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USER'S MANUAL

Model 35, 35DL, 35HP, 35DLHP

Ultrasonic Precision Thickness Gages

Part No. 910-261D

September, 2006

 **PANAMETRICS-NDT™**

Nondestructive Testing Products

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Appendix I: Sound Velocities

Preface

Model 35 Series Ultrasonic Gages are designed and manufactured as precision instruments. Under normal working conditions, they 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 Olympus NDT so that we may assist you in the damage claims, and provide replacement equipment, if necessary.

Warranty

Olympus NDT guarantees Model 35 Series Ultrasonic Gages to be free from defects in materials and workmanship for a period of two years (twenty-four months) from date of shipment. The warranty covers only equipment that has been used in a proper manner as described in this instruction manual and has not been subject to excessive abuse, unauthorized repair, or modification. DURING THIS WARRANTY PERIOD, OLYMPUS NDT LIABILITY IS STRICTLY LIMITED TO REPAIR OR REPLACEMENT OF A DEFECTIVE UNIT AT ITS OPTION. Olympus NDT does not warrant Model 35 Series Ultrasonic Gages to be suitable for intended use, and assumes no responsibility for unsuitability for intended use. Olympus NDT accepts no liability for consequential or incidental damages including damage to property and/or personal injury.

This warranty does not include the transducer, transducer cable,

charger or battery. The customer will pay shipping expense to the Olympus NDT plant for warranty repair; Olympus NDT will pay for the return of the repaired equipment. For instruments not under warranty, the customer will pay shipping expenses both ways.

Olympus NDT offers an optional third year warranty coverage (at an additional cost), under the same terms, at the time of purchase.

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

1 GENERAL INFORMATION

The Panametrics-NDT™ 35 Series of hand-held ultrasonic thickness gages includes precision microprocessor-based instruments that use pulse-echo techniques to measure material thickness when both sides of the test material are not easily accessible.

Four 35 Series models described in this manual include:

- Model 35: Basic precision thickness gage using transducers in the frequency range of 2.25 - 30.0 MHz
- Model 35DL: Thickness gage with file-based, alphanumeric Datalogger using transducers in the frequency range of 2.25 - 30.0 MHz
- Model 35HP: Basic high penetration precision thickness gage using transducers in the frequency range of 0.5 - 5.0 MHz
- Model 35DLHP: Precision high penetration precision thickness gage with file-based alphanumeric Datalogger gage using transducers in the frequency range of 0.5-5.0 MHz

The gages also measure sound velocity and pulse transit time in most solids and liquids.

35 Series gages use three (3) modes of operation with contact, delay line, and immersion transducers and include an Application Auto-Recall feature, which allows both Standard Default and Custom Stored Application Setups. In general, one of the Default Transducer Setups is adequate for most applications. However, if your application requires a specialized setup, the 35 Series offers ten (35 and 35HP) and twenty (35DL and 35DLHP) custom setup locations that may be programmed by the user or by the company.

The 35 Series is equipped with a USB port for connecting the gage to the GageView interface program or to 35PCScope software. The PCScope program allows users to make adjustments to transducer setups while viewing RF waveforms. This can also be done using the optional waveform feature.

Other 35 Series features include:

- Thickness range: 0.004 - 25.000" (0.100-635 mm), dependent on material and transducer type
- Backlit display
- High-Low alarm functions
- Differential Mode
- Maximum resolution of 0.0001" (0.001 mm)
- Display HOLD/BLANK mode
- Long battery life
- Measurement in inches or millimeters
- MIN/MAX Mode
- RF Waveform output for optional 35PCScope interface program
- Rugged case and sealed, color-coded keypad for tactile and audio feedback
- Semi-automatic keyboard calibration
- Internal self-test modes
- Calibration lockout function (prevents accidental change to calibration or measurement mode)
- Optional live waveform for all models.

In addition, special prompts inform the user of instrument conditions such as: active transducer type and setup, low battery, loss of signal, calibration mode, alarms, and differential mode.

Panametrics-NDT gages can use a variety of broadband contact, delay line, and immersion transducers to permit optimum application on most engineering materials. For applications assistance, please consult the company or refer to Chapter 7 of this manual for a list of Default Transducer Setups and approximate thickness ranges.

Table 1: Model 35 Series Features

	35	35HP	35DL	35DLHP
Mode 1, 2, 3 Measurements	●	●	●	●
Transducer Frequency 0.050-5.0 MHz		●		●
Transducer Frequency 2.25-30.0 MHz	●		●	
Application Setup Recall	●	●	●	●
Thickness Display Resolution to 0.0001" (0.001 mm)	●		●	

Table 1: Model 35 Series Features

	35	35HP	35DL	35DLHP
Thickness Display Resolution to 0.001" (0.01 mm)		•		•
Electroluminescent Display Back Lighting	•	•	•	•
Fast Measurement Rate: Up to 20 per second	•	•	•	•
Fast Minimum Mode	•	•	•	•
Freeze Mode	•	•	•	•
Display Hold/Blank	•	•	•	•
Inches/Millimeter	•	•	•	•
Low Battery Indicator	•	•	•	•
150-Hour Battery Operating Time	•	•	•	•
Battery Saver	•	•	•	•

Table 1: Model 35 Series Features

	35	35HP	35DL	35DLHP
Two Year Limited Warranty	●	●	●	●
Differential Mode	●	●	●	●
Hi-Low Alarm	●	●	●	●
Internal Datalogger			●	●
Optional Live Waveform	●	●	●	●
USB Note: The USB port on the Model 35 and Model 35 HP is used for internal software upgrade only and transducer communications.	●	●	●	●
Optional RS-232 Port			●	●

The gages employ a full range of user-controlled display functions to measure the thickness of materials from one side only. A full line of transducers is available to measure materials between 0.004" (0.08 mm) and 25" (635 mm) thickness.

The Model 35 series makes full use of its microprocessor to offer selectable, advanced measurement features. The Model 35DL and 35DLHP built-in datalogger allows a simple method for recording thickness readings and for labeling each point with an identification code. The Model 35DL and 35DLHP can store up to 8000 thickness readings or 350 waveforms with thickness readings (Waveform Option), providing an alternative to the manual recording of data.

2 BASIC OPERATION

This section demonstrates how to create basic thickness measurements with a 35 Series gage. The unit ships from the factory containing default conditions for the transducer(s) you have purchased. Parameters may be changed after you become familiar with the more sophisticated gage features.

2.1 Initial Setup

Follow the initial setup procedure when operating the gage for the first time, in addition to using the default settings and test block included with the gage.

To begin the initial setup:

- Step 1: Plug the transducer cable into the transducer connector located on the top panel of the 35 Series.
- Step 2: Connect the transducer to the other end of the cable.
- Step 3: Press the [ON/OFF] key to turn the gage on. Ensure that the 'probe type' shown in the initial startup screen matches the transducer you have attached to the gage. This part number is engraved on the back or side of the transducer.

Note: If the probe type does not match the transducer, please refer to Section 3.2 of this manual.

- Step 4: Approximately three (3) seconds after the gage is turned on the following screen will appear (current units are indicated on the right side of the display):

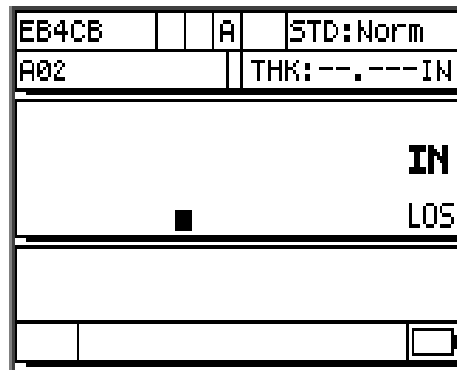


Figure 2-1: Zero Screen

To alternate measurement units between inches (IN) and millimeters (mm):

- Step 1: Press [2ndF], [↓](Setup).
- Step 2: Use the [↓] in the measurement Tab to select Units, and then use the [←] or [→] key to select English or Metric.
- Step 3: Press [MEAS] Key.

The gage is now ready to make measurements based on the default settings and the included test block.

2.2 Making Measurements

- Step 1: Apply couplant to the test block or material at the spot to be measured. In general, the smoother the material surface, the thinner the couplant may be. Rough surfaces require more viscous couplant such as gel or grease. Special couplants are required for high temperature applications.
- Step 2: Press the tip of the transducer to the surface of the material to be measured. Use moderate to firm pressure and keep the transducer as flat as possible on the material surface.
- Step 3: Read the material thickness on the gage display.

Note: For highest accuracy both a velocity and zero calibration must be done.

2.3 Low Battery

The gage will operate for at least 150 hours on one set of three (3) AA alkaline batteries under normal conditions (not in FAST mode and with backlight off). The battery symbol in the bottom right corner of the display indicates remaining battery life.

3 CALIBRATION AND MEASUREMENT

3.1 Measurement Mode Selection (Thickness, Velocity, or Time of Flight)

The 35 Series ultrasonic gages can operate in either a Velocity, Thickness, or Time of Flight mode. In Thickness mode, which is the default measurement mode, the gage calculates and displays the material thickness based on a time of flight measurement and a calibrated material velocity. In Velocity mode the gage can directly display velocity based on a time of flight measurement and user entered Ref Value (Thickness). The 35 series can also operate in a Time of Flight mode to display total time of flight.

To Select Measurement Mode:

- Step1: Press [2nd F],[↓] (Setup).
- Step2: While the MEAS Tab is Highlighted use the [↓] key to highlight MEAS OPTION.
- Step3: Use the [←] and [→] keys to change between Thickness, Velocity, or TOF (Time of Flight).
- Step4: Press [MEAS] to return to the Measurement Mode using the new settings.

3.2 Choosing a Default or User Defined Setup

The 35 Series gages can use a variety of transducers through the Auto-Application Recall feature. Stored within the gage are twenty-one (21) default setups (35 and 35DL) and seventeen (17) default setups (35HP and 35DLHP) as well as twenty (20) user-defined application setups (35D1 and 35 DLHP) and ten (10) user-defined application setups (35 and 35HP) that provide maximum flexibility for a wide range of applications.

The Pre-Defined setups always remain in the gage as defaults and cannot be removed. This section describes how to choose an appropriate stored transducer setup and how to calibrate the 35 Series gages for a specific application.

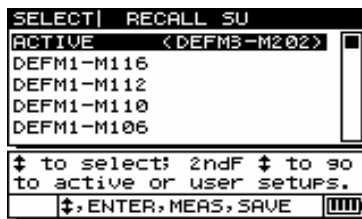
To setup a 35 Series gage:

Step 1: Select a transducer for the desired application and connect it to the gage.

Note: To determine an appropriate transducer, please refer to Section 7.1. Use the table as a guideline only; exact thickness ranges will vary depending on the application.

Step 2: While the gage is in the Measure mode, press [2nd F][←], (RECALL SETUP).

The following screen appears:



Step 3: Use the [↑] or [↓] keys to scroll through the available stored setups until the correct setup for the application is highlighted.

Note: During the time that the list of transducer setups is displayed, pressing [2nd F][↓] will jump to the first custom transducer setup and pressing [2nd F],[↑] will jump to the first default transducer setup.

Step 4: Once the correct setup is highlighted, press [MEAS]. This action automatically recalls the setup parameters for the chosen setup and brings the user back to the measure screen. Begin taking measurements.

Available SETUP choices include:

Table 3-1: 35 and 35DL

ACTIVE
DEFM1- M116
DEFM1- M112
DEFM1- M110
DEFM1- M106
DEFM1- M109
DEFM1- M1016
DEFM1- M1036
DEFM3-M208
DEF2P-M208
DEFM3-M202
DEFM2-M202
DEFP2-M202
DEFM3-V260
DEFM2-V260
DEFP2-V260

Table 3-1: 35 and 35DL

DEFM2-M201
DEFP2-M201
DEFM2-M206
DEFP2-M206
DEFM2-M207
DEFP2-M207
USER-1
USER-2
USER-3
USER-4
USER-5
•
•
•
USER-10 or 20

Table 3-2: 35HP and 35DLHP

DEFM1- M110
DEFM1- M106
DEFM1-M1036
DEFM1-M101
DEFM1-M102
DEFM1-M103
DEFM1-M109
DEFM2-M201
DEFP2-M201
DEFM2-M206
DEFP2-M206
DEFM2-M207
DEFP2-M207
DEFP1-M2008
DEFM1/V153
DEFM1/V154

Table 3-2: 35HP and 35DLHP

DEFM1/V156
USER-1
USER-2
USER-3
USER-4
USER-5
•
•
•
USER-10 or 20

Note: The setups listed as USER-1 through USER-XX may be renamed for special applications. For a complete description see Section 9–Application Notes.

Note: Ten (10) user-defined setups can be stored in the 35 and 35HP. Twenty (20) user-defined setups can be stored in the 35DL and 35DLHP.

3.3 Calibration and Measurements (Thickness Measurement Mode)

3.3.1 Velocity and Zero Calibration

The Material Velocity and Zero Calibration procedures may be combined using a thick and a thin calibration block of the same material.

- Step 1: Couple the transducer to the thick calibration block.
- Step 2: Press [CAL VEL].
- Step 3: When the thickness reading is stable, press [ENTER].
- Step 4: Uncouple the transducer from the block and use the [\uparrow , \downarrow , \leftarrow , and \rightarrow] slewing keys to enter the thickness of the thick block.
- Step 5: Couple the transducer to the thin block and press the [CAL ZERO] key.
- Step 6: When the reading is stable, press the [ENTER] key.
- Step 7: Uncouple the transducer from the block and use the [\uparrow , \downarrow , \leftarrow , and \rightarrow] slewing keys to enter the thickness of the thin block.
- Step 8: Press the [MEAS] key to complete the calibration and go to the Measure Mode.

3.3.2 Material Velocity Calibration When Material Sound Velocity Is Unknown

To do the Material Velocity Calibration, a calibration block made from the material to be measured must be used. The block should be

approximately as thick as the thickest section to be measured and have flat, smooth, and parallel front and back surfaces. The thickness of the block must be known exactly.

Step 1: Couple the transducer to the block.

Step 2: Press the [CAL VEL] key.

Step 3: When the thickness reading is stable, press [ENTER].

Step 4: Uncouple the transducer and use the [↑, ↓, ←, and →] slewing keys to enter the thickness of the standard.

Step 5: Press [MEAS] to complete the calibration and return to Measure Mode.

If the gage double beeps before returning to the Measure Mode, then an error has been made in the calibration procedure, and the velocity has not been changed. The most likely problem is that the thickness value entered was not correct.

In order to read and record the material velocity for this particular material, [2ndF], [CAL VEL](VEL) may be pressed following Velocity Calibration (or at any time from the Measure Mode). This velocity may be entered by means of the slewing keys in the future when measuring this material, without using the block.

Note: Sound velocity in all materials changes with temperature. For maximum accuracy the calibration block should be at approximately the same temperature as the samples to be measured.

3.3.3 When Material Sound Velocity Is Known

When preparing to measure a different material, of known sound velocity, the velocity may be entered directly without doing the CAL VEL procedure discussed above.

- Step 1: From the Measure mode press [2ndF], [CAL VEL](VEL). The current velocity will be displayed.
- Step 2: This number may then be changed to the desired value using the [↑, ↓, ←, and →] slewing keys.
- Step 3: Press [MEAS] to complete the entry and return to the Measure mode. If the gage is turned off before the [MEAS] key is pressed, the velocity will not be updated to the new value, but instead will retain the previous value.

3.4 Zero Calibration

To do the Zero Calibration, a calibration block of the material to be measured must be used. The block should be approximately as thin as the thinnest section to be measured. If the surface of the material to be inspected is rough, the surface of the calibration block may be roughened to simulate the actual surface to be measured. Rough surfaces generally reduce the accuracy of measurements but simulating actual surface conditions on the calibration block can help to improve results. The exact thickness of the sample must be known.

- Step 1: Couple the transducer to the standard.
- Step 2: Press the [CAL ZERO] key.
- Step 3: When the thickness reading is stable, press the [ENTER] key. The [ENTER] key will not be accepted if the LOS display flag is on.

- Step 4: Uncouple the transducer and use the [↑, ↓, ←, and →] slewing keys to enter the known thickness.
- Step 5: Press the [MEAS] key to complete the calibration and return to the Measure Mode.

Note: If the gage is turned off before the [MEAS] key is pressed, the Zero value will not be updated to the new value but instead will retain the previous value. If the gage sounds a long beep before returning to the Measure Mode, an error has been made in the calibration procedure, and the Zero value has not been changed. The most likely cause is that the entered thickness was not correct.

The model 35 series is now calibrated for the transducer and material and is ready to make thickness measurements on samples of the material that was used for calibration that have unknown mechanical thickness. Simply couple the transducer to the material and the Gage will display the Thickness

3.5 Calibration and Measurements (Velocity Measurement Mode)

3.5.1 Two Point Calibration (Velocity Measurement Mode)

Two Point Calibration requires two samples of the same material velocity and known thickness. The velocity value does not need to be known.

- Step 1: Activate the Velocity Measurement Mode as described in Section 3.1.

-
- Step 2: Couple to a thick sample and press [CAL VEL]. The gage will display a thickness reading.
- Step 3: When the thickness reading is steady, press [ENTER].
- Step 4: Use the [↑, ↓, ←, and →] slewing keys to enter the known thickness.
- Step 5: Couple the transducer to a thin sample and press [CAL Zero]. The gage will display a thickness reading.
- Step 6: When the thickness reading is steady, press [ENTER].
- Step 7: Use the [↑, ↓, ←, and →] slewing keys to enter the known thickness.
- Step 8: Press the [MEAS] key to complete the calibration.

The Model 35 Series gage is now calibrated for the transducer and is ready to make velocity measurements on a sample with known mechanical thickness.

