: RW = RF

Response: RF,#9000000440<data>...<data><EOT>

This space is for user's notes.

RW?
Command

The RW? command is similar to the RW command, expect that it uploads the Waveform buffer continuously at a rate of one per second. The buffer is in the same form as mentioned in the RW command section.

Command Syntax RW?<type><type> = {ASCAN, RF, PEAKMEM, DAC}

Response Format <type>,#9000000<# of data><data>...<data><EOT>

To Cancel Command RW=<type>

Example

Command: RW?ASCAN

Response: ASCAN,#9000000220<data> ...<data><EOT>

To Cancel: RW=ASCAN

This space is for user's notes.

ZOOM
Command/Query

The ZOOM command is used to get the detailed view of the an indication. This command can set the Zoom in on or off mode.

The ZOOM? query returns either ON or OFF depending on the status of the Zoom.

Command Syntax	ZOOM<state> ZM<state> ZOOM = <state> ZM=<state> <state> = {ON, OFF}
Query Syntax	ZOOM? ZM?
Response Format	ZOOM <state>

This space is used for user's notes:

RS232 COMMAND LIST

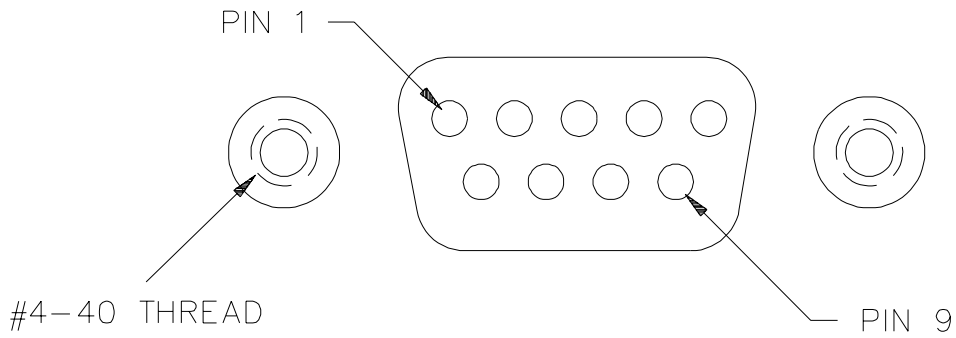
DESCRIPTION	ENGLISH	GERMAN	FRENCH	SHORTFORM
STATUS RELATED				
Angle	ANGLE	WINKEL	ANGEL	AE
Damping	DAMPING	DAEMPFUNG	AMORTIS	DG
Gain	GAIN	DB	DB	GN
Gate1 Alarm	GATE1 ALARM	MON1ALARM	ALARMEMON1	1A
Gate2 Alarm	GATE2 ALARM	MON2ALARM	ALARMEMON2	2A
Gate1 Level	GATE1 LEVEL	MON1HOEHE	SEUILMON1	1L
Gate2 Level	GATE2LEVEL	MON2HOEHE	SEUILMON2	2L
Gate1 Start	GATE1START	MON1START	DEPARTMON1	1S
Gate2 Start	GATE2START	MON2START	DEPARTMON2	2S
Gate1 Width	GATE1WIDTH	MON1BREITE	LARGMON1	1W
Gate2 Width	GATE2WIDTH	MON2BREITE	LARGMON2	2W