To make a velocity measurement:

- Step 1: Press [2nd F], [ENTER] (REF VALUE) and use the [↑, ↓, ←, and →] slewing keys to enter the known thickness and then press [MEAS].
- Step 2: Couple to the sample. The calculated velocity will be displayed.

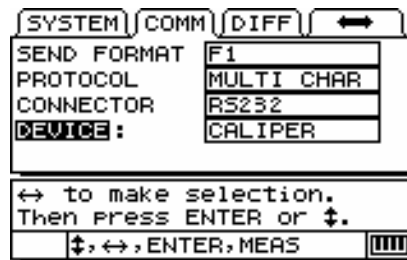
Note: When coupling to samples with the same mechanical thickness, it is not necessary to re-enter the Reference Thickness. A new reference thickness must be entered when the mechanical thickness of the material to be tested changes.

The company offers a digital caliper that can be used to measure mechanical thickness and automatically input the Reference Thickness directly into the gages. To use the digital caliper, the 35 Series Gage requires an optional RS-232 communication port, a special digital caliper, and a communication cable. For more information, please contact the company.

3.5.2 Optional HPV/C Digital Caliper

- Step 1: Cable Connection: Remove the RS-232 environmental plug from the caliper, located in the RS-232 port above the Fowler Sylvac label.
- Step 2: Insert the HPV/CC cable into the caliper's RS-232 slot with the words "OPTO RS232" facing down.
- Step 3: Plug the other end of the 35HPV/CC cable into the optional RS-232 port of the 35 Series gage.
- Step 4: When setting up the Units on the HPV/C digital caliper, press the Set Button or Mode Button to turn ON the digital caliper. To turn OFF the caliper, press and hold the Set Button for two (2) seconds.
- Step 5: Press the Mode Button. "SET" displays (active for three [3] seconds).
- Step 6: Press Mode Button twice to display "UNIT" (active for three [3] seconds).
- Step 7: Press Set Button to toggle between Inch and MM.
- Step 8: Set the 35 Series gage for Velocity Measurement (see Section 3.1).
- Step 9: With the 35DL or 35DLHP, press [2nd F], [↓] (Setup) and use [→] to highlight the COMM tab, and then use the [↑],

↓, ←, and →] slewing keys to set the connector to RS-232 and the device to Caliper.



Step 10: Use the digital caliper to measure the thickness of the material and then press Set Button. The displayed thickness value will be transferred to the 35DL or 35DLHP gage and be displayed in the REF THK box.

3.6 Calibration and Measurements (Two Point Calibration - Time of Flight Measurement Mode)

Two point calibration requires two samples of the same material velocity and known thickness. The velocity value does not need to be known.

- Step 1: Activate the Time of Flight Measurement Mode as described in Section 3.1.
- Step 2: Couple to a thick sample and press [CAL VEL]. The gage will display a thickness reading.

- Step 3: When the thickness reading is steady, press [ENTER].
- Step 4: Use the [↑, ↓, ←, and →] slewing keys to enter the known thickness.
- Step 5: Couple the transducer to a thin sample and press [CAL Zero]. The gage displays a thickness reading.
- Step 6: When the thickness reading is steady, press [ENTER].
- Step 7: Use the [↑, ↓, ←, and →] slewing keys to enter the known thickness.
- Step 8: Press the [MEAS] key to complete the calibration.

The model 35 Series gage is now calibrated for the transducer and is ready to make round trip time measurements.

To make a time of flight measurement, couple to the sample and the gage displays the round trip time of flight.

4 ADDITIONAL Model 35 SERIES GAGING FEATURES

Model 35 Series thickness gages have several additional convenient features. The use of these features is not required for basic operation. However, they make the gages more versatile instruments.

The following additional features may be accessed directly from the keypad:

Tables 4-1A & 4-1B:

Model 35, Model 35HP, Model 35DL, and Model 35DLHP	Model 35DL and Model 35DHP
Backlight	Datalogger
Freeze	

Additional features may be accessed in the setup mode. To access or change any of these functions, press [2nd F], [↓](SETUP).

These features include the following functions:

Model 35, 35HP, 35DL, and 35DLHP Series Gages

- Inches/Millimeters Conversion
 - Resolution
 - Min/Max
 - Hold/Blank
 - Measure Rate
 - CAL Lock
 - Beeper
 - Inactivity time
 - Radix
 - Backlight mode
 - LCD Contrast adjust
 - Resets
 - Diagnostics
 - Alarms
 - Differential Mode
-

4.1 Back Light

The display backlight feature internally illuminates the liquid crystal display with a bright, uniform light. This allows the display, which has excellent visibility in normal to high ambient light conditions, to be viewed in low to zero ambient light conditions.

To switch Backlight On/Off:

- **Model 35 and Model 35HP** - Press the [Light Bulb] key.
- **Model 35DL and 35DLHP** - Press [2nd F],[Freeze](LIGHT/LCD).

Additionally, when the backlight is switched on, you may select a power-saver Auto Backlight mode, which turns the backlight on only when a reading is being made and turns it off five seconds after LOS of signal.

To select Auto Backlight:

- Step 1: Press [2nd F], [↓](SETUP).
- Step 2: Use [→] to select the System Tab.
- Step 3: Use the [↓] key to highlight Backlight Mode
- Step 4: Use the [←] and [→] keys to change between Normal and Auto.
- Step 5: Press [MEAS] to return to the measure mode with the new settings.

Note: The next time the backlight is turned on, it will function in the as set (Normal) mode.

To adjust Contrast:

The Contrast adjustment feature allows the Model 35 Series thickness gages to adjust the contrast (light or dark) of the display.

To adjust the display contrast for the Model 35 and Model 35HP:

- Step 1: From Measure Mode, press [2nd F][Light Bulb](LCD ADJ).
- Step 2: Use the [↑] or [↓] key to adjust contrast.
- Step 3: Press [ENTER] to exit Contrast Adjust Mode.

To adjust the Display Contrast for the Model 35DL and 35DLHP:

- Step 1: From Measure Mode, press [2nd F][FREEZE](LIGHT/LCD) to turn on the back light and begin contrast adjustment.
- Step 2: Use the [↑] or [↓] key to adjust contrast.
- Step 3: Press [ENTER] to exit Contrast Adjust Mode.
- Step 4: Press [2nd F][FREEZE](LIGHT/LCD) to turn the back light off.

4.2 Freeze Mode

The freeze function allows the operator to freeze the thickness display when the [FREEZE] key is pressed. The display is returned to an active status by pressing [FREEZE] a second time or by pressing [MEAS]. This function is useful in a situation when the user wishes to hold a displayed thickness reading. This is helpful for high temperature thickness measurement applications to limit the transducer contact time. The freeze can also be used in combination with the Min/Max function.

4.3 Measurement Setup

The measurement setup menu allows the user to turn on/off many of the additional measurement features of the Model 35 Series gages.

Measurement setup features include:

- Meas Option (Thickness, Velocity, or Time of Flight)
- Units
- Resolution
- Min/Max
- Hold Blank
- Measure rate
- Averaging
- Cal Lock
- Quick Setup
- ID Overwrite (Model 35DL and 35DLHP only)

4.3.1 Meas Option

The Meas Option allows the user to select the measurement type. The 35 Series gages can measure and display thickness, velocity, or round trip time of flight. See Sections 3.2, 3.4, and 3.5 for details.

To activate the Meas Option:

Step 1: Press [2ndF][↓](Setup) to display the setup tabs.

Step 2: Use the [←, →] to highlight the MEAS tab.

Step 3: Use the [↓] key to highlight Meas Option and [←, →] to select Thickness, Velocity or TOF (Time of Flight).

Step 4: Press [MEAS] to return to the Measure Mode.

4.3.2 Units

Changing units allows the user to change from inch measurement units to millimeter measurement units.

To change units:

Step 1: Press [2ndF][↓](Setup) to display the setup tabs.

Step 2: Use the [←,→] keys to highlight the MEAS tab.

Step 3: Use the [↓] key to highlight Units and the [←,→] keys to select English (in.) or metric (mm).

Step 4: Press [MEAS] to return to the Measure Mode.

4.3.3 Resolution

Resolution allows the user to change the number of decimal points displayed in the thickness display.

To changing resolution:

Step 1: Press [2ndF][↓](Setup) to display the setup tabs. Use the [←,→] keys to highlight the MEAS tab.

Step 2: Use the [↓] key to highlight Resolution and the [←,→] keys to select Standard, Low, or High.

Note: High resolution is available only for the Models 35 and 35DL.

Step 3: Press [MEAS] to return to the Measure Mode.

4.3.3.1 Resolution (Thickness Mode)

For Models 35 and 35DL, the user can select among Standard (0.001" or 0.01 mm), Low (0.01" or 0.1 mm), and High (0.0001" or 0.001 mm).

For Models 35HP and 35DLHP, the user can select between Standard (0.001" or 0.01 mm) and Low (0.01" or 0.1 mm).

4.3.3.2 Resolution (Velocity Mode)

For Models 35 and 35DL, the user can select between Standard (0.0001 in/ μ sec or 0.001 mm/ μ sec) and Low (0.001 in/ μ sec or 0.01 mm/ μ sec).

For Models 35HP and 35DLHP, the user can select between Standard (0.0001 in/ μ sec or 0.001 mm/ μ sec) and Low (0.001 in/ μ sec or 0.01 mm/ μ sec).

4.3.3.3 Resolution (Time of Flight Mode)

The resolution for the Time of Flight Mode is fixed at 0.01 μ sec.

4.3.4 Min/Max

Min/Max allows the user to put the gage in Min or Max scanning mode. This feature allows the user to scan over an area and quickly determine the minimum or maximum thickness.

Min Mode displays live thickness values and recalls the minimum thickness when a LOS (loss of signal) occurs. Live thickness values are displayed in filled-in form, and recalled min values are displayed in outlined form. The minimum values are retained in a temporary

memory until new minimum thickness values replace them or until the [Meas] key is pressed to reset the minimum. When Min Mode is selected, the Model 35 Series gage automatically changes to MAX update mode.

Max Mode displays live thickness value and recalls the maximum thickness when a LOS (loss of signal) occurs. Live thickness values are displayed in filled-in form, and recalled max values are displayed in outlined form. The maximum value is retained in a temporary memory until a new maximum thickness value replaces it or until the [Meas] key is pressed to reset the maximum. When Max Mode is selected, the Model 35 Series gage automatically changes to MAX MEAS Rate (up to 20 Hz).

To select Min/Max:

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←,→] keys to highlight the MEAS tab.
- Step 3: Use the [↓] key to highlight Min/Max and the [←,→] keys to select among Off, Min, or Max.
- Step 4: Press [MEAS] to return to the Measure Mode.

Note: The Freeze key can be used with the Min/Max feature to prevent the gage from reading false signals while the transducer is being removed from the surface of the material. While in Min or Max Mode, scan the area of interest and then press the [Freeze] key. Uncouple the transducer from the material and press the [Freeze] key again to recall Min or Max.

4.3.5 Hold/Blank

Hold/Blank controls:

- Hold: The gage holds the last measurement when no measurements (LOS) are being made.
- Blank: The display blanks out the thickness value when no measurements (LOS) are being made.

The Model 35 Series is set by default to blank out the measurement display when no measurements are being made. When Hold mode is selected, live (active) thickness readings are displayed with filled-in numbers, and held measurements are displayed with outlined numbers.

To change Hold/Blank:

- Step 1: Press [2ndF],[↓](Setup) to display the setup tabs.
- Step 2: Use the [←,→] to highlight the MEAS tab.
- Step 3: Use the [↓] key to highlight Hold/Blank and [←,→] to select between Blank and Hold.
- Step 4: Press [MEAS] to return to the Measure Mode.

4.3.6 Measure Rate

Measure Rate allows the user to display the measurement update rate. The user can select among update rates of 4 Hz, 8 Hz, 16 Hz, and MAX (MAX rate is within a range of 16 - 20 Hz, dependent on the measurement mode and the application).

Note: Changing to the MAX update rate will greatly affect the battery life of the Model 35 Series thickness gages.

To change Measure Rate:

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←,→] keys to highlight the MEAS tab.
- Step 3: Use the [↓] key to highlight Measure Rate and the [←,→] keys to select among 4 Hz, 8 Hz, 16 Hz, and MAX.
- Step 4: Press [MEAS] to return to the Measure Mode.

4.3.7 Averaging Mode

In the Averaging Mode, the displays shows the average value of the ten (10) most recent readings. The Q-Bar (quality bar) is an indicator of measurement stability – a longer Q-Bar indicates more stable readings, that is, readings that do not vary from one another.

Averaging and Q-Bar are available for all measure rate settings.

Three options for the Averaging setting are available: ON, OFF and Q-Bar.

To change Measure Rate:

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [↓] key to enter the MEAS tab.
- Step 3: Press [↑] or [↓] to scroll to AVERAGING.

Step 4: Press [←, →] to choose On, Off, or Q-Bar.

Step 5: Press [MEAS/RESET].

4.3.8 CAL Lock

CAL Lock allows the user to lock the calibration so that it cannot be changed while CAL Lock is enabled. If the user tries to change the calibration while the lock is activated, the gage displays a CAL Lock message.

To activate CAL Lock:

Step 1: Press [2ndF][↓](Setup) to display the setup tabs.

Step 2: Use the [←, →] keys to highlight the MEAS tab.

Step 3: Use the [↓] key to highlight CAL Lock and [←, →] to select between Off and On.

Step 4: Press [MEAS] to return to the Measure Mode.

4.3.9 Quick Setup

When activated, the Quick Setup feature permits the user to quickly recall the first four (4) user-defined setups by the use of a simple keypad shortcut.

To activate Quick Setup:

Step 1: Press [2ndF][↓](Setup) to display the setup tabs.

Step 2: Use the [↓] key to highlight the MEAS tab.

Step 3: Press the [↑] or [↓] to scroll to Quick Setup.

Step 4: Press the [←] or [→] to choose On or Off.

Step 5: Press [MEAS/RESET].

Once Quick Setup is activated:

- Press [ENTER], [↑] to recall the first user-defined transducer setup.
- Press [ENTER], [→] to recall the second user-defined transducer setup.
- Press [ENTER], [↓] to recall the third user-defined transducer setup.
- Press [ENTER], [←] to recall the fourth user-defined transducer setup.

4.3.10 ID Overwrite (Model 35DL and 35DLHP Only)

ID Overwrite allows the user to lock ID locations so that once a thickness reading is saved at the ID# location, users will be prompted with a message asking if they wish to overwrite the stored thickness value when attempting to overwrite stored readings.

To activate ID Overwrite:

Step 1: Press [2ndF][↓](Setup) to display the setup tabs.

Step 2: Use the [←, →] keys to highlight the MEAS tab.

Step 3: Use the [↓] key to highlight ID Overwrite and [←, →] to select between Off and On.

Step 4: Press [MEAS] to return to the Measure Mode.

4.4 System Setup

The System Setup menu allows the user to turn on/off many Model 35 Series gage configurations.

Features include:

- Beeper
- Inactive Time
- Language
- Radix
- Backlight Mode
- Save Key Function
- File Mode

4.4.1 Beeper

Beeper allows the user to turn the audio beeper of the Model 35 Series gages on and off. The Beeper is set to On by default and will generate an audio beep when any key is pressed or when an alarm condition has been detected.

Step 1: Press [2ndF][↓](Setup) to display the setup tabs.

Step 2: Use the [←, →] keys to highlight the System tab.

Step 3: Use the [↓] key to highlight Beeper and [←, →] to select between Off and On.

Step 4: Press [MEAS] to return to the Measure Mode.

4.4.2 Inactive Time

Inactive Time allows the user to set the Auto Power Off feature to either On or Off. When Inactive Time is set to On, the Model 35 Series gage powers off after approximately six (6) minutes during which no thickness measurements or key presses have occurred. When Inactive Time is set to Off, the Model 35 Series unit remains powered up until the user turns the unit Off or the battery voltage becomes low.

To change Inactive Time:

- Step 1: Press [2ndF][\downarrow](Setup) to display the setup tabs.
- Step 2: Use the [\leftarrow , \rightarrow] keys to highlight the System tab.
- Step 3: Use the [\downarrow] key to highlight Inactive Time and [\leftarrow , \rightarrow] to select between Off and On.
- Step 4: Press [MEAS] to return to the Measure Mode.

4.4.3 Language

The default language for the 35 Series gages is English, but the gages can add a custom language so that text will be shown in the custom programmed language. This feature will be added to the 35 Series gages in early 2006. Please contact the company for more information.

To activate Custom Language:

- Step 1: Press [2ndF],[\downarrow] (Setup) to display the setup tabs.
- Step 2: Use the [\leftarrow , \rightarrow] keys to select the System tab.
- Step 3: Press the [\uparrow] or [\downarrow] to scroll to Language.

Step 4: Press [←, →] to choose English or Custom.

Step 5: Press [MEAS/RESET].

4.4.4 Radix

Radix allows the user to select the display of the radix character (the character that separates the whole and decimal part of the thickness value). In the United States, the period (.) is used as radix (Example: 0.123"). In many other countries, the comma (,) is used (Example: 1,25 mm).

To change radix:

Step 1: Press [2ndF][↓](Setup) to display the setup tabs.

Step 2: Use the [←, →] keys to highlight the System tab.

Step 3: Use the [↓] key to highlight Radix and [←, →] to select between Period and Comma.

Step 4: Press [MEAS] to return to the Measure Mode.

4.4.5 Backlight Mode

Backlight Mode allows the user to determine how the backlight works once it has been turned on. When Backlight Mode is set to Normal, the backlight will stay on until it is turned off. When Backlight Mode is set to Auto and the backlight is turned on, it will stay on while a thickness measurement is being displayed and automatically turn off five (5) seconds after a LOS (Loss of Signal) has occurred.

To Change Backlight Mode:

Step 1: Press [2ndF][↓](Setup) to display the setup tabs.

- Step 2: Use the [←, →] keys to highlight the System tab.
- Step 3: Use the [↓] key to highlight Backlight Mode and [←, →] to select between Normal and Auto.
- Step 4: Press [MEAS] to return to the Measure Mode.

4.4.6 Save Key Function

The Save key on the 35DL and 35DLHP units can be programmed to initiate a Save or Send function. When the Save key is set to “SAVE”, pressing the [SAVE] key will save the current thickness reading to the internal datalogger. When the Save key is set to “SEND”, pressing the [SAVE] key will send the reading through the optional RS-232 port.

Note: The 35DL and 35DLHP cannot single send thickness data through the USB port.

The ability to program the Save key is helpful when using the optional RS-232 output or the remote foot switch options. Pressing the remote foot switch acts in the same way as pressing the Save key so that programming the Save key function allows the remote foot switch to initiate a Save or Send function.

To change the Save key function:

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←, →] keys to highlight the System tab.
- Step 3: Use the [↓] key to highlight Save and [←, →] to select between “SAVE” and “SEND”.
- Step 4: Press [MEAS] to return to the Measure Mode.

4.4.7 File Mode (35DL and 35DLHP Only)

When creating data files in the 35DL and 35DLHP, it is necessary to designate the type of data that will be stored in the file. The File Mode parameter in the System Setup tab allows the user to set the default file mode. This sets the default file type that is designated when a new file is created. The user can change this during the file creation. The file Modes are:

- Normal - For saving standard thickness measurements
- Velocity - For saving velocity measurements
- Time of Flight - For saving time of flight measurements
- Reduction Rate - For saving both Thickness and % Reduction Rate measurements

To Change the default File mode;

Step 1: Press [2nd F], [↓](Setup) to display the setup tabs.

Step 2: Use the [←, →] keys to highlight the System tab.

Step 3: Use the [↓] key to highlight File Mode and [←, →] to select among Normal, Velocity, Time of FLT, and Reduction RT.

Step 4: Press [MEAS] to return to the Measure Mode.

4.5 Communication

The 35 Series gages are supplied with a standard USB communication port. This port is used to:

- Communicate with the optional 35PCSCOPE program for

creating custom transducer setups.

- Upgrade gage operating software.
- Communicate with the Panametrics-NDT Gageview interface program.
 - 35 and 35HP gages can send and receive Custom Transducer setups.
 - 35DL and 35DLHP can send and receive Thickness, Velocity and Time of Flight data as well as Custom Transducer setups.

An optional (unit must be returned to the company for modification) RS-232 port is available for the 35DL and 35DLHP for use with:

- Serial port printers
- RS-232 serial communication programs
- RS-232 digital caliper (supplied)
- Bar code reader (supplied)

4.5.1 Send Format

The Send format selects the format of the data being sent from 35 Series gages. It is set by default to F1 and should be changed only when communicating with custom software. Contact the company for information concerning additional Send formats.

Single sending can only be done using the optional RS-232 output. Send can only be done with the thickness reading. Formats F1-F5 are used when performing File Sends or Range Sends to external software or printers.

F1 Format: Sends ID#, Thickness Table, and Setups Table

Identifier	Thickness	Units	Flags	SU#
001	1.091	IN	M1--	2
002	1.091	IN	M1--	2
003	1.091	IN	M1--	2
004	1.091	IN	M1--	2
005	1.091	IN	M1--	2
OK				

SU#	VEL (μ S)	DIFF	LO ALM	HI ALM	UNITS	BASE MEAS SETUP
2	0.22600	0.000	0.000	25.000	In	DEFM1-M110
OK						

F2 Format: Sends ID#, Thickness Table, Setup Table, and Statistics

Identifier	Thickness	Units	Flags	SU#
001	1.091	IN	M1--	2
002	1.091	IN	M1--	2
003	1.091	IN	M1--	2
004	1.091	IN	M1--	2
005	1.091	IN	M1--	2
OK				

SU#	VEL (μ S)	DIFF	LO ALM	HI ALM	UNITS	BASE MEAS SETUP
2	0.22600	0.000	0.000	25.000	In	DEFM1-M110
OK						

*****STATISTICS*****

OF THK 5
MEAN 1.091"
MEDIAN 1.091"
RANGE 0.000"
STD. DEV 0.000"
OF HIGH ALARM 0
% OF HIGH ALARM 0%
OF LOW ALARM 0
% OF LOW ALARM 0%

IDENTIFIER **MINIMUM THK**

001	1.091"
002	1.091"
003	1.091"
004	1.091"
005	1.091"

IDENTIFIER	MAXIMUM THK
001	1.091"
002	1.091"
003	1.091"
004	1.091"
005	1.091"

OK

F3 Format: Sends the ID#, Thickness Table, Setup Table, and Transducer Setup Table

Identifier	Thickness	Units	Flags	SU#
001	1.091	IN	M1--	2
002	1.091	IN	M1--	2
003	1.091	IN	M1--	2
004	1.091	IN	M1--	2
005	1.091	IN	M1--	2

OK

SU#	VEL (μ S)	DIFF	LO ALM	HI ALM	UNITS	BASE MEAS SETUP
2	0.22600	0.000	0.000	25.000	In	DEFM1-M110

OK

Setup Name: DEFM1-M110
Probe Type: M110
Material Velocity: 0.22600"/ μ s
Zero: 220.0
Pulser Voltage: 110 V
Maximum Gain: 55.1 dB
Initial Gain: 26.1 dB
TVG Slope: 4.97 dB/ μ s
Main Bang Blank: 500.15 ns
Echo Window: 199.50 μ s
Mode: 1
Echo1 Detection: -slope

Echo2 Detection: N/A
Interface Blank: N/A
Mode3 Echo Blank: N/A

OK

F4 Format: a "+" or "-" Sign and Thickness Table (No ID#'s)

+1.091
+1.091
+1.091
+1.091
+1.091

F5 Format: Sends the ID# , Thickness Table, Setup Table, Transducer Setup Table, and Statistics

Identifier	Thickness	Units	Flags	SU#
001	1.091	IN	M1--	2
002	1.091	IN	M1--	2
003	1.091	IN	M1--	2
004	1.091	IN	M1--	2
005	1.091	IN	M1--	2
006	--	IN	LI--	2
OK				

SU#	VEL (μS)	DIFF	LO ALM	HI ALM	UNITS	BASE MEAS SETUP
2	0.22600	0.000	0.000	25.000	In	DEFM1-M110
OK						

Table continues on the following page.

Setup Name: DEFM1-M110
Probe Type: M110
Material Vel: 0.22600"/ μ s
Zero: 220.0
Pulser Voltage: 110 V
Maximum Gain: 55.1 dB
Initial Gain: 26.1 dB
TVG Slope: 4.97 dB/ μ s
Main Bang Blank: 500.15 ns
Echo Window: 199.50 μ s
Mode: 1
Echo1 Detection: -slope
Echo2 Detection: N/A
Interface Blank: N/A
Mode3 Echo Blank: N/A

OK

Statistics

OF THK: 5
MEAN: 1.091"
MEDIAN: 1.091"
RANGE: 0.000"
STD. DEVIATION: 0.000"
OF HIGH ALARM: 0
% OF HIGH ALARM: 0%
OF LOW ALARM: 0
% OF LOW ALARM: 0%

IDENTIFIER	MINIMUM THK
001	1.091"
002	1.091"
003	1.091"
004	1.091"
005	1.091"

IDENTIFIER	MAXIMUM THK
001	1.091"
002	1.091"
003	1.091"
004	1.091"
005	1.091"

OK

F6 Format: Used with the Reduction Rate function to output both the thickness and the Reduction Rate along with an alarm indicator. If the alarm is set and triggered at an ID# location, a single asterisk (*) indicates a YELLOW alarm condition, and a double asterisk (**) indicates a RED alarm condition.

01	0.503	0.0
02	0.503	0.0
03	0.402	0.0
04	0.401	0.0
05	0.301	24.7*
06	0.301	24.7*
07	0.202	49.5**
08	0.202	49.6**
09	0.103	74.3**
10	0.103	74.3**

4.5.2 Protocol

Two sets of remote commands can be used to communicate with 35 Series gages. Normally, communication between the 35 Series gages and 35pcscope or Gageview is done using the Multi Char command set. The Single Char command set is used for communication with custom software and external devices like digital calipers, RS-232 printers, and RS-232 bar code readers.

4.5.3 Connector

35 Series gages are standardly supplied with a USB communication port only. An optional RS-232 port is available for communication with RS-232 base equipment. Normally, the connector should be set to USB and should be set to RS-232 only when the option has been installed and you are communicating via RS-232 protocol.

When RS-232 is selected, the user can also configure the device (printer, terminal, bar code or caliper). In addition, the user can set the

baud rate when printer and terminal are selected. The baud rate can be set to 1200, 2400, 4800, 9600, or 19200. Additional RS-232 parameters are fixed at:

- Word Length Fixed at 8 bits
- Parity Fixed at None
- Stop Bits Fixed at 1

To change the communication settings:

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←,→] keys to highlight the Comm tab.
- Step 3: Use the [↓] key to highlight the parameter and [←,→] to select settings.
- Step 4: Press [MEAS] to return to the Measure Mode.

4.5.4 Continuous Output (Optional RS-232 Output Only)

The 35DL and 35DLHP can send continuous thickness data via the optional RS-232 port. This allows the 35DL and 35DLHP to be integrated into custom systems that require the continuous monitoring of thickness readings.

Continuous Output Configuration

OFF:	Continuous output is turned off.
-------------	----------------------------------

Continuous Output Configuration

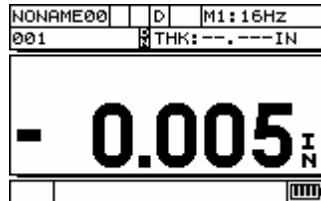
ON:	Continuous thickness at the measurement update rate (selectable in Measure tab 4, 8, 16 or Max (approximately 20 Hz)).
5 SEC AVG:	Average thickness reading every five (5) seconds. The output is the average of every thickness value since the last output interval (approximately 100 readings). Data is collected at the maximum measure rate (approximately 20 Hz). LOS (Loss of Signal) readings are ignored in the average calculation.
10 SEC AVG:	Average thickness reading every ten (10) seconds. The output is the average of every thickness value since the last output interval (approximately 200 readings). Data is collected at the maximum measure rate (approximately 20 Hz). LOS (Loss of Signal) readings are ignored in the average calculation.
Output Format:	0.092<CR>,<LF> 0.095<CR>,<LF> 0.097<CR>,<LF> 0.093<CR>,<LF> 0.091<CR>,<LF> 0.095<CR>,<LF> 0.090<CR>,<LF> 0.092<CR>,<LF>

To change the continuous output mode (for 35DLand 35DLHP and optional RS-232 output):

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←, →] keys to highlight the Communication tab.
- Step 3: Use the [↓] key to highlight “CONT OUTPUT” and [←, →] to select among OFF, ON, 5 SEC AVG, and 10 SEC AVG.
- Step 4: Press [MEAS] to return to Measure Mode.

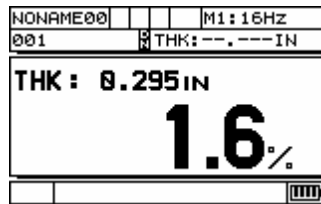
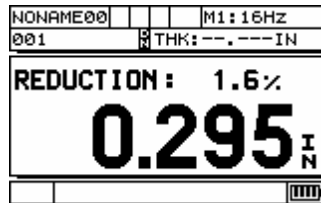
4.6 Normal Differential and Reduction Rate Diff Mode

Differential (Diff) Mode allows the user to set a differential set point. When Diff Mode is activated, the gage displays the difference between the Diff set point and the actual thickness value. The gage displays a “D” to indicate that Diff Mode is active.



Reduction Rate Diff Mode is used in metal bending or applications in which the user needs to track the percentage of wall thinning that has occurred during a metal bending process. The user enters the original wall thickness in the gage, which then displays the actual thickness

and the percentage difference between the current thickness and the reference thickness. The user can select to show either the thickness value or the reduction rate in large font.



To activate Diff Mode:

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←,→] keys to highlight the Diff tab.
- Step 3: Use the [↓] key to highlight Enable and [←,→] to select On or Off.
- Step 4: Press the [↓] key to highlight Diff Type and use the

[←, →] keys to select Normal or Reduction Rate.

Step 5: Press the [↓] key or [ENTER].

Step 6: Press the [→] key to highlight the former value and use [↑, ↓, ←, →] to edit the value.

Step 7: Press [ENTER].

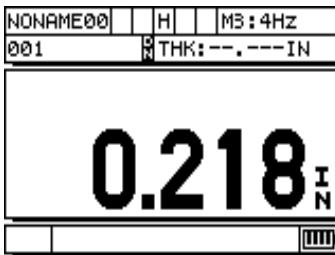
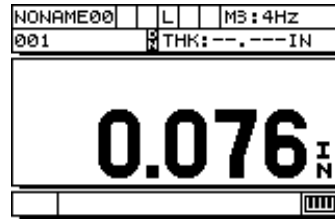
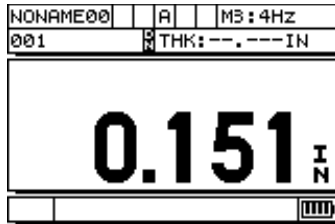
Step 8: Press [←, →] to select large font Thickness or Reduction RT.

Step 9: Press [MEAS] to return to the Measure Mode.

4.7 High/Low Alarms

The High/Low alarm allows the user to establish high and low alarm set points. When a thickness is displayed below the Low Alarm set point or above the High Alarm set point, an audio beep is sounded and an alarm flag is displayed.

When the alarm is active but not above or below set points, the gage displays an "A". The gage displays an "L" to indicate a Low Alarm condition and an "H" to indicate a High Alarm condition only when set points have been violated.



Note: The Alarm Mode and the Diff Mode are mutually exclu-

sive (cannot be used at the same time except when Reduction Rate is selected). If one of these functions is activated, it will be automatically turned off when the other function is turned on.

4.7.1 Activate the High/Low Alarm (When Reduction Rate Is Inactive)

To activate the High/Low Alarm (when Reduction Rate is inactive):

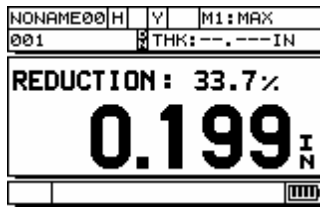
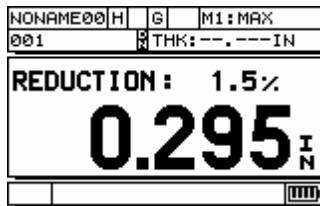
- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←,→] keys to highlight the Alarm tab.
- Step 3: Use the [↓] key to highlight Enable and [←,→] to select On or Off.
- Step 4: Press the [↓] key to highlight Lo-Alarm and use the [←,→] keys to slew to the low alarm set point.
- Step 5: Press the [↓] key to highlight Hi-Alarm and use the [←,→] keys to slew to the high alarm set point.
- Step 6: Press [MEAS] to return to the Measure Mode.

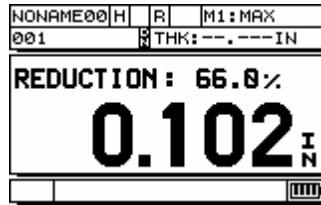
4.7.2 Activate the High/Low Alarm (When Reduction Rate Is Active)

High and low Reduction Rate alarms can be set when the Reduction Rate differential mode is activated. The user will set a high (RED) and Low (YELLOW) reduction percentage, and the gage will display:

- “R” flag for reduction rates that are greater than or equal to the Red Alarm (high).

- “Y” flag for reduction rates that are between the Yellow Alarm (low) and Red Alarm (high) set points.
- “G” flag for reduction rates that are less than the Yellow Alarm (low) set point.





To activate the High/Low Alarm (when Reduction Rate is active):

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←,→] keys to highlight the Alarm tab.
- Step 3: Use the [↓] key to highlight Enable and [←,→] to select On or Off.
- Step 4: Press the [↓] key to Red Alarm (high) and use the [→] key and the [↓, ↑, ←,→] keys to edit the alarm value set point.
- Step 5: Press [ENTER].
- Step 6: Press the [→] key to highlight Yellow Alarm (low) and use the [↓, ↑, ←,→] keys to edit to the alarm set point.
- Step 7: Press [MEAS] to return to the Measure Mode.

4.8 Activating Waveform Option

An optional Live Waveform can be added to any of the 35 Series gages. If the Live Waveform option has been purchased with a new 35

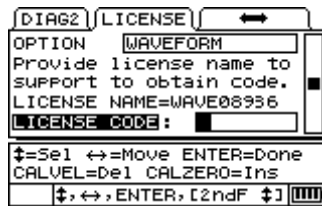
Series gage, then the optional software will already be loaded and activated on the unit. When this feature is activated, a waveform tab will be placed in the Setup menu. See Section 4.9 for more information on using the optional Live Waveform.

If the Live Waveform software was purchased after the unit was initially supplied, then the Waveform option must be activated using a unique license name and license name code system.

Each 35 Series gage will generate a unique license name. To activate the internal Live Waveform feature, the user must enter a valid license code. Contact Panametrics-NDT™ or our local Panametrics-NDT representative to obtain a valid license code for the license name. This license code is not valid for any other 35 Series unit.

Activate the Live Waveform software through the following procedure:

- Step 1: Press [2ndF],[↓] (SETUP).
- Step 2: Use the [→] key to select the License Tab.
- Step 3: Press [ENTER] twice. The gage displays a License Name.



- Step 4: Enter the License Code provided by Panametrics-NDT™ using the [↓, ↑, ←, →] keys and then press [ENTER].
- Step 5: Use the [←, →] keys to select Done and press [ENTER].
- Step 6: Press [ENTER] to accept.
- Step 7: Power the unit Off, then On again to complete the Live Waveform activation.