High Pass Filter	HPFILTER	HPFILTER	HPFILTER	HR
Mode Pulse-echo mode Dual mode Through mode	MODE PULSE-ECHO MODE DUAL MODE THROUGH MODE	MODE IMPLUS/ECHO S/E-PRUEFKOPF DURCHSCHALLUNG	MODE ECHOS TRADUCTEUR E/R TRANSPARENCE	MD PL DL TG
Pulser Pulser Low Pulser Medium Pulser High	PULSER PULSER LOW PULSER MEDIUM PULSER HIGH	PULSER PULSER‘ PULSER] PULSER ^	ENERGIE ENERGIE BAS ‘ENERGIE MOYENNE] ENERGIE HAUTE ^	PR
Range	RANGE	DIST	BEREICH	RN
Rectify Fullwave rectify Halfwave+ rectify Halfwave - rectify RF Waveform	RECTIFY FULLWAVE RECTIFY HALFWAVE+ RECTIFY HALFWAVE- RECTIFY RF WAVEFORM	RECTIFY VOLLWELLE HALBWELLE+ HALBWELLE HFFORM	RECTIFY 1/1ONDE 1/2ONDE+ 1/2ONDE SIGNALHF	RY FW H+ H- RF
Reject	REJECT	REJECT	REJECT	RT
Reference	REF	REF	REF	RG
Status	STATUS	STATUS	STATUS	SS
Thickness	THICK	DICKE	EPAISS	TS
Velocity	VEL	VEL	VEL	VY
Zero	ZERO	NULL	ZERO	ZR
Database RELATED				
Directory	EPDIR	EPDIR	EPDIR	ER
File	EPFILE	EPFILE	EPFILE	EL
Directory size	EPDSIZ	EPDSIZ	EPDSIZ	ED
File Size	EPFSIZE	EPFSIZE	EPFSIZE	EF
MEASUREMENT RELATED				
Current amplitude	CURRENT	JEIZT	INSTANT	CT
Amplitude max	AMPLITUDE MAX	AMPLITUDE MAX	AMPLITUDE MAX	AX
Amplitude dac	AMPLITUDE DAC	AMPLITUDE DAC	AMPLITUDE CAD	AD
Edge depth	EDGE	FLANKE	FLANC	EH
Peak depth	PEAK	SPITZE	CRETE	PH
Min depth	MINDEPTH	MINTIEFE	EPMINI	MH
Angular edge depth	\EDGE	\FLANKE	\FLANC	\E
Angular peak depth	\PEAK	\SPITZE	\CRETE	\P
Horizontal edge depth	>EDGE	>FLANKE	>FLANC	>E
Horizontal peak depth	>PEAK	>SPITZE	>CRETE	>P
Vertical edge depth	|EDGE	|FLANKE	|FLANC	|E
Vertical peak depth	|PEAK	|SPITZE	|CRETE	|P
Echo-to-Echo	ECHO	ECHO	ECHO	EE