4.9 Optional Waveform

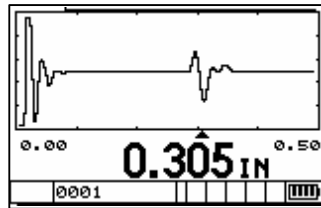
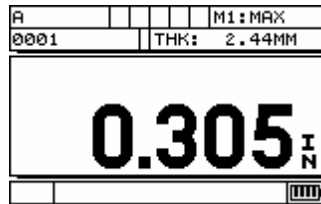
An optional live waveform available for all 35 Series gages allows the user to view the live ultrasonic waveform to help align the transducer for difficult applications. When this feature is added, the user can change between the standard thickness display and the optional live waveform display. The user can also select an automatic tracking zoom for the waveform so that measurement echoes will always be displayed on screen.

A Save Key designation is also set in the waveform setup tab (35DL and 35DLHP) to allow the user to define the function of the Save Key. Setting the Save Key to “THK ONLY” will save only the thickness value when the Save Key is pressed, and setting the Save Key to “THK + WF” will save the thickness and waveform when the Save Key is pressed.

Note: This tab is available only if the Waveform option is activated on the gage. Please contact the company for more information concerning activating the optional Waveform feature.

Note: The 35DL and 35DLHP can save approximately 8000 thickness readings or 350 waveforms with thickness

readings.

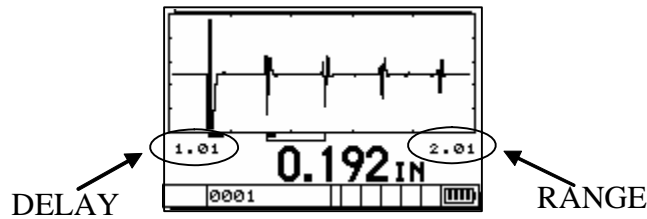


To activate the optional waveform:

- Step 1: Press [2ndF], [↓] (Setup) to display the Setup tabs.
- Step 2: Use the [←, →] keys to select the Waveform tab.
- Step 3: Press the [↓] or [↑] to scroll to Enable.
- Step 4: Press [← or →] to choose On or Off.
- Step 5: Press [↓] or [ENTER] to scroll to Zoom.

- Step 6: Press [← or →] to choose On or Off.
- Step 7: Press [↓] or [ENTER] to scroll to Save Key (Models 35DL and 35DLHP only).
- Step 8: Press [←, →] to choose THK ONLY or THK + WF.
- Step 9: Press [MEAS/RESET].

Note: When the waveform has been enabled and the Zoom feature is turned off, the user can adjust the range and delay of the waveform by using [↓] or [↑] keys (changes the range to the next higher or lower range set point) or [←, →] keys (increases or decreases the waveform delay).



4.9.1 Transducer Setup Adjust Mode

The Transducer Setup Adjust Mode feature allows the user to make transducer setup adjustments.

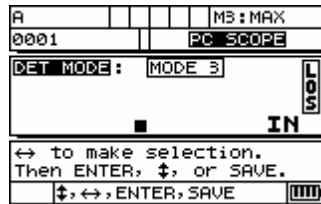
Note: These adjustments can affect the measurement capability of the instrument and should be undertaken only by a person with extensive knowledge of ultrasonic theory.

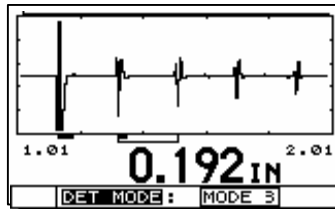
This mode can be activated while the optional waveform is enabled or while in standard thickness display mode. Adjusting the transducer setup should only be done while viewing the live ultrasonic waveform. If your unit does not have the optional live waveform, then the gage can be connected to the optional 35PCScope program for viewing and adjusting transducer setups.

To activating Transducer Setup Adjust Mode:

- Step 1: Make sure that the proper default transducer or custom transducer setup has been recalled. Refer to section 3.2 for information concerning recalling stored transducer setups.
- Step 2: Press [2ndF], [←] (Setup Recall) and press [Enter].
- Step 3: Press [2ndF], [←] again to enter Transducer Adjust Mode.
- Step 4: Press [↓] or [↑] to select the transducer setup parameter and press [← , →] to adjust the value.

Note: A complete list of setup parameters and their definitions appears in Chapter 9.





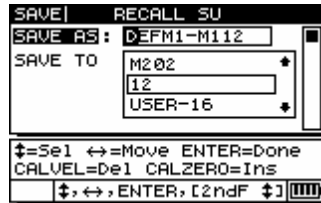
Note: When in Setup Adjust Mode with live waveform, range and delay parameters are displayed in the Setup Parameter list.

4.9.2 Saving Custom Transducer Setups

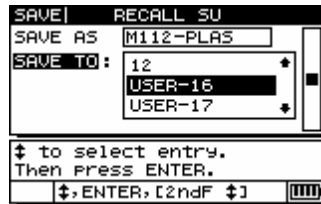
Once the proper adjustments are made, you can store the settings as a custom transducer setup file. The 35 Series gages can store multiple setups in its internal memory. The 35 and 35HP can store 10 custom transducer setup files. The 35DL and 3DLHP can store 20 custom transducer setup files.

To save setup parameters, follow these steps:

- Step 1: Make the appropriate changes to the setup parameters.
- Step 2: Press [2nd F] ,[←](RECALL SETUP).
- Step 3: Press [SAVE]. The gage displays the Save Recall Setup screen.



- Step 4: Use the [←, →, ↓, ↑] keys to edit/enter a new file name.
- Step 5: Press [ENTER].
- Step 6: Use the [↑, ↓] keys to select a location in which to store the file and press [ENTER]. Note that locations labeled User1 through UserXX are blank locations. If you chose a location that has a setup already stored in it, the old setup will be overwritten.



- Step 7: Press [ENTER] while SAVE is highlighted to save the custom transducer setup or use the [←, →] keys to highlight CANCEL and press [ENTER] to cancel the setup save.
- Step 8: Press [MEAS] to return to Measurement Mode.

4.9.3 35PCScope

35PCScope is an optional interface program that allows the user to view the live waveform and transducer setup parameters for all 35 Series gages. This program allows the user to:

- View live waveforms and make transducer setup adjustments
- Upload/download custom transducers setups
- Print the waveform screen
- Save/recall waveform screens

For more information concerning 35PCScope, contact the company.

4.10 Clock Setup (Models 35DL 35DLHP Only)

The clock is used to set the internal date and time for the Model 35DL and 35DLHP, so that a time/date stamp, indicating when data was last stored in a file, can be given to a data file.

To set the internal date and clock:

Step 1: Press [2ndF][\downarrow](Setup) to display the setup tabs.

Step 2: Use the [\leftarrow , \rightarrow] keys to highlight the Clock tab.

Step 3: Use the [\downarrow] key to highlight Hour and [\leftarrow , \rightarrow] to set the hour.

Step 4: Press the [\downarrow] key to highlight Minute and use the [\leftarrow , \rightarrow] keys to set the minute.

Step 5: Press the [\downarrow] key to highlight Year and use the [\leftarrow , \rightarrow]

keys to set the year.

- Step 6: Press the [↓] key to highlight Month and use the [←,→] keys to set the month.
- Step 7: Press the [↓] key to highlight Day and use the [←,→] keys to set the day.
- Step 8: Press the [↓] key to highlight Set/Cancel and use the [←,→] keys to select Set or Cancel.
- Step 9: Press [Enter] when Set is highlighted to set the clock and then press [MEAS] to return to the Measure Mode.

4.11 Resets

Resets restore Model 35 Series operating software to factory default settings. Three resets can be performed: Measurement, Master, and Database (Model 35DL and 35DLHP only).

4.11.1 Measurement Reset

Measurement Reset resets the measurement parameters to their default values. The parameters that are reset and their reset values are:

- Material Velocity (0.2260 in/μsec)
- Measure Option (Thickness)
- Unit (Inches)
- Resolution (Standard)
- Min/Max (Off)
- Hold/Blank (Blank)
- Measure Rate (4 Hz)

- Averaging (Off)
- CAL Lock (Off)
- Quick Setup (Off)
- ID Overwrite (Off) Model 35DL and 35DLHP only
- Beeper (On)
- Inactive Time (On)
- Language (English)
- Radix (Period)
- Backlight Mode (Normal)
- Battery Type Alkaline
- Alarm (Off). Default Values: Low = 0.000; High = 25.000
- Diff (Off). Default Value = 0.000

To perform Measurement Resets:

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←, →] keys to highlight the Reset tab.
- Step 3: Use the [↓] key to highlight Measurement Reset and press [ENTER].
- Step 4: Use the [←, →] keys to highlight Reset or Cancel and press [ENTER].
- Step 5: Press [MEAS] to return to the Measure Mode.

4.11.2 Master Reset

Master Reset resets the entire instrument to its default values and also deletes the database on the Model 35DL and 35DLHP.

Note: Caution should be used when performing a Master Reset because it will cause the gage to delete all stored thickness readings. Once a master reset has been performed, the thickness data cannot be retrieved.

To perform Master Resets:

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←,→] keys to highlight the Reset tab.
- Step 3: Use the [↓] key to highlight Master Reset and press [ENTER].
- Step 4: Use the [←,→] keys to highlight Reset or Cancel and press [ENTER].
- Step 5: Press [MEAS] to return to the Measure Mode.

4.11.3 Database Reset (Model 35DL and 35DLHP Only)

Database Reset resets and clears the entire database.

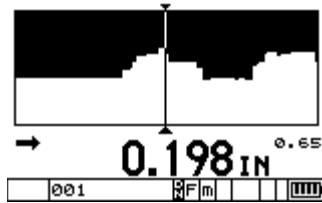
Note: Caution should be used when performing a Database Reset because it will cause the gage to delete all stored thickness readings. Once a database reset has been performed, the thickness data cannot be retrieved.

To perform Database Resets:

- Step 1: Press [2ndF][↓](Setup) to display the setup tabs.
- Step 2: Use the [←,→] keys to highlight the Reset tab.
- Step 3: Use the [↓] key to highlight Database Reset and press [ENTER].
- Step 4: Use the [←,→] keys to highlight Reset or Cancel and press [ENTER].
- Step 5: Press [MEAS] to return to the Measure Mode.

4.12 B-scan

B-scan converts thickness readings to cross-sectional image profiles. The B-scan function is used to scan over an area and look at how the cross sectional thickness is changing. The B-scan, DB Grid, and Optional Waveform are mutually exclusive features. Only one of these functions can be active at a time. Activation of one of these functions will automatically deactivate any of the others. You can save these images (datalogger versions only) in the gage internal datalogger in order to review them later or download them to a computer (GageView) or printer at a later time. A maximum of 350 B-scan images can be stored to the internal datalogger.



The following are definitions of the available B-Scan options and parameters.

Enable: Allows the user to turn the function On or Off.

B-Scan Direction: Determines the direction in which data is updated or drawn on the screen. Choose the B-Scan direction based on the direction of transducer movement.

- Left to right: Causes the data to start at the right of the screen and scroll to the left and produces a B-Scan that is properly orientated based on transducer movement.
- Right to left: Causes the data to start at the left of the screen and scroll to the right and produces a B-Scan that is properly orientated based on transducer movement.

Save Key: Determines what gets saved when the Save key is pressed. Saving B-scan images can only be done with the Datalogger version (DL) of the gages.

- THK ONLY: Will save only the current thickness reading when the Save key is pressed.
- THK + B-scan: Will Save the Thickness and the B-scan image

when the Save key is pressed.

B-Scan Freeze Mode: Determines which thickness readings are displayed when the [FREEZE] key is pressed during a scan.

- Show Minimum: Will recall the minimum thickness in the scan to the center of the screen, even if the minimum has scrolled off the current B-scan screen.
- Show Current: Will stop the B-scan at its current position when the [FREEZE] key is pressed.

Max Thickness: Allows the user to set the thickness range for the B-scan image. This should be set slightly larger than the maximum thickness that will be encountered. The maximum value for Max Thickness is 25.00" (635.00 mm).

4.12.1 Using the B-scan Function

To activate the B-scan feature:

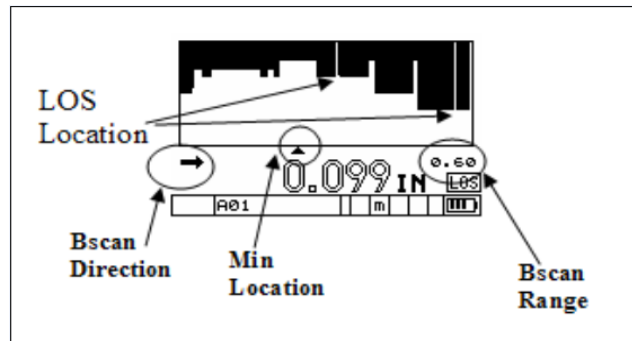
- Step 1: Press the [2nd F],[↓](SETUP) key to display the Setup Tabs.
- Step 2: Use the [→] key to highlight the B-scan Tab.
- Step 3: Use the [↓] Key to enter the B-scan Setup menu.
- Step 4: Use [↓ and ↑] to select a parameter and [← and →] to adjust the setting.
- Step 5: When the Max thickness is highlighted, press [← or →] to adjust the Max thickness (range for the B-scan) value with the [↓, ↑, ←, →] keys and then press [ENTER].
- Step 6: Press the [MEAS] key to return to the Measure mode and

save the adjusted settings.

WAVEFORM	B-SCAN	↔
ENABLE:	ON	
DIRECTION	LEFT TO RIGHT	
SAVE KEY	THK + B-SCAN	
FREEZE MODE	MIN	
MAX THICKNESS	0.6000 IN	
↔ to make selection. Then Press ENTER or ↓.		
↓, ↔, ENTER, MEAS		

Once the B-scan function has been enabled, the B-scan starts drawing the cross-sectional thickness when the transducer make contact with the material and the first thickness reading is displayed. The B-scan will continue to draw while displaying the live thickness at the transducer location until one of the following events occurs:

- The gage encounters a LOS condition (Loss of Signal), no thickness value. When an LOS occurs, the B-scan stops updating and will start up again if a new thickness reading is acquired. A vertical blank line will be inserted into the B-scan image to indicate that a LOS condition has occurred.
- The user presses the Freeze key and stops the B-scan update. The gage will either recall the minimum thickness (Freeze Min) or freeze at the current location (Freeze Current). This will also display the B-scan Review screen. The user can use the [← and →] keys to review the thickness readings on the frozen B-scan. A triangle marks the location of the minimum thickness in the B-scan.
- The user presses the [MEAS] key. The B-scan is reset and blanked out allowing the user to start another scan.

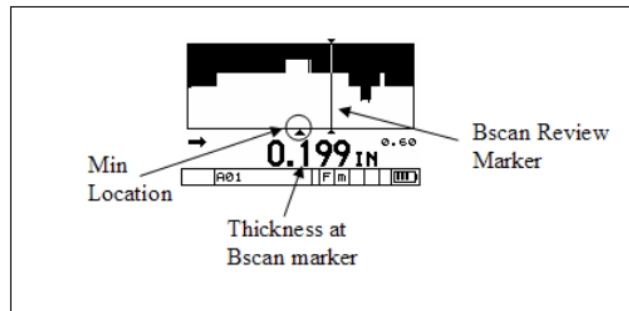


Live B-scan Screen

4.12.2 B-scan Freeze

Freezing the B-scan allows the user to review all the thickness values of the current B-scan. When the [FREEZE] key is pressed, a vertical line (Review Marker) appears to indicate the location of the displayed thickness. This is either the Minimum or Current thickness location of the B-scan, depending on the Freeze option selected. The unit displays the thickness and the location of the minimum. Pressing [←] and [→] moves the Review Marker to the left or the right of the scan. During review, the gage always displays the thickness at the Review Marker location.

Tip: Set the B-scan to Freeze Min if you wish to recall the Minimum thickness to the center of the B-scan screen even if the minimum value moved off the B-scan screen.



B-scan Review Screen

4.12.3 Saving B-scan to the Internal Datalogger (DL Models Only)

B-scan images can be saved to the internal datalogger and recalled to the screen or uploaded to the optional GageView interface program. Only one thickness value is saved with the B-scan image. This value can be the current thickness, minimum thickness, or the thickness at the Review Marker on a frozen B-scan. The Datalogger can store a maximum of 350 B-scan images.

To save the B-scan image to the internal datalogger:

- Step 1: In the B-scan setup tab, set the Save Key option to "THK + B-scan".
- Step 2: Press the Save key.
 - A. Pressing the Save key while the B-scan is live (currently scrolling) saves the B-scan image and the thickness at

the current update position.

- B. Pressing the Save key on a frozen B-scan saves the B-scan image and the thickness at the position of the review marker. The user can move the review marker to any location on the frozen B-scan.

4.13 DB Grid (DL Models Only)

The DB Grid feature allows the user to view the open data file in a Grid or Expanded Liner format. 2D Grid files display the rows and columns of the grid file. This allows the user to easily see the thickness data being saved to the grid file at the current position. Incremental and Sequential files are displayed in an Expanded Liner format, showing the last six (6) ID# locations in a linear file list. DB Grid, B-scan, and the Optional Waveform are mutually exclusive features and cannot be used at the same time. Turning one of these functions on will turn any of the other functions off.

	A	B	C
01	0.298	0.380	0.199
02	0.298	0.380	0.199
03	0.298	0.380	0.199
04	0.199	0.380	--- ---
05	0.380	0.380	--- ---
06	0.380	0.380	--- ---

0.199 IN

C04									
-----	--	--	--	--	--	--	--	--	--

DB Grid of a 2D Grid type File

DB Grid of a 2D Grid Type File

ID	THICKNESS
12	0.398
13	0.398
14	0.395
15	---
16	---
17	---

0.199 IN

15	8									
----	---	--	--	--	--	--	--	--	--	--

DB Grid of an incremental file

DB Grid of Incremental File

DB Grid allows the user to easily navigate through grids by simultaneously displaying the grid positions with the current thickness reading. This gives the user the ability to move in any direction on the grid file rather than following a pre-set list of ID's. Instead of automatically incrementing to the next ID location, the user may press the ID# key and use the arrow keys to move to any row or column in the grid file.

The following are definitions of the available DB Grid options and parameters:

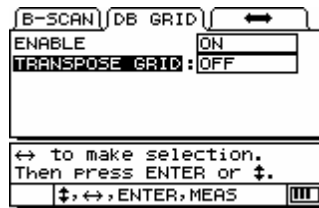
Enable: Allows the user to turn the DB Grid function On or Off.

Transpose Grid: Allows the user to switch the position of the Row and Columns of a 2D Grid file. This parameter has no affect on incremental or sequential files.

4.13.1 Using the DB Grid Function

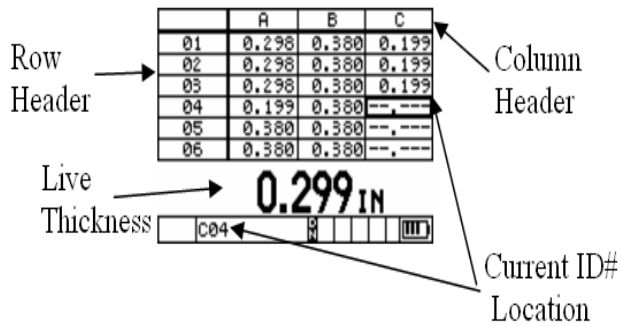
To activate the DB Grid feature:

- Step 1: Press the [2nd F],[↓](SETUP) key to display the Setup Tabs.
- Step 2: Use the [→] key to highlight the DB GRID Tab.
- Step 3: Use the [↓] Key to enter the DB GRID Setup menu.
- Step 4: Use the [↓ and ↑] to select a parameter and the [← and →] to adjust the setting.
- Step 5: Press the [MEAS] key to return to the Measure mode and save the adjusted settings.



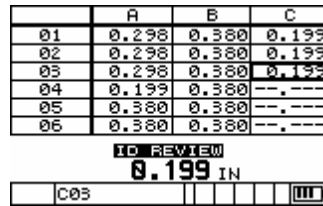
4.13.2 Saving Data While DB Grid Is Active

Once DB Grid is activated, press the Save key to store the current thickness reading in the Current ID# location.



4.13.3 Reviewing Stored Thickness Data While DB Grid Is Active

Step 1: From Measure mode, press the [2nd F], [→] (ID#) key. The gage displays the ID REVIEW screen.



Step 2: Use [↑, ↓, ←, →] to move to a new grid or ID# location. For incremental or sequential files, only the [↑, ↓] keys can be used.

Note: The user can jump to the beginning of the file by press-

ing [2nd F], [↓] or to the end of the file by pressing [2nd F], [↑].

Step 3: Press the [MEAS] key to go back to the Measure mode at the new ID# location. The gage increments from this new ID# location.

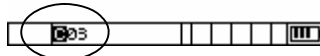
4.13.4 Editing and Moving Directly to Any ID# Location in the Active File

Step 1: From Measure mode, press the [2nd F], [→] (ID#) key. The gage displays the ID REVIEW screen.

Step 2: Press the [2nd F], [→] (ID#) again to enter the ID# EDIT screen. A cursor appears in the current ID# and the [↑, ↓, ←, →] keys can be used to edit to any location in the active file.

	A	B	C
01	0.298	0.380	0.199
02	0.298	0.380	0.199
03	0.298	0.380	0.199
04	0.199	0.380	---, ---
05	0.380	0.380	---, ---
06	0.380	0.380	---, ---

ID EDIT



Step 3: Press the Measure key to return to the Measure screen at the new ID# location or press [2nd F], [→] (ID#) to go back to Review mode at the edited ID# location.

4.13.5 Inserted ID# Location in Grid Files

ID# locations can be inserted into or appended to 2D Grid files. If the user adds an additional ID# location in a grid file, the Row and Column cell is displayed in reverse video indicating that there are additional ID#s stored at the current Row and Column locations. Inserted points in incremental or sequential files are shown as added ID#s in the current file list.

	A	B	C
01	0.298	0.380	0.199
02	0.298	0.380	0.199
03	0.298	0.380	0.199
04	0.199	0.380	--- ---
05	0.380	0.380	--- ---
06	0.380	0.380	--- ---

C04	IN	LOS
-----	----	-----

To view the inserted or appended ID# location in a file, enter the ID# Review screen by pressing [2nd F], [→] (ID#). Use the [↑, ↓, ←, →] keys to highlight the reverse video cell. Press [ENTER]. The grid will be displayed in an Expanded Linear format, and the inserted ID# can be viewed. Press [Enter] again to switch back to the normal DB Grid view.

ID	THICKNESS
002	0.020
005	0.398
004	0.298
004A	0.299
005	0.199
006	0.099

004A	IN	LOS
------	----	-----

Inserted ID#

5 DATALOGGER and Data Transmission for Models 35DL and 35DLHP

Two important features of the Model 35DL and 35DLHP are the internal datalogger and USB communication. The operation of the datalogger and data transmission are described in this section.

Topics include:

- Datalogger Overview
- Organizing the Datalogger
- Creating Data Files
- Opening a File
- Saving Data
- Using ID# Review Mode
- Using ID# Edit Mode
- Deleting a File
- Receiving Files and Using the GageView Interface Program
- Statistics Reports

5.1 Datalogger Overview

The Model 35DL and 35DLHP datalogger have a built-in file and data management system. Each thickness reading is stored and tagged with an alphanumeric identification number and file name with descriptive fields. A complete description of the measurement type, gage calibration and setup parameters is stored along with each reading. Datalogger functions include:

- Store thickness measurements or optionally thicknesses with waveforms
- Recall stored data to the gage displays
- Receive previously transmitted thickness data back from a computer
- View current datalogger settings while simultaneously taking measurements.

You can store thickness measurements. When each measurement is stored, the gage also stores a complete description of the measurement conditions. The additional data stored with each thickness value includes:

- File Name
- Identifier
- Units (in or mm)
- LOS (Loss of Signal)
- Differential Mode
- Differential Reference Value
- Alarm Mode
- Alarm Status
- Alarm Set Points
- Minimum or Maximum Mode
- Minimum or Maximum Reading
- Velocity
- Resolution
- Transducer Setup Number Information

You can store a maximum of 8,000 thickness (or optionally 350 waveforms with thicknesses), velocity, or time of flight values at any one time (Models 35DL and 35DLHP only).

5.2 Organizing the Datalogger

The Model 35DL and 35DLHP datalogger is a flexible, file-based system. Every measurement stored in the datalogger is tagged with a file name and identification number (ID number). The file name and ID number may be thought of as the place in the gage memory where the measurement data is stored. This description usually corresponds to the physical location numbers of each measurement point in the actual application.

When stored data is loaded into a computer and later recalled back to the gage, each measurement is always uniquely identified by the file name and ID number where it was initially stored.

5.2.1 File Name Structure

File names consist of up to eight (8) alphanumeric characters. Allowable characters are as follows:

0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
space - . / , : # *

The total number of files is limited by the number of ID numbers.

5.2.2 Identifier (ID Number) Structure

ID numbers consist of up to 10 alphanumeric characters. Allowable characters are as follows:

0 1 2 3 4 5 6 7 8 9
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
space - . / , : # *

The allowable number of ID numbers within a file depends on the total number of identifiers in the datalogger. There are no restrictions on the use of any allowed character at any position in an ID number except that you cannot use a space as either the first or last character of the ID number.

5.3 Creating Data Files

You can create data files for the Model 35DL and 35DLHP datalogger from within the gage.

Throughout this section there are references to the use of the Model 35DL and 35DLHP Standard Editing Commands. These commands are described in the section below.

5.3.1 Standard Editing Commands

To enter a character or a symbol at any character location, follow these steps:

Step 1: Press [↑] or [↓] to select a letter, number, or punctuation mark.

Step 2: Press and quickly release a slewing key to change the character by one value. Hold down an arrow key to continuously cycle through the letters, numbers, and punctuation marks until the desired character is displayed.

The [↑] key moves forward from A to Z then *, #, :, ,, /, ., -, blank, 9, 8, 7, 6, 5, 4, 3, 2, 1, A, and so forth.

The [↓] key moves backward from 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, ., /, ,, :, #, *, Z to A blank - and so forth. After selecting an alpha character, press [←] or [→] to move the cursor position to another character.

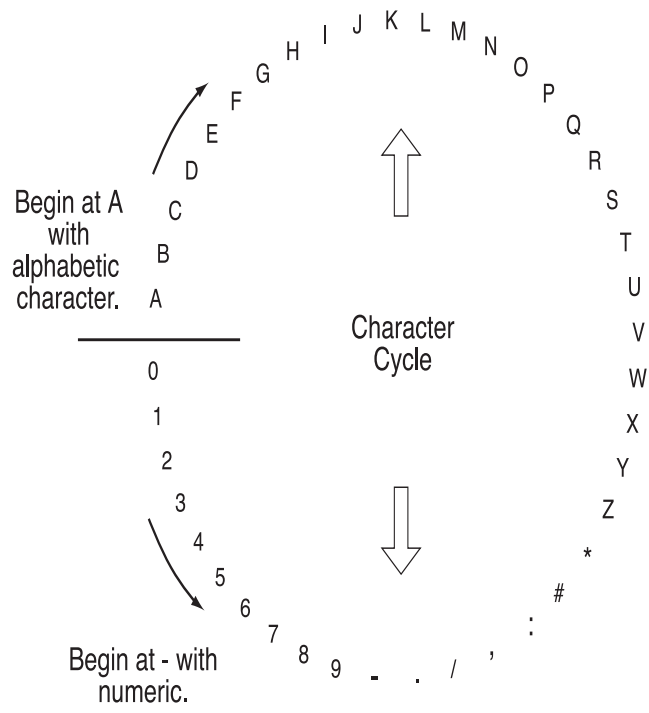


Figure 5-1: Organization of Character Cycle

To insert a character at the cursor position, do the following:

Press [**CAL ZERO**]. The character at the cursor and all those to the right move one position to the right, making a space for a new character.

To delete the character at the cursor position, do the following:

Press [**CAL VEL**]. The character at the cursor is deleted and any characters to the right moves left one position to fill-in the empty space.

5.3.2 Create Files From a Computer (Using GageView)

See the GageView Interface Program Instruction Manual.

5.3.3 Create Files from the Model 35DL

To create files from the Model 35DL and 35DLHP, follow these steps:

Step 1: Press [**2ndF**],[**↑**](**FILE**). The File Tab menu opens.

Step 2: Press [**←**] and [**→**] to highlight the **Create** option.

Step 3: Press [**↓**].

5.3.3.1 Incremental

After a starting ID number (up to 10 alphanumeric characters) has been entered, the gage automatically increments to the subsequent ID numbers using the following incrementing rules:

- Only that portion of an ID number consisting of digits and letters (no punctuation marks) beginning with the right-most character and extending leftward to the first punctuation mark or to the left-most character (whichever is first) can increment.
- Digits are cycled 0, 1, 2, ..., 9. The 9 to 0 transition is done only after incrementing the character to the left. Letters are cycled A, B, C, ..., Z, A, etc. The Z to A transition is done only after incrementing the character to the left. In either case, if there is no character to the left, or if the character to the left is a punctuation mark, then the ID number cannot increment.
- If an ID number cannot increment, after a reading is saved, a long error beep sounds and the momentary message "CANNOT INCREMENT" is shown on the display.

Note: To make the gage increment through a range of numbers several digits wide while beginning with a single digit ID number, the maximum number of digit positions must be entered initially using leading zeroes.

Some examples of automatically generated incremented ID number series include:

Table 5-1: Five Examples of Automatically Generated Incremented ID Number Series

1:	
Initial	1
	2
	3
	.
	.
	.
Limit	9

Table 5-1: Five Examples of Automatically Generated Incremented ID Number Series

2:	
Initial	ABC ABD ABE . . ABZ ACA ACB . . .
Limit	ZZZ
3:	
Initial	ABC*12*34 ABC*12*35 ABC*12*36 . . .
Limit	ABC*12*99
4:	
Initial	001 002 003 . . 009 010 . . .
Limit	999

Table 5-1: Five Examples of Automatically Generated Incremented ID Number Series

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

To create an Incremental File, follow these steps:

- Step 1: Press [2ndF][↑](File) to display the File Tabs.
- Step 2: Use the [←] and [→] keys to select the Create Tab.
- Step 3: Use the [↓] key to highlight the file name and press [→] to enter a file name using the [↑, ↓, ←, →] editing function. Press [ENTER].
- Step 4: Use the [← and →] keys to select Incremental. Press [ENTER].
- Step 5: Use the [← and →] keys to select Thickness, Velocity, or Time of Flight (TOF) and press [ENTER]. Thickness is for storing thickness data in the file. Velocity is for storing velocity data in the file. TOF is for storing TOF (Time of Flight) data in the file.
- Step 6: Use the [← and →] keys to select Continue and then press [ENTER].
- Step 7: Use the [→] key to enter the start ID number using the editing function keys [↑, ↓, ←, →]. Press [ENTER].
- Step 8: Use the [←, →] to select Done or Cancel. Press [ENTER].

5.3.3.2 Sequential

A Sequential File is defined by a starting and an ending ID number. The resulting file is inclusive of the starting and ending points and all points in between.

Example: Start ID# = ABC123
End ID# = ABC135
The resulting file would contain the following list of ID numbers:
ABC123
ABC124
ABC125
.
.
.
ABC135

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

To create a Sequential File, follow these steps:

Step 1: Press [2ndF][↑](File) to display the File Tabs.

Step 2: Use the [← and →] keys to select the Create Tab.

Step 3: Use the [↓] key to highlight the file name. Press the [→]

key to enter a file name using the [↑, ↓, ←, →] editing function. Press [ENTER].

- Step 4: Use the [← and →] keys to select Sequential. Press [ENTER].
- Step 5: Use the [← and →] keys to select Thickness, Velocity, or Time of Flight (TOF). Press [ENTER]. Thickness is for storing thickness data in the file. Velocity is for storing velocity data in the file. TOF is for storing TOF (Time of Flight) data in the file.
- Step 6: Use the [← and →] keys to select Continue. Press [ENTER].
- Step 7: Use the [→] key to enter the Start ID# using the [↑, ↓, ←, →] editing function. Press [ENTER].
- Step 8: Use the [→] key to enter the End ID# using the [↑, ↓, ←, →] editing function. Press [ENTER].
- Step 9: Use the [← and →] keys to select Done or Cancel. Press [ENTER].

5.3.3.3 2-D Grid File

A 2-D grid is a sequence of ID numbers arranged to describe a path through a two-dimensional matrix. Each part of the ID number corresponds to a particular matrix dimension.

A 2-D (two-dimensional) sequence begins with the ID number that refers to the first column and the first row. Then the column (or row) increments one value at a time until the sequence reaches the last column (or row) value while the other dimension value stays constant. At this

point the other dimension increments from its first to its last value. This continues until the ID number that refers to the last column and last row is reached.

Note: Either the columns or the rows can be selected to increment first. Refer to the following figure.

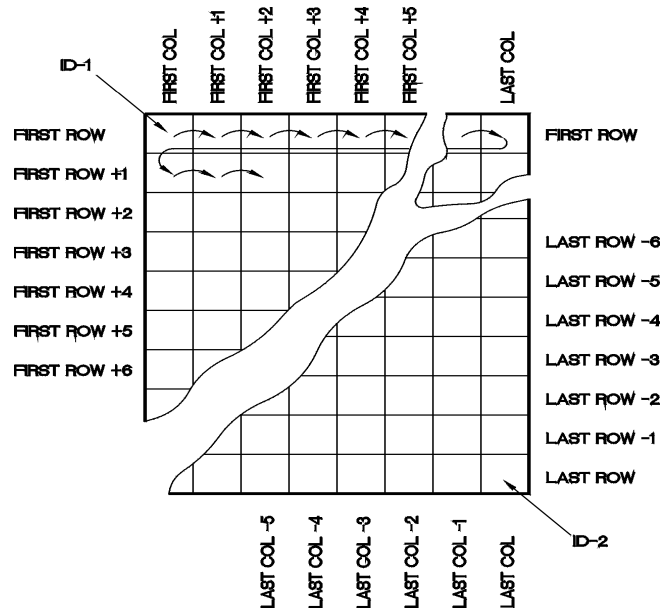


Figure 2 General Grid Database

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

Alternatively, the rows and columns of a grid may refer to a two dimensional map of measurement points on the surface of one part. In this case, a different grid is made for each part.

To create a 2-D Grid file, follow these steps:

Step 1: Press [2ndF][↑](File) to display the File Tabs.

Step 2: Use the [← and →] keys to select the Create Tab.

Step 3: Use the [↓] key to highlight the file name. Press [→] to enter a file name using the [↑, ↓, ←, →] editing function. Press [ENTER].

Step 4: Use the [← and →] keys to select 2D Grid. Press [ENTER].

Step 5: Use the [← and →] keys to select Thickness, Velocity, or Time of Flight (TOF). Press [ENTER]. Thickness is for storing thickness data in the file. Velocity is for storing velocity data in the file. TOF is for storing TOF (Time of Flight) data in the file.

Step 6: Use the [← and →] keys to select Continue. Press [ENTER].

Step 7: Use the [→] key to enter the Start COL using the [↑, ↓, ←, →] editing function. Press [ENTER].

Step 8: Use the [→] key to enter the End COL using the [↑, ↓,

←, →] editing function. Press [ENTER].