DESCRIPTION	ENGLISH	GERMAN	FRENCH	SHORTFORM
MISCELLANEOUS				
ALL lock	ALLLOCK	ALLES VERRIEGELN	BLOCAGE GENERAL	AK
Battery	BAT	BAT	BAT	BT
Beep	BEEP	PIEPSER	BEEP	BP
CAL lock	CALLOCK	JUSTVERRIEGELN	BLOCAGECAL	CK
DAC	DAC	DAC	CAD	DC
Display	DISPLAY	DISPLAY	DISPLAY	DY
Freeze	FREEZE	FREEZE	FREEZE	FZ
Grid	GRID	RASTER	GRATICULE	GD
ID	ID	ID	ID	ID
Ok	OK	OK	OK	OK
Peak mem	PEAKMEM	PEAKMEM	PEAKMEM	PM
Master reset	MASTERRESET	MASTERRESET	MASTERRESET	MR
Save	SAVE	SAVE	SAVE	SV
Version	VERSION	VERSION	VERSION	VN
Wave	WAVE	WAVE	WAVE	WV
Zoom	ZOOM	ZOOM	ZOOM	ZM
	ON	AN	EN	
	OFF	AUS	HORS	

APPENDIX IV–RS-232 CABLE CONNECTOR DIAGRAMS

EPOCH 2300 RS232 PORT

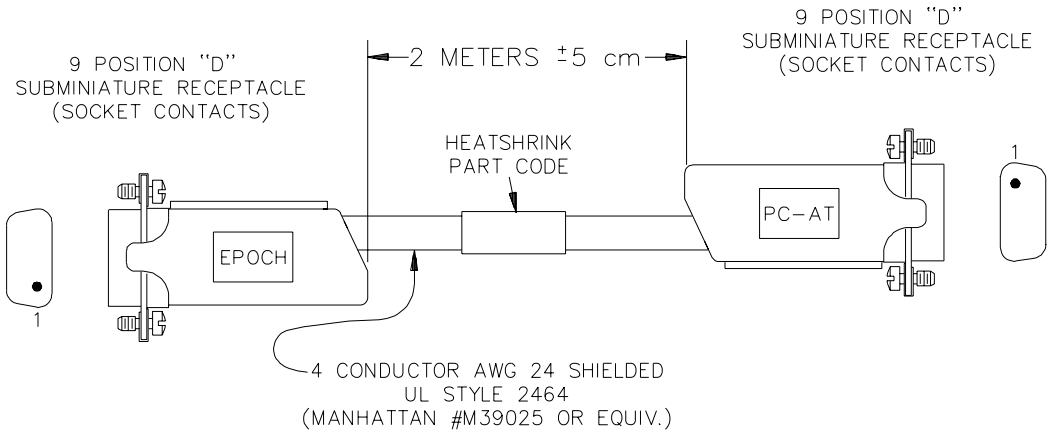
CONNECTOR TYPE: 9 PIN "D" SUBMINIATURE
MALE/PLUG W/4–40 JACKSOCKETS



PIN	FUNCTION
1	5V/1 AMPERE POWER SUPPLY
2	DATA IN
3	DATA–OUT
4	READY OUT (DTR)
5	GROUND
6	READY IN (DSR)
7	SYNC INPUT
8	ALARM OUTPUT
9	END OF MEASURE

ALL OTHER PINS HAVE NO CONNECTION

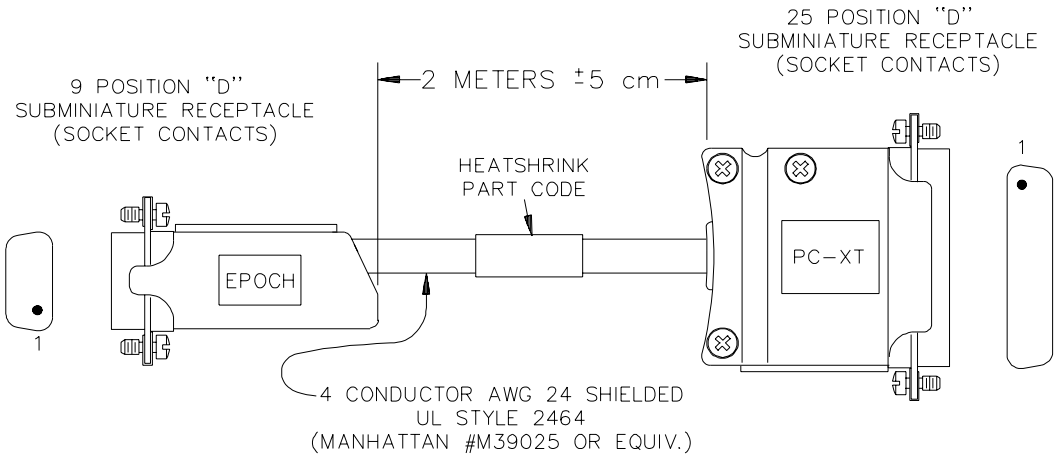
CABLE, EPOCH 2300 RS232 TO IBM PC-AT



SIGNAL NAME	CONTACT		CONTACT	SIGNAL NAME
DATA IN	2	BLACK	3	DATA OUT
DATA OUT	3	RED	2	DATA IN
READY OUT (DTR)	4	WHITE	6	DSR
GROUND	5	DRAIN	5	SIGNAL GND
READY IN (DSR)	6	GREEN	4	DTR