Step 9: Use the [→] key to enter the Start ROW using the [↑, ↓, ←, →] editing function. Press [ENTER].

Step 10: Use the [→] key to enter the END ROW using the [↑, ↓, ←, →] editing function. Press [ENTER].

Step 11: Use the [← and →] keys to select to increment first by Row or Column. Press [ENTER].

Step 12: Use the [← and →] keys to select Done or Cancel. Press [ENTER].

5.4 Opening a File

Use the File Open function to retrieve a file stored in the datalogger and mark it as the active file in the Measure Mode.

To open a File, follow these steps:

Step 1: Press [2nd F][↑](FILE) to go to the File Tabs.

Step 2: Press [←] and [→] to scroll to the Open tab.

Step 3: Press [↓] to enter the Open tab.

Step 4: Use [↑] or [↓] to scroll files.

Step 5: Press [ENTER] to select the file.

Step 6: Use [←] or [→] to choose Open or Cancel.

Step 7: Press [ENTER].



5.5 Saving Data

To store displayed thickness values in the datalogger, press [SAVE]. All appropriate calibration and setup parameters are also stored simultaneously.

If a measurement is already stored at the current ID number, pressing [SAVE] overwrites the old thickness reading with the current thickness reading, unless ID Overwrite Protection is enabled in Meas Setup.

If you do not want to save a measurement at a specific ID, press [SAVE] while no measurement is taken. The gage will store an LOS condition and “_.” at the specific ID number.

To save a thickness reading, do the following:

While the thickness value is being displayed, press [SAVE].

An audible beep indicates that the reading is saved. The displayed thickness value and setup information is stored at the current ID number in the current file. If the thickness display is blank when [SAVE] is pressed, then “_.” is saved in place of a value.

Note: When saving data with the optional Live Waveform, you must select Save Thickness and Waveform in the Waveform Setup tab to save the waveform with thickness. If

the Save key is set to Thickness Only, only the thickness value will be saved.

The ID number is automatically updated to the next ID number in the sequence. The new ID number is indicated on the display. If the ID number cannot be updated, a long beep sounds and the gage displays a message explaining why the ID was unable to update. In this case, the ID number on the display remains unchanged.

Some of the special features of the Model 35DL and 35DLHP allow the gage to store more than one thickness value at an ID location. For this reason, the gage has four file forms for saving data:

- Thickness - Standard one thickness saved
- Velocity - One velocity reading saved
- TOF - One time of flight reading saved
- Reduction Rate - One thickness and one reduction rate saved

Note: The gage cannot store different file type data in a single file.

5.6 Using the Review ID Mode

The review ID mode has two purposes:

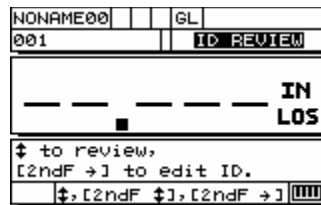
- Review datalogger contents by scanning through stored ID locations in the active file.
- Move within the file and change the current ID location to any location that already exists in the file.

To review stored thickness values or move to an existing ID location, follow these steps:

Step 1: Press [2nd F][→](ID#).

Step 2: Use [\uparrow] or [\downarrow] to change ID.

Step 3: Press the [MEAS] key to return to Measure Mode at the new ID# location.



Note: In ID Review Mode, the user can jump to the beginning of a file by pressing [2ndF],[\downarrow] or to the end of a file by pressing [2ndF],[\uparrow].

5.7 Using Edit ID Mode

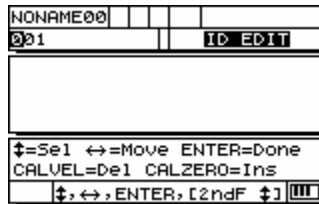
The ID Edit mode is generally used for one of two purposes:

- To change the current ID Location to a different ID Location already in the database. This mode is useful when you are using a large data file and it would take too long to locate the desired ID by pressing [\uparrow] and [\downarrow].
- To change the current ID Location to a new ID, which does not yet exist in the database. This mode is useful when you want to include additional measurement points to the active file. Additional ID locations can be added anywhere in the file.

Note: No stored data is shown while in ID Edit Mode and no measurements can be made.

To use the **ID Edit** mode, follow these steps:

- Step 1: Press [2nd F][→](ID#).
- Step 2: Press [2nd F][→](ID#) again.
- Step 3: Use the [↑, ↓, ←, →] keys to make changes to the current ID#.
- Step 4: Press [2ndF][→](ID#) to view the content of the new ID#, or press [MEAS] to return to Measure mode at the new ID# location.



5.8 Delete

5.8.1 Delete a Range of ID#s in a File

Note: When deleting a range of ID's in an incremental file, both the ID# and the stored value will be deleted.

Note: When deleting a range of ID's in a sequential or 2-D grid file, only the thickness values will be deleted. The ID# structure will remain.

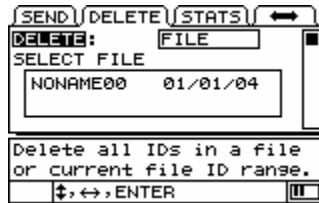
- Step 1: Press [2nd F][↑](FILE) to go to the File Tabs.
- Step 2: Press [→] to scroll to the Delete tab.
- Step 3: Press [↓] to enter the Delete tab.
- Step 4: Press [←] or [→] to select ID Range.
- Step 5: Press [↓] to select the starting ID#.
- Step 6: Use [→] to edit the Start ID# using the [↑,↓,←,→] editing function keys. Press [ENTER].
- Step 7: Press [→] to edit the End ID# number using the [↑,↓,←,→] editing function keys. Press [ENTER].
- Step 8: Use [←] or [→] to choose Delete or Cancel. Press [ENTER].
- Step 9: Press [MEAS] to return to Measurement Mode.



5.8.2 Delete Selected File

- Step 1: Press [2nd F][↑](FILE) to go to the File Tabs.

- Step 2: Press [→] to scroll to the Delete tab.
- Step 3: Press [↓] to enter the Delete tab.
- Step 4: Press [←] or [→] to select Delete File. Press [ENTER].
- Step 5: Press [↑] or [↓] to highlight the file.
- Step 6: Press [ENTER] to select the file for deletion.
- Step 7: Use [←] or [→] to choose Delete or Cancel.
- Step 8: Press [ENTER].
- Step 9: Press [MEAS] to return to Measurement Mode.



5.8.3 Delete Stored Value

You may erase the current stored value at a specified ID location by overwriting the value with new data or a LOS value. You may enable ID# Overwrite, and the gage will display a message that states whether data already exists at an ID location.

To enable ID# Overwrite:

Step 1: Press [2nd F][↓](SETUP) to go to the Setup Tabs.

Step 2: Press [↓] to enter the MEAS tab.

Step 3: Press [↑] or [↓] to scroll to ID Overwrite.

Step 4: Use [←] or [→] to choose ON or OFF.

Step 5: Press [MEAS] to end.





5.8.4 Quick Clear Contents of the Active File (35DL and 35DLHP Only)

The 35DL and 35DLHP allow the user to quickly clear the contents of the active file without deleting the file or any of the ID#s in the file. This feature is useful for applications that require the user to store and download data repeatedly using the same exact file format. The user can save the data in the file, download it, and quickly clear the file and start again. When using this function, it is not necessary to build a new file each time.

To quickly clear the content of the active file:

Step 1: Press [2nd F] and press and hold the [↑] (FILE) key. The File Clear screen will be displayed.



Step 2: Press [ENTER] while Clear is highlighted to clear the data in the file, or press [MEAS] to cancel the quick clear.

5.9 Receiving Files and Using the GageView Interface Program

5.9.1 Receiving (Downloading) Files From a Computer

Datalogger information can be downloaded from a computer into the gage. This has two benefits:

1. Thickness survey data previously saved with ID#s and stored in a computer file may be retrieved to the gage at a later date to guide you through the measurement sequence using ID#s or to compare current values with previous thickness values.
2. You may create ID# sequences in a computer and then download them to the gage. This externally created sequence can guide you through the prescribed measurement location path. The ID sequence created in the

computer must have setup information.

Data downloaded to the Model 35DL and 35DLHP gage must be in the same format in which data is transmitted. We recommend using the GageView Interface Program to manage all functions of interfacing, storing, and creating Model 35DL and 35DLHP data.

5.9.2 Using the Optional GageView Interface Program

GageView is the interface program for the Model 35DL and 35DLHP. GageView is a Windows®-based program compatible with Windows 2000® and XP®. It can create inspection database files, load data files, and generate reports. GageView is compatible with Model 35DL and 35DLHP data files and offers advanced ODBC compatibility and enhanced OLE features.

For more information on GageView, refer to the GageView Instruction Manual.

5.10 Statistics Reports

The Model 35DL and 35DLHP can generate statistic reports from within the gage without having to connect to a computer.

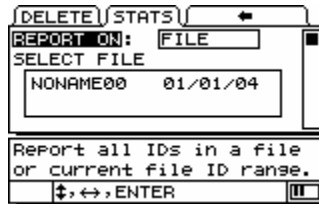
5.10.1 Statistics Report for an Entire File

Step 1: Press [2nd F][↑](FILE) to go to the File tabs.

Step 2: Press [→] to scroll to Stats tab.

Step 3: Press [↓] to enter the Stats tab.

- Step 4: Press [←] or [→] to select Report on File. Press [ENTER].
- Step 5: Use [↑] and [↓] to scroll to files.
- Step 6: Press [ENTER] to select the file.
- Step 7: Use [←] or [→] to choose Report or Cancel.
- Step 8: Press [ENTER].
- Step 9: Press [ENTER] again to view the next screen.



5.10.2 Statistics Report for a Range of ID#s in a File

Use the following procedure to read statistics for a range of ID#s in a file:

- Step 1: Press [2nd F][↑](FILE) to go to the File tabs.
- Step 2: Press [→] to scroll to the Stats tab.
- Step 3: Press [↓] to enter the Stats tab.
- Step 4: From Report On, press [←] or [→] to select Report on ID# Range. Press [ENTER].
- Step 5: Use [→] to edit Start ID# using the [↑,↓,←,→] editing function keys. Press [ENTER].
- Step 6: Use [→] to edit the ID# using the [↑,↓,←,→] editing function keys. Press [ENTER].
- Step 7: Use [←] or [→] to choose Report or Cancel.
- Step 8: Press [ENTER].
- Step 9: Press [ENTER] again to view the next screen.

```

DELETED | STATS | ←
REPORT ON: ID RANGE
START ID 001
END ID 001
REPORT CANCEL
Report all IDs in a file
or current file ID range.
↓, ←, ENTER
    
```

```

DELETED | STATS | ←
#IDS 0 #LOS 0
#MINS 0 MIN VAL ---
#MAXS 0 MAX VAL ---
NEXT EXIT REPEAT
↔ to select button,
then ENTER or ↓.
↓, ←, ENTER
    
```

```

DELETED | STATS | ←
#L ALARMS 0 %LO 0.0
#H ALARMS 0 %HI 0.0
MEAN MEDIAN ST DEV
0.000 0.000 0.000
PREV EXIT REPEAT
↔ to select button,
then ENTER or ↓.
↓, ←, ENTER
    
```

6 SPECIFICATIONS

THICKNESS MEASUREMENT RANGE: 0.0040 to 25.000 inches or 0.100 to 635.0 mm (depending on material and application)

VELOCITY MEASUREMENT RANGE: 0.0200 - 0.7362 in/ μ sec
0.5080 - 18.699 mm/ μ sec

TIME OF FLIGHT MEASUREMENT RANGE: 0.0 - 109.5 μ sec

THICKNESS DISPLAY RESOLUTION: 35 AND 35DL

- Standard - 0.001 in (0.01 mm)
- Low - 0.01 in (0.1 mm)
- High - 0.0001 in (0.001 mm)

35HP and 35DLHP

- Standard - 0.001 in (0.01 mm)
- Low - 0.01 in (0.1 mm)

**VELOCITY
RESOLUTION**35 AND 35DL

- Standard - 0.0001 in/ μ sec
(0.001 mm/ μ sec)
- Low - 0.001 in/ μ sec (0.01 mm/ μ sec)
- High - 0.0001 in/ μ sec (0.001 mm/ μ sec)

35HP and 35DLHP

- Standard - 0.0001 in/ μ sec
(0.001 mm/ μ sec)
- Low - 0.001 in/ μ sec (0.01 mm/ μ sec)

**TIME OF FLIGHT
RESOLUTION**

Model 35, 35DL, 35HP, and 35DLHP

Fixed at 000.01 μ sec**MEASUREMENT
RATE:**Selectable 4, 8, 16, or MAX
measurements per second

Note: MAX is between 16 and 20
measurements per second
and is dependent on
measurement mode and
application.

MEASUREMENT
MODE:

Echo Detection Methods (selected as part of the application setup)

- Mode 1 - Time between excitation pulse and first echo following blank period using contact transducers.
- Mode 2 - Time between the interface echo and the first backwall echo. Normally used with delay line or immersion transducers.
- Mode 3 - Time between a pair of backwall echoes following the interface echo. Normally used with delay line or immersion transducers.

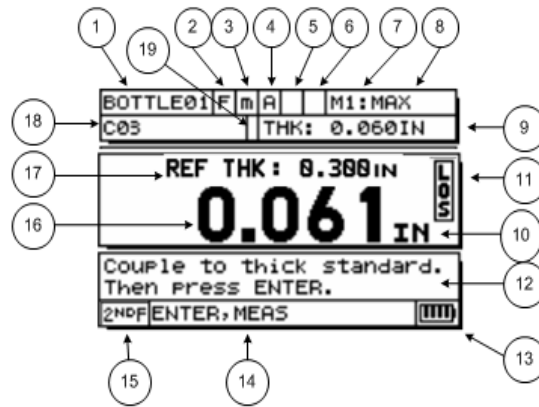
DISPLAY:

5-digit Liquid Crystal Display (LCD), 0.425" (10.8 mm) numerals; 160X100 pixel resolution.

DISPLAY UNITS, SYMBOLS, and FLAGS:

1. File Name (35DL and 35DLHP)
2. Freeze Flag: F, _
3. Min/Max Flags: M, m, _
4. Diff/Alarm Flags: D, A, H, L, G, Y,
R
5. ZOOM, Z, _
6. Waveform, W, _
7. Measure Mode Flags: M1, M2, M3
8. Measure Rate: 4 Hz, 8 Hz, 16 Hz,
MAX
9. Stored Thickness (35DL and
35DLHP)
10. Units: IN, MM
11. LOS Flag: LOS, _
12. Help Text
13. Battery Life Indicator
14. Key Press Guide
15. 2nd Function Key Press Indicator:
2nd F
16. Current Measurement Box
17. Reference thickness (Velocity
Mode) Reduction % (Reduction
Rate)
18. ID Box (35DL and 35DLHP)
19. DN Flag: DN, (35DL and
35DLHP)

**Note: See diagram on following
page.**



- METRIC/ENGLISH MODES:** Allows selection between English and metric units via the keypad.
- BATTERY:** Three (3) AA alkaline batteries or three (3) AA NiMH batteries.
- BATTERY LIFE:** 150 hours minimum (Mode 1, 4 Hz Meas Rate, Backlight Off); 20 hours minimum (Backlight On)

OPERATING TEMP. RANGE (ELECTRONICS):	-10° C to +50° C (+14°F to +122°F)
SIZE:	6.0" L x 3.31" W x 1.50" H 152mm L x 84mm W x 38mm H
WEIGHT:	8.5 oz. (0.24 Kg)
TRANSDUCERS OPERATION:	35 and 35DL can use single element direct contact, delay, or immersion transducer in the frequency range of 2.25 MHz - 30 MHz. 35HP and 35DLHP can use single element direct contact, delay, or immersion transducer in the frequency range of 0.50 MHz - 5.0 MHz.

DATALOGGER Model 35DL and 35DLHP Only:

STORAGE CAPACITY: 8000 thickness measurements;
Waveform option, 350 waveforms with thickness.

INFORMATION STORED:	ID Number, File Name, Thickness Value, Units, LOS Condition, Differential Mode, Differential Reference Value, Alarm Mode, High Alarm Setpoint, Low Alarm Setpoint, Minimum Reading Flag, Gain Mode Velocity Value, Transducer Setup Information.
DATALOGGER FILES	8-character alphanumeric file names
IDENTIFICATION NUMBERS:	10 alphanumeric characters, character set A-Z, 0-9, and the special characters -, ., /, ,, :, #, *
FILE FORMATS	Incremental, sequential, 2-dimension grid
DATALOGGER FEATURES:	Save Reading at ID# Review Stored Contents of Data Erase a File Move to specific ID#'s in a file Communications with USB 2.0 Full Speed

Environmental IP-65 Compliant:

Tested to IP-65. Gasket sealed case protected against water and dust ingress. Impact resistant.

7 APPLICATION SETUPS

Application Setups are sets of stored configurations of the gage parameters for various measurement applications. Setups are optimized for application features such as material, thickness range, and required accuracy or resolution.

When the gage is turned on, the last setup used is automatically selected, and the gage is ready to make similar measurements. If the application has changed, choose an Application Setup name based on the new application.

Model 35 and 35DL Application Setup Name/Application		
Setup Name	Probe Type	
DEFMI-M116	M116	Steel: 0.020 - 1.5" (0,500 - 38 mm) Plastic: 0.010" min. (0,25 mm min.)
DEFMI-M112	M112	Steel: 0.030 - 10" (0,75 - 254 mm) Plastic: 0.010" min. (0,25 mm min.)
DEFMI-M110	M110	Steel: 0.040 - 15" (1,00 - 380 mm) Plastic: 0.025" min. (0,6 mm min.)

DEFM1-M109	M109	Steel: 0.050 - 20" (1,25 - 508 mm) Plastic: 0.025" min. (0,6 mm min.)
DEFM1-M106	M106	Steel: 0.080 - 20" (2,00 - 508 mm) Plastic: 0.050" min. (1,25 mm min.)
DEFM1-M1016	M1016	Steel: 0.030 - 1.5" (0,76 - 38 mm) Plastic: 0.010" min. (0,25 mm min.)
DEFM1-M1036	M1036	Steel: 0.080 - 25" (2,00 - 635 mm) Plastic: 0.050" min. (1,25 mm)
DEFM3-M208	M208	Steel: 0.008 - 0.200" (0,2 - 5 mm)
DEF2P-M208	M208	Plastic: 0.005 - 0.2" (0,12 - 5 mm)
DEFM3-M202	M202	Steel: 0.010 - 0.500" (0,25 - 12,5 mm)
DEFM2-M202	M202	Steel: 0.020 - 0.750" (0,5 - 19 mm)
DEFP2-M202	M202	Plastic: 0.025 - 0.25" (0,6 - 6 mm)
DEFM3-V260	V260	Steel: 0.010 - 0.200" (0,25 - 5 mm)
DEFM2-V260	V260	Steel: 0.020 - 0.400" (0,5 - 10 mm)
DEFP2-V260	V260	Plastic: 0.010 - 0.120" (0,25 - 3 mm)
DEFM2-M201	M201	Steel: 0.030 - 0.750" (0,75 - 19 mm)
DEFP2-M201	M201	Plastic: 0.020 - 0.500" (0,50 - 12,5 mm)
DEFM2-M206	M206	Steel: 0.050 - 1.00" (1,25 - 25 mm)

DEFP2-M206	M206	Plastic: 0.040 - 0.500" (1,0 - 12,5 mm)
DEFM2-M207	M207	Steel: 0.080 - 1.00" (2,0 - 25 mm)
DEFP2-M207	M207	Plastic: 0.080 - 0.500" (2,0 - 12,5 mm)
Note: Exact thickness range depends on material and application.		

Model 35HP and 35DLHP Application Setup Name/Application		
Setup Name	Probe Type	
DEFM1-M110	M110	Steel: 0.040 - 15" (1,00 - 380 mm) Plastic: 0.025" min. (0,6 mm min.)
DEFM1-M109	M109	Steel: 0.050 - 20" (1,25 - 508 mm) Plastic: 0.025" min. (0,6 mm min.)
DEFM1-M106	M106	Steel: 0.080 - 20" (2,00 - 508 mm) Plastic: 0.050" min. (1,25 mm min.)
DEFM1-M1036	M1036	Steel: 0.100 - 25" (2,50 - 635 mm) Plastic: 0.080" min. (2,00 mm)

DEFM1-M101	M101	Steel: 0.5 - 25" (12 - 635 mm) Plastic: 0.20" - 5.0" (5-127 mm)
DEFM1-M102	M102	Steel: 0.200 - 25" (5 - 635 mm) Plastic: 0.1" - 3.0" (2,5 - 75 mm)
DEFM1-M103	M103	Steel: 0.1 - 25" (2,5 - 635 mm) Plastic: 0.100 - 3.0" (2,5-75 mm)
DEFM2-M201	M201	Steel: 0.050 - 1.00" (1,25 - 25 mm)
DEFP2-M201	M201	Plastic: 0.050 - 0.400" (1,25 - 10 mm)
DEFM2-M206	M206	Steel: 0.050 - 1.00" (1,25 - 25 mm)
DEFP2-M206	M206	Plastic: 0.040 - 0.500" (1,0 - 127 mm)
DEFM2-M207	M207	Steel: 0.080 - 1.00" (2,0 - 25 mm)
DEFP2-M207	M207	Plastic: 0.080 - 0.500" (2,0 - 127 mm)
DEFP1-M2008	M2008	Smooth Fiberglass: 0.2 - 3.0" (5,0 - 75 mm)
DEFM1-V153	V153	Steel 0.500 - 10.00" (12 - 400 mm)
DEFM1-V154	V154	Steel: 0.150 - 3.0" (3,75 - 75 mm)
DEFM1-V156	V156	Steel 0.050 - 0.75" (1,25 - 19 mm)
Note: Exact thickness range depends on material and application.		

TRANSDUCER SETUP PARAMETERS		
Name	Description	Units/Resolutions/ Range
Det Mode	Echo Detect Mode	1, 2, or 3
Setup Name	Name for transducer setup	10-character alphanumeric
Probe Type	Transducer type	One of the 13 transducer types from default setup list for 35 and 35DL. One of the 14 transducer types from default setup list for 35HP and 35DLHP.
MatVel	Ultrasonic sound velocity of material to be measured	0.030 - 0.5511"/ μ sec (0,762-13,999 mm/ μ sec)
Zero	Zero calibration factor	0 -999.99
Pulser Pwr	Pulser power	30, 60, or 110 Volts
Max Gain	Maximum receiver	0 - 80.0 dB in 0.3 dB gain steps
Init Gain	Initial T.V.G. gain	0 - Max Gain in 0.3 dB steps
TDG Slope	Time Varied Gain	0 - 26.52 dB/s in 0.1 dB/ μ s steps
MB Blank	Main Bang Blank	57.16 nsec to 225 μ sec in 0.1 nsec steps

Echo Win	Echo window	55 ns to 200 s in 0.014 ns steps.
Ech1Dtect	Detection polarity of first echo	+ or -
Ech2Dtect	Detection polarity of second echo	+ or -
I/FBLANK	Blank after Interface echo	0 - 999.99 ns; 1.00 - 20.00 μ s
M3EchBlnk	Blank after first measured backwall echo in Mode 3	0 - 20.01 μ s in 0.01 μ s steps

8 THEORY OF OPERATION

Panametrics-NDT™ Model 35 Ultrasonic Thickness Gages operate on the “Pulse/Echo” principle. This principle works by precisely timing the reflection of high frequency sound waves from the transducer to the far wall of a test piece. This technique, derived from sonar, has been widely applied to nondestructive testing because it permits accurate measurement of material thickness even though access may be available from only one side.

The 35 Series gages use a variety of piezoelectric transducers that generate bursts of mechanical vibrations, or sound waves, when excited by short electrical pulses. The frequency of these sound waves is far beyond the limit of human hearing, from one million to twenty million cycles per second, versus a typical limit of less than twenty thousand cycles per second for the human ear. Sound at these very high frequencies does not travel well through air, so a coupling medium such as a drop of liquid (usually propylene glycol, glycerin, water, or oil) is used between the transducer and the test piece.

The sound waves generated by the transducer are coupled into the test piece and reflected back from the opposite side. The same transducer then receives the reflected sound waves and converts them to electrical pulses. The gage amplifies the received signal, digitizes a selected portion of the wave train, and then very precisely measures a time interval corresponding to one round trip of the sound waves in the test piece. This measurement is made in one of three modes as described below. The gage, which has been calibrated to the speed of sound in the test material, computes the thickness of the test material using the relationship:

$$X = \frac{(t)V}{2}$$

Where:

- x = the thickness of the material
- V = the velocity of sound in the material
- t = the measured round-trip transit time of the pulse
- t0 = the zero offset factor (to correct for transducer wearplate delay, cable delay, and other fixed delays)

Model 35 Series gages can employ any of three measurement modes to calculate pulse transit time. The selection of the proper mode for a given application is dependent on a number of factors discussed in detail in Application Notes.

Mode 1 is employed with contact transducers. In this mode, measurement is made from the initial excitation pulse to the first returning echo from the back wall of the test piece. The MTI marker indicates the Measured Time Interval.

Mode 2 is employed with delay line and immersion transducers. In this mode, measurement is made between an interface echo marking the time the sound wave enters the test piece and the first backwall echo. The MTI marker indicates the Measured Time Interval.

Mode 3 is also employed with delay line and immersion transducers. In this mode, measurement is made between two successive back wall echoes that follow an interface echo. The MTI marker indicates the Measured Time Interval.

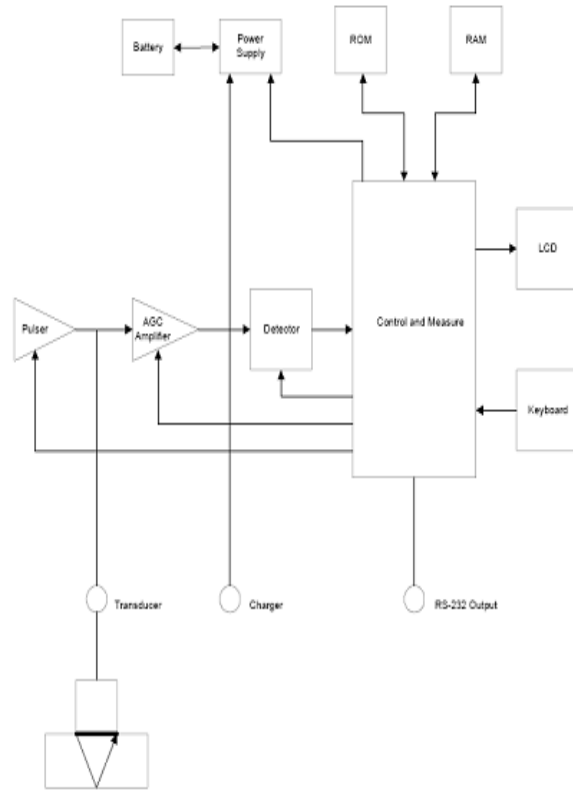


Figure 8-1: Block Diagram of the Model 35

The pulser, under the control of the microprocessor, provides a unidirectional broadband spike voltage impulse to a heavily damped broadband ultrasonic transducer. The broadband ultrasonic pulse generated by the transducer is coupled to the test piece by means of liquid couplant. Echoes returning from the back or inside surface of the test piece are received by the transducer and converted to electrical signals, which in turn are fed to the receiver AGC amplifier. The microprocessor-based control and timing logic circuits both synchronize the pulser and select the appropriate echo signals that will be used for the time interval measurement.

If echoes are not detected during a given measurement period, the gage will shut down to save power until a new measurement cycle is required. If echoes are detected, the timing circuit will precisely measure an interval appropriate for the selected measurement mode, and then repeat this process a number of times to obtain a stable, averaged reading. The microprocessor then uses this time interval measurement, along with sound velocity and zero offset information stored in the Random Access Memory (RAM), to calculate thickness. Finally, the thickness is shown on the Liquid Crystal Display (LCD) and updated at a selected rate.

9 APPLICATION NOTES

Model 35 Ultrasonic Thickness Gages can be used in a variety of applications when proper technique is employed. This section discusses advanced gage usability and measurement techniques to assist in challenging applications.

To take maximum advantage of the gages' versatility, the user should be familiar with the basic principles of ultrasonic nondestructive testing. There are several textbooks that discuss this subject in detail, as well as classroom training opportunities. Consult the company for further information.

9.1 Measurement Mode

Model 35 Series gages are capable of operating in three measurement modes, representing three alternate ways of timing echoes. Mode selection is usually based on the requirements of a particular application as described below:

Mode 1: Measurements are made between an excitation pulse and the first back wall echo from the test piece, using contact-type transducers. Mode 1 is a general purpose test mode, and is normally recommended for use, unless one of the conditions described under Modes 2 or 3 is present.

Mode 2: Measurements are made between an interface echo representing the near surface of the test piece and the first back wall echo, using delay line or immersion transducers. Mode 2 is most often used for high-temperature measurements with high-temperature delay line transducers, measurements on sharp concave or convex radii, in confined spaces with delay line or immersion transducers, and for on-

line measurement of moving material with immersion transducers.

Mode 3: Measurements are made between two successive back wall echoes, using delay line or immersion transducers. This mode may be employed only when clean multiple backwall echoes appear, which typically limits its use to materials of relatively low attenuation and high acoustic impedance such as fine-grained metals, glass, and ceramics. Mode 3 typically offers the highest measurement accuracy and the best minimum thickness resolution in a given application, at the expense of penetration, and it is used when accuracy and/or resolution requirements cannot be met in Mode 1 or Mode 2.

Ultrasonic thickness measurements using contact transducers in Mode 1 are generally the simplest to implement and may be used in the majority of applications. For most material, the contact method of measurement provides the highest coupling efficiency of ultrasound from the transducer to the test piece. Mode 1 contact measurements can generally be used with the Model 35 Series when minimum material thickness does not fall below approximately 0.005" (0.12 mm) of plastic or 0.010" (0.25 mm) of metal, precision required is not better than 0.0005" (12.5 microns), test material is at room temperature, and geometry permits contact coupling. Mode 2 and Mode 3 measurements with delay line and immersion transducers are, as noted above, generally recommended when application requirements preclude use of Mode 1.

9.2 Transducer Selection

The selection of the appropriate transducer for a given application is based on the range and resolution of the thickness measurement required, the acoustic properties of the test material, and part geometry. Choose the best mode by experimenting with test standards representing the desired range of measurement.

Generally, the highest frequency and smallest diameter transducers that give acceptable results over the required range are recommended. Small diameter transducers are easily coupled to test material and permit the thinnest couplant layer at a given contact pressure. Furthermore, higher frequency transducers produce echo signals of faster rise time and thereby enhance the precision of thickness measurements. On the other hand, the acoustic properties or surface condition of the test material may require larger, low frequency transducers to overcome poor coupling or signal losses due to scattering or attenuation.

The Model 35 Series gages are programmed with many different internal setups for use with a wide variety of transducers. Many additional custom setups may be created for special applications not measurable by any of the standard internal setups. In some applications, optimum performance will entail the use of more than one transducer.

See Chapter 7 for lists of some common transducers and typical measurement ranges. For further information on specific transducer recommendations, consult the company.

Note: For best results, only recommended Panametrics-NDT transducers should be used with Model 35 Series gages, insuring suitable electrical impedance, bandwidth, sensitivity, and main bang recovery characteristics. While the gage may work with transducers from other manufacturers, the company cannot guarantee performance. Additionally, transducers must be maintained in good condition. Broken or cracked wearplates, worn delay lines, and thermal damage will all degrade performance and affect measurements.

9.3 Factors Affecting Performance and Accuracy

1. **Calibration:** The accuracy of any ultrasonic measurement is only as good as the accuracy and care with which the gage has been calibrated. Model 35 Series gages are shipped from the factory with standard setups for a number of transducers and applications. In some cases, it may be desirable to optimize these setups for specific measurement situations, as described in Section 3. In all cases, it is essential that the velocity and zero calibrations, also described in Section 3, are performed whenever the test material or transducer is changed. Periodic checks with samples of known thickness are recommended to verify that the gage is operating properly.
2. **Surface Roughness of the Test Piece:** The best measurement accuracy is obtained when both the front and back surfaces of the test piece are smooth. If the contact surface is rough, then the minimum thickness that can be measured will be increased because of sound reverberating in the increased thickness of the couplant layer. Additionally, if either test piece surface is rough, it may cause distortion in the returning echo due to the slightly different multiple sound paths seen by the transducer, resulting in measurement inaccuracies.
3. **Coupling Technique:** In Mode 1 (contact transducer) measurements, the couplant layer thickness is part of the measurement and is compensated by a portion of the zero offset. If maximum accuracy is to be achieved, then the

coupling technique must be consistent. In order to accomplish consistent measurements, use a couplant of reasonably low viscosity; employ only enough couplant to achieve a reasonable reading; and apply the transducer with uniform pressure. Practice will show the degree of moderate to firm pressure that produces repeatable readings. In general, smaller diameter transducers require less coupling force to squeeze out the excess couplant than larger diameter transducers. In all modes, tilting the transducer distorts echoes and causes inaccurate readings, as noted below.

4. Curvature of the Test Piece: A related issue to this section involves the alignment of the transducer with respect to the test piece. When measuring on curved surfaces, it is important that the transducer be placed approximately on the centerline of the part and held as steadily to the surface as possible. In some cases, a spring-loaded V-block holder may be helpful for maintaining this alignment. In general, as the radius of curvature decreases, the size of the transducer should be reduced, and the more critical transducer alignment will become. For very small radii, an immersion approach will be necessary. In some cases it may be useful to observe the waveform display via the PCScope option as an aid in maintaining optimum alignment. Practice the best way to hold a transducer with the aid of a waveform display. On curved surfaces it is important to use only enough couplant to obtain a reading. Excess couplant will form a fillet between the transducer and the test surface where sound will reverberate and possibly create spurious signals that may trigger false readings.
5. Taper or eccentricity: If the contact surface or back surface of the test piece is tapered or eccentric with respect to the

other, the return echo will be distorted due to the variation in sound path across the width of the beam. Accuracy of measurement will be reduced. In severe cases, no measurement will be possible.

6. Acoustic Properties of the Test Material: There are several conditions found in certain engineering materials that can potentially limit the accuracy and range of ultrasonic thickness measurements:
 - Sound Scattering: In materials such as cast stainless steel, cast iron, fiberglass, and composites, sound energy will scatter from individual crystallites in the casting or boundaries of dissimilar materials within the fiberglass or composite. Porosity in any material can have the same effect. Gage sensitivity must be adjusted to prevent detection of these spurious scatter echoes. This compensation can in turn limit the ability to discriminate a valid return echo from the backside of the material, thereby restricting measurement range.
 - Sound Attenuation or Absorption: In many organic materials such as low density plastics and rubbers, sound energy is attenuated very rapidly at the frequencies used for ultrasonic gaging. This attenuation typically increases with temperature. The maximum thickness that can be measured in these materials will often be limited by attenuation.
 - Velocity Variations: An ultrasonic thickness measurement will be accurate only to the degree that material sound velocity is consistent with gage calibration. Some materials exhibit significant variations in sound velocity from point to point. This happens in certain cast metals

due to the changes in grain structure that result from varied cooling rates, and the anisotropy of sound velocity with respect to grain structure. Fiberglass can show localized velocity variations due to changes in the resin/fiber ratio. Many plastics and rubbers show a rapid change in sound velocity with temperature, requiring that velocity calibration be performed at the temperature where measurements are made.