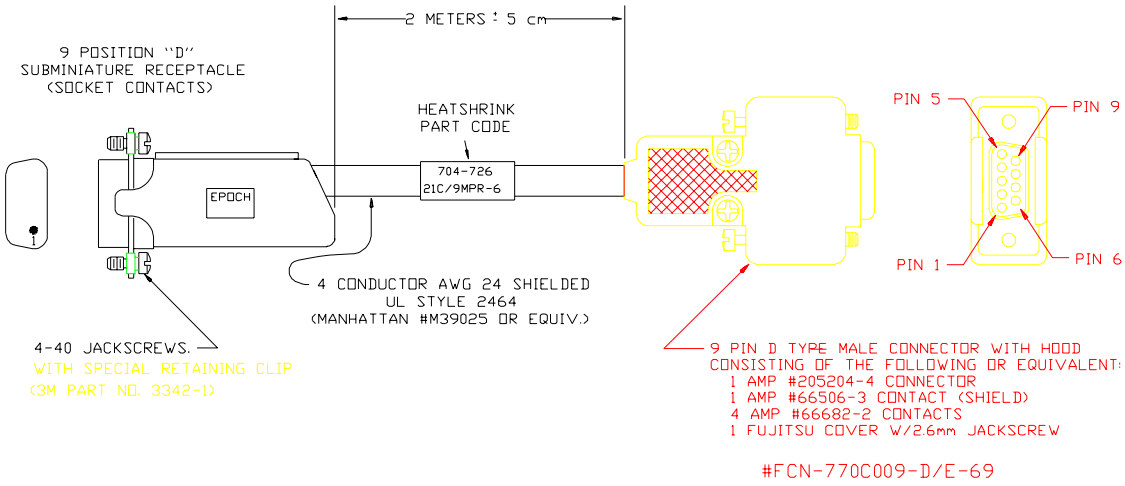
NOTE: THIS CABLE IS REVERSIBLE-THE CONNECTOR TYPE AND FUNCTIONS ARE IDENTICAL.

CABLE, EPOCH 2300 RS232 TO IBM PC–XT



SIGNAL NAME	CONTACT		CONTACT	SIGNAL NAME
DATA IN	2	BLACK	2	DATA OUT
DATA OUT	3	RED	3	DATA IN
READY OUT (DTR)	4	WHITE	6	DSR
GROUND	5	DRAIN	7	SIGNAL GND
READY IN (DSR)	6	GREEN	20	DTR

CABLE, EPOCH 2300 RS232 TO SEIKO DPU-414 PRINTER



SIGNAL NAME	CONTACT		CONTACT	SIGNAL NAME
DATA IN	2	BLACK	N/C	
DATA OUT	3	RED	3	DATA IN
READY OUT (DTR)	4	DRAIN		CHASSIS
GROUND	5	GREEN	5	SIGNAL GND
READY IN (DSR)	6	WHITE	8	PRINTER READY

NOTE: FOR USE WITH SEIKO MODEL DPU-414 SERIAL PRINTER.

APPENDIX V–SOUND VELOCITIES

The following is a tabulation of the ultrasonic velocity in a variety of common materials. It is provided only as a guide. The actual velocity in these materials may vary significantly due to a variety of causes, such as, composition, preferred crystallographic orientation, porosity, and temperature. Therefore, for maximum accuracy, establish the sound velocity in a given material by first testing a sample of the material.

Table I: Sound Velocities of Various Materials (Longitudinal Wave Velocity)

MATERIAL	V (in./usec)	V(M/S)	REF
Alumina, $Al_2 0_3$ 99.5%	0.4013	10190	2
Aluminum, rolled	0.253	6420	1
Aluminum, 6061T6	0.251	6383	2
Beryllium	0.5073	12890	1
Brass, yellow 70 Cu, 30 Zn	0.1850	4700	1
Brass, yellow 70 Cu, 30 Zn	0.1726	4385	2
Copper, rolled	0.1972	5010	1
Duraluminum, 17S	0.2487	6320	1
Fused Silica	0.2349	5968	1
Fused Silica	0.2335	5932	2
Glass, crown	0.2008	5100	5
Glass, flint	0.1567	3980	5
Glass, pyrex	0.2220	5640	1
Iron, Armco	0.2345	5960	1
Lead, rolled	0.0771	1960	1
Lucite	0.1055	2680	1
Magnesium, drawn annealed	0.2270	5770	1
Molybdenum	0.247	6250	3
Monel	0.2105	5350	1
Nickel	0.2377	6040	1
Nylon	0.1031	2735	2
Polyethylene	0.0705	1950	1
Polystyrene	0.0925	2350	1
Silicone Rubber RTV	0.0373	0948	4
Steel, low alloy	0.2259	5734	2
Stainless Steel #347	0.2278	5790	1

Table I: Sound Velocities of Various Materials (Longitudinal Wave Velocity)			
Titanium	0.237	5990	3
Tungsten, drawn	0.2129	5410	1
Uranium	0.133	3370	3
Water	0.0590	1498	5
Zinc, rolled	0.1657	4210	1
Zinc, extruded	0.1756	4460	2

References

1. W.P.Mason, **Physical Acoustics and the Properties of Solids**, D.Van Nostrand Co., New York, 1958.
2. E.P.Papadakis, Panametrics - unpublished notes, 1972.
3. J.R.Fredericks, **Ultrasonic Engineering**, John Wiley & Sons, Inc., New York, 1965.
4. D.L.Folds, “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.
5. “Handbook of Chemistry and Physics” Chemical Rubber Co., Cleveland, Ohio, 1963.

APPENDIX VI–GLOSSARY

ACV CALBLOCK: Losses in db/meter due to attenuation of the calibration block.

ACV SPECIMEN: Losses in db/meter due to attenuation of the specimen.

ACOUSTIC IMPEDANCE: A material property defined as the product of sound velocity (C) and the material's density (d).

ACOUSTIC INTERFACE: The boundary between 2 media of different acoustic impedance.

ACOUSTIC ZERO: Can be considered for practical purposes to be the point on the CRT display which represents the entry surface of the specimen.

AMPLIFIER: An electronic device which 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 CRT screen, the vertical height of an indication measured from the lowest to the highest point on the indication. In wave motion, the maximum displacement of the particles of the material.

ANGLE BEAM TESTING: A testing technique in which the crystal is placed at an angle to the test surface so that the ultrasonic waves enter the material (via a plastic wedge) in a direction angular to the test surface.

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 CRT 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.

ATTENUATION: The loss in acoustic energy which occurs between any two points of travel. This loss may be due to absorption, reflection, etc.

BACK ECHO OR BACKWALL 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: The point on the base of an angle beam probe's wedge from which the sound leaves the wedge and enters the specimen.

B-SCAN: A sectional representation (side view) of a test specimen, often performed in an immersion system. This sectional representation can be in the form of a photograph or recorder display.

CAL BLOCK VELOCITY: Calibration block velocity.

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.

DECIBEL: 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 of some reference level.

In the case of the displayed voltages on a cathode ray tube screen, the relationship becomes:

$$n = 20 \log_{10} \left(\frac{V_2}{V_1} \right)$$

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 CRT.

DELTA V: Gain correction value. The difference between the measured value (off a calibration block) and the theoretical DGS curve drawn only on transducer parameters.

DELTA VK: Calibration block correction value. Gain difference between a flat reflector and a curved reflector. Gain loss from a flat reflector to a curved reflector is entered as a positive value.

DELTA VT: Gain difference between calibration block and test specimen.

DETECTABILITY: The ability of a test system (instrument and transducer) to detect or “see” a given size reflector.

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 CRT screen that represents the amplitude of that size reflector throughout a given distance range. This curve shows 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 cathode ray tube (usually based on decibel ratios).

ELECTRONIC ZERO: The point in time when the pulser fires the initial pulse to the transducer and the point on the cathode ray tube screen where the electron beam leaves the baseline due to the initial pulse signal coming from the transmitter.

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 which may be undesirable but does not necessarily call for rejection.

FREQUENCY: The number of complete cycles undergone or produced by an oscillating body in one second.

GAIN: A term used in electronics with reference to an increase in signal power; usually expressed as the ratio of the output power (for example, of an amplifier) to the input power in decibels.

GAIN (CONTROL): Selects the amount of calibrated gain (dB's) available within the instrument. Usually consists of a coarse gain control (additions at 20dB increments), and a fine gain (additions at 1 or 2dB increments).

GATE: An electronic baseline display used to electronically monitor portions of the displayed range with reference to distance or amplitude.

HERTZ: 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. Named after Heinrick Hertz (1857-94).

HORIZONTAL A: The smaller length (if rectangular) of the actual crystal. The software will compute the "affective length" automatically.

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 search unit 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 (i.e., perpendicular) to the surface at that point. Usually designated by the Greek symbol α (alpha).

INDICATION: The signal displayed on the CRT 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 CRT 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.

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 a range of echo signals, produced by specified reflectors, variable in time, usually a series of multiple back reflections.

LONGITUDINAL WAVE: Mode of wave propagation characterized by particle movement parallel to the direction of wave travel.

“MAIN BANG”: The slang term used to describe the combination of a) Initial Pulse Voltage (as displayed on the CRT screen), b) Electric Zero, c) Acoustic Zero on a straight beam contact test, and d) Ringing of the crystal.

MATERIAL LOSS ATTENUATION (M.L.A.): The loss of sound pressure in a traveling wavefront caused by the scattering of some of the wave's sound pressure by the grain structure and/or porosity of the medium, and by absorption, a conversion of sound energy into heat.

MODE CONVERSION: The changing of a portion of a sound beam's 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 CRT screen by positioning the main axis of the sound beam directly over the reflector.

PENETRATION: The ability of the test system to overcome material loss attenuation; i.e., 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 elements (such as lead metaniobate, quartz, lithium sulfate) which 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 or search unit.

PULSE REPETITION RATE: 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 CRT screen 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 CRT 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 CRT screen.

REFERENCE LINE: A predetermined horizontal line (usually dictated by specifications) on the CRT-screen representing some percentage of total screen height (e.g., 40%), 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, it limits the input sensitivity of the amplifier in the receiver. “Grass” or scattering noise can be reduced or eliminated from the CRT screen by its use. On most analog instruments it also destroys the vertical linearity relationship between echo heights.

RESOLUTION: The ability of the test system (instrument and transducer) to distinguish reflectors at slightly different depths.

SCANNING LEVEL: The number of dB’s of calibrated gain above the reference level added to insure 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.

SHEAR (TRANSVERSE) WAVE: Mode of wave propagation characterized by particle movement perpendicular to the direction of wave travel.

SIGNAL-TO-NOISE RATIO: The ratio of amplitudes and indications 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 wavefront moves forward, this movement penetrating the specimen to a depth of one wavelength.

THROUGH TRANSMISSION: A test method in which the vibrations emitted by one search unit are directed toward, and received by, another search unit. The ratio between quantity of vibration sent and received is a measure of the integrity, or quality of the material being tested.

TIME CORRECTED GAIN (TCG): Circuit that automatically adjusts gain so that the echo amplitude of a given size reflector is displayed at a constant screen 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; e.g., above 20,000 cycles/sec. (Hertz).

ULTRASONICS: The study of pressure waves which are of the same nature as sound waves, but which have frequencies above the human audible limit, i.e., above 20,000 cycles/sec. (Hertz).

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 will compute the “affective length” automatically.

WARNING: Above the DGS curve, an alarm curve with the same shape is drawn at an imputed db level above the DGS curve.

WAVELENGTH: The distance between like points on successive wavefronts; i.e., 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).

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