7. Phase Reversal or Phase Distortion: The phase or polarity of a returning echo is determined by the relative acoustic impedances (density x velocity) of the boundary materials. The Model 35 Series assumes the customary situation where the test piece is backed by air or a liquid, both of which have a lower acoustic impedance than metals, ceramics, or plastics. However, in some specialized cases, such as measurement of glass or plastic liners over metal, or copper cladding over steel, this impedance relationship is reversed and the echo appears phase reversed. In these cases, it is necessary to change the appropriate Echo Detection polarity in order to maintain accuracy. A more complex situation can occur in anisotropic or in homogeneous materials such as coarse-grain metal castings or certain composites, where material conditions result in the existence of multiple sound paths within the beam area. In these cases, phase distortion can create an echo that is neither cleanly positive nor negative. Careful experimentation with reference standards is necessary in these cases to determine effects on measurement accuracy.

9.4 Couplants

A wide variety of couplants may be used in ultrasonic gaging. We have found that propylene glycol (Couplant A) is suitable for most applications. For a list of other suitable couplants, typical for thickness measurements, please refer to Table 9-1 below.

Couplant	Purpose	Description	Temperature
A Propylene Glycol	Smooth surfaces	General purpose, non-corrosive, washes off with water	Max. 200°F (90°C)
B Glycerin	Rough surfaces; highly attenuated materials	General purpose, slightly viscous, high acoustic impedance	Max. 200°F (90°C)
D Gel	Rough surfaces, sand-cast metals, fiber-glass lay-ups, weld inspections, overhead surfaces, and vertical walls	Slides across wide surfaces, does not drip or run	Max. 200°F (90°C)

Note: For more information, refer to the Ultrasonic Transducer catalog or call your local representative.

Table 9-1: Couplants

Couplant	Purpose	Description	Temperature
E-2 High Temp	Test materials at elevated temperatures	Remains stable without boiling off when used at intended temperatures	500° - 1000°F (260° - 540°C)
F-2 Medium Temp		Easy removal at high temperatures	32° - 540°F (0° - 280°C)
G-2 Medium Temp		Non-toxic, bio-degradable	0° - 600°F (-12° - 315°C)

Note: For more information, refer to the Ultrasonic Transducer catalog or call your local representative.

Table 9-1: Couplants

9.5 High Temperature Measurements

Measurements at elevated temperatures (higher than approximately 125°F or 50°C) represent a special category. Standard contact transducers will be damaged or destroyed by exposure to temperatures higher than this limit because of the varying thermal expansion coefficients of the materials used to construct them, which will cause disbonding at elevated temperatures. Contact transducers should never be used on a surface that is too hot to comfortably touch with bare fingers. High temperature measurements with the Model 35 will always be done in Mode 2 or Mode 3 with either a delay line transducer (using an appropriate high temperature delay line) or an

immersion transducer. Consult the company for further information on specific transducer selection.

Sound velocity in all materials changes with temperature, normally increasing as the material gets colder and decreasing as it gets hotter, with abrupt changes at freezing or melting points. This effect is much greater in plastics and rubber than it is in metals or ceramics. For maximum accuracy, the gage sound velocity setting should be calibrated at the same temperature at which measurements will be made. Measurement of hot materials with a gage set to room temperature sound velocity will often lead to significant error.

Finally, at temperatures greater than approximately 200°F or 100°C, special high temperature couplants are recommended. Refer to Table 9-1 or consult the company for details.

9.6 Cable Lengths

Model 35 Series gages should normally be used with transducer cables no longer than approximately 3 feet or 1 meter. The maximum length of cable that can be used in a specific case will depend on the type of transducer and minimum thickness to be measured. Generally, very long cables are not recommended, except in certain specialized cases (usually involving low frequency transducers). Particular attention must be paid to the problems of electrically matching the transducer to the cable, accounting for attenuation of the signal in the cable, and compensating for pulse transit time through the cable. Consult the company for further information.

9.7 Pulsar/Receiver and Gating Adjustments

In addition to providing programmed standard transducer setups, the Model 35 Series permits the user to create custom setups by changing a series of pulser/receiver and gating parameters. Custom setups are used when the measurement requirements of a particular application are not optimally met by one of the standard setups. In some cases, a Model 35 Series will be shipped from the factory pre-programmed with one or more custom setups to meet special customer requirements. In any case, users may wish to create custom setups of their own. The adjustments described in this section should be made only by a qualified technician who is familiar with the basic theory of ultrasonic gaging and the interpretation of ultrasonic waveforms. Many of these adjustments are interactive, and all of them have an effect on the measurement range and/or measurement accuracy of the Model 35. In most cases, adjustments should not be attempted without monitoring waveforms via the 35PCScope option. Additionally, when establishing a custom setup for a specific application, it is essential to verify performance on reference standards representing the material(s) and thickness range to be measured.

9.7.1 Pulsar Power

Excitation pulse (main bang) voltage may be adjusted in three steps of 30, 60, and 110 Volts. Higher voltages may provide greater penetration at the expense of near surface resolution, especially in Mode 1, while lower voltages may provide better near surface resolution at the expense of penetration. For most applications, the 110 Volt setting provides the best signal-to-noise ratio for returning echoes.

9.7.2 Maximum Gain

Maximum available receiver gain may be adjusted from 0.0 dB to 79.6d B. The Model 35 uses Automatic Gain Control (AGC) and Time Dependent Gain (TDG) functions to automatically adjust receiver gain to an optimum level when an echo is detected. When no echo is being detected (LOS prompt), gain will rise to the maximum level set by Initial Gain, Slope, and Maximum Gain. If maximum gain is set too high, the gage may hang up on transducer noise or other spurious signals. If it is set too low, returning echoes may not be boosted high enough for detection. In general, for a given application the Max Gain should be set high enough that all echoes of interest are detected, but a steady LOS prompt is displayed when the transducer is not coupled to a test piece.

9.7.3 Initial Gain

Initial Gain and TDG Slope are part of a Time Dependent Gain system that may be used to optimize near-surface resolution while providing a higher maximum gain for thicker samples. Initial Gain may be adjusted from 0 dB to the maximum defined by the Max Gain setting. This parameter sets an upper limit on receiver gain in the vicinity of the excitation pulse (Mode 1) or interface echo (Modes 2 and 3). By effectively making the excitation pulse or interface echo smaller, the TDG system permits detection of echoes occurring close to pulse or echo in time. The TDG system is also used in measurements of highly scattering materials, such as cast metals and fiberglass, to minimize detection of scatter echoes occurring ahead of the backwall. From the initial gain level, receiver gain slopes up to the maximum gain level at the rate determined by the TDG Slope setting. Initial Gain setting is most critical in applications where minimum thickness measurement must be optimized, and should always be set with the aid of a reference standard representing that minimum. In cases where

minimum thickness capability is less important than penetration and scatter echoes are not a problem, Initial Gain may simply be set equal to Max Gain.

9.7.4 Main Bang Blank

Main Bang Blank creates a blank or dead zone (up to 18 microseconds from the excitation pulse) where it is not possible to detect echoes. The blank is used to prevent detection of the trailing edge of the excitation pulse as if it were a backwall or interface echo. In Modes 2 and 3, the setting of the Main Bang Blank is not critical; it merely needs to be set at some point between the end of excitation pulse ringdown and the interface echo. In Mode 1, however, the length of the Main Bang Blank determines the minimum thickness that can be measured, and it must be positioned with care after selecting the Initial Gain level. If the Main Bang Blank is too short, then the gage will hang up on the excitation pulse, and readings will not be possible. If the Main Bang Blank is too long, then the minimum measurable thickness will be unnecessarily restricted. In general, set the Main Bang Blank just beyond the point where the gage hangs up, and test with the transducer both coupled to and uncoupled from the test material to ensure accurate measurements.

9.7.5 Echo Window

The Echo Window is the time interval in each main bang period during which the gage is enabled to detect echoes. The Echo Window interval begins at the end of the Main Bang Blank. The end of the Echo Window depends on the Detect Mode and Echo Win parameters

as shown in Table 9-2:

	DtectMode = 1	DtectMode = 2 or 3
Echo Window Starts	At the end of Main Bang Blank	At the end of Main Bang Blank
Echo Window Ends	EchoWindow $x\mu\text{sec}$ following Main Bang	EchoWindow $x\mu\text{sec}$ following the detected interface echo
Note: $x\mu\text{sec}$ where x is the parameter set by the user.		

Table 9-2: Echo Window

In Mode 1, the Echo Window may usually be set to any value greater than the round-trip pulse transit time in the thickest or slowest piece of material to be measured. The exact setting is not critical as long as it is long enough to include the farthest echo of interest. In Modes 2 and 3, the Echo Window is limited to the time interval between successive interface echoes. The end of the Echo Window must be set ahead of the second interface echo to prevent detection of that echo, which in turn will determine a maximum measurable thickness for Mode 2 and Mode 3 setups. In applications involving Mode 2 and Mode 3 immersion measurements, this condition must apply throughout the range of water paths to be used.

9.7.6 Detect Mode

The Detect Mode function selects Mode 1, Mode 2, or Mode 3 measurements. See Table 9.2 for further explanation.

9.7.7 Echo 1 Detect, Echo 2 Detect

Echo 1 Detect and Echo 2 Detect select positive or negative polarity echo detection as determined by application requirements. Selection is dependant on the mode of measurement and the type of test material. Note that positive and negative polarity refer to processed echoes displayed on the PCScope.

- Mode 1: In Mode 1 with contact transducers, Echo 1 is the back wall echo and Echo 2 is not applicable. Echo 1 is normally negative. An exception occurs in measurement of a material of low acoustic impedance bonded to a material of high impedance (such as plastic or rubber over metal), where the echo is phase-reversed and positive detection for Echo 1 is appropriate.
- Mode 2: In Mode 2 with delay line or immersion transducers, Echo 1 is the interface echo and Echo 2 is the backwall echo. Echo 1 is normally positive for high impedance materials such as metals and ceramics, and negative for low impedance materials such as most plastics. Echo 2 is normally negative unless the back wall echo represents the sort of low-to-high impedance boundary described above.
- Mode 3: In Mode 3 measurements with delay line or immersion transducers, Echo 1 is the interface echo and Echo 2 represents the backwall echoes. Since Mode 3 generally involves measurement of high impedance materials, the general rule is to set Echo 1 positive and Echo 2 negative. In some special cases involving difficult geometries, phase distortion may cause the positive side of the backwall echoes to be better defined than the negative side. In such cases set, Echo 2 positive.

9.7.8 Interface Blank

Use Interface Blank in Modes 2 and 3 only. Interface Blank represents

a blank or dead zone up to twenty (20) microseconds in length that follows the leading edge of the interface echo. In Mode 2, the Interface Blank prevents detection of trailing lobes or cycles of the interface echo, which might otherwise be detected as backwall echoes, resulting in a hang-up condition. The Interface Blank should be set as short as possible to avoid unnecessarily restricting minimum measurable thickness. The Initial Gain function will often help reduce interface echo amplitude and permit use of a shorter interface blank. Check Interface Blank settings with the transducer both coupled to and uncoupled from the test material. In Mode 3, the Interface Blank selects which pair of backwall echoes will be measured. In most conditions, the Interface Blank would be set just short of the first backwall echo. However, as a practical matter, the first backwall echo from thin materials is often distorted or lost in the interface ringdown, and with some challenging geometries (such as tight radii), later pairs of backwall echoes may be cleaner than early ones. In these cases, the Interface Blank should be set to a length that insures detection of a clean and well-defined pair of backwall echoes, even if they are not the first two.

9.7.9 Mode 3 Echo Blank

The function of Mode 3 Echo Blank in Mode 3 is analogous to that of Interface Blank in Mode 2 or Main Bang Blank in Mode 1. This function creates a blank or dead zone up to twenty (20) microseconds long following the leading edge of the first detected backwall echo, to prevent detection of trailing lobes or cycles of that echo and the resulting gage hang-up. Because Mode 3 Echo Blank limits minimum measurable thickness, set the controls as short as possible (seldom longer than a few hundred nanoseconds). Special cases may occur where mode conversion effects on curved samples cause significant spurious signals between legitimate echo peaks. In such cases, set the Mode 3 Echo Blank as long as necessary to prevent detection of the

spurious signals.

9.7.10 TDG Slope

The Time Dependent Gain (TDG) Slope function controls the rate receiver gain slopes up from the Initial Gain level to the Max Gain level. The Slope may be set from 0.0 to 26.5 dB per microsecond. Generally, TDG Slope should be set as high as possible to reach maximum gain as quickly as possible without having the gage hang up on spurious signals.

10 MAINTENANCE AND TROUBLESHOOTING

10.1 Routine Care And Maintenance

The Model 35 Series case is sealed to prevent intrusion of environmental liquids and dust. However, it is not completely waterproof. Therefore, the unit should never be immersed in any fluid.

The case, keypad and display window may be cleaned with a damp cloth and mild detergent if necessary. Do not use strong solvents or abrasives.

10.2 Transducers

The ultrasonic transducers or probes used with the Model 35 Series are rugged devices that need little care. They are not indestructible, however, and a little attention to the following items will result in the longest transducer life:

The cables can be damaged by cutting, pinching, or pulling. Care must be taken to prevent mechanical abuse to the cables. Never leave a transducer where a heavy object can be placed on the cable. Never remove a transducer from the gage by pulling on the cable. Pull on the molded connector housing only. Never tie a knot in a transducer cable.

Do not twist or pull the cable at the point where it connects to the transducer. These precautions are particularly important for all transducers other than the models that have field-replaceable cables.

Transducer performance will be degraded by excessive wear at the tip. To minimize wear, do not scrape or drag the transducer across rough surfaces. When a transducer tip becomes too rough, concave, or otherwise non-flat, operation may become erratic or impossible. Although some wear is normal in corrosion gaging applications, severe wear will limit transducer life. A transducer resurfacing procedure can be performed to improve performance of worn transducers. Contact the company for details.

10.3 Error Messages

During the normal operation of the gage, certain special error messages may be displayed. Usually these indicate a problem with the operating procedure but some may indicate a physical problem with the gage itself. Consult the company for further information.

10.4 Turn On And Low Battery Problems

The bars on the batteries symbol show operating time remaining. If the gage turns off immediately after turn-on, or if it does not turn on at all, then the battery is probably completely discharged. The batteries should be replaced. If, after replacing the batteries, the unit still does not turn on, there has probably been a component failure within the gage, which should be serviced.

10.5 Self Diagnostics

Model 35 Series thickness gages include two self-diagnostic screens that permit the user to identify hardware or software problems.

To view the Diagnostic 1 screen and see internal self-test results:

Step 1: Press [2ndF][↓](Setup) to display the setup tabs.

Step 2: Use the [←,→] keys to highlight the DIAG1 tab.

The following results are displayed:

Gain	Internal Calibration
BLK, DET, SMP	Internal Blank, Detector and Sampler Test
Thresh Cal (RCVR1)	Threshold Calibration Test Receiver 1
Thresh Cal (RCVR2)	Threshold Calibration Test Receiver 2

Table 10-1: DIAG1 Results

Note: Highlighted parameters indicate that the specific self-test failed based on the expected values.

To view the Diagnostic 2 screen, which shows information about your Model 35 series gage:

Step 1: Press [2ndF][↓](Setup) to display the setup tabs.

Step 2: Use the [←,→] keys to highlight the DIAG2 tab.

The following results are displayed:

SW REV	Reports software version (1.00/1.00G)
Battery	Indicates current battery voltage
Probe	Indicates current attached probe
PR TX	Indicates the time of flight for the transmit delay line
PR RX	Indicates the time of flight for the receiver delay line

Table 10-2: DIAG2 Results

Note: If PR TX displays N/A, then either the cable is broken or there is a problem with the transducer.

10.6 Tests

The Model 35-DL gage tests include:

- **KEYPAD** - Tests keypad keys.
- **VIDEO** - Tests to assure that pixel locations are functional.

10.6.1 KEYPAD TEST

The Keypad test tests to assure that keypad keys are functional. The KEYPAD test displays each functional keypad key. The gage display

during the test should match the keypad. Where mismatches occur, keys are not functional. To test the keypad, use the following procedure:

- Step 1: From the Main screen, press [2ndF][↓] and use the [→] arrow to move across the top of the screen to the TESTS tab.
- Step 2: Press the [↓] arrow to select KEYPAD TEST and then press ENTER or [2ndF][↑] to abort the test. Determine visually that the keypad keys are functional.
- Step 3: Press ENTER to Exit to the TESTS screen.

10.6.2 VIDEO TEST

The Video test tests to assure that pixel locations are functional. Non-functional pixel locations display in white when the VIDEO test is run. To test the video display, use the following procedure:

- Step 1: From the Main screen, press [2ndF][↓] and use the [→] arrow to move across the top of the screen to the TESTS tab.
- Step 2: Press the [↓] arrow to select VIDEO TEST and then press ENTER or [2ndF][↑] to abort the test. Determine visually that video pixels are functional by observing if white spots occur in the screen test display.
- Step 3: Press ENTER to Exit to the TESTS screen.

10.7 Repair Service

The company will repair any Model 35 gage at its Waltham, Massachusetts, USA factory. In addition, some local Panametrics-NDT dealers can perform repairs.

10.8 Replacement Parts And Optional Parts And Equipment

Replacement parts for the Model 35 Series as well as additional related equipment are available from the company.

APPENDIX I: SOUND VELOCITIES

The following table presents 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 for a variety of reasons, 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 - 1
Sound Velocities of Various Materials
(Longitudinal Wave Velocity)

Material	V(in./μsec)	V(m/sec)
Acrylic resin (Perspex)	0.107	2730
Aluminum	0.249	6320
Beryllium	0.508	12900
Brass, naval	0.174	4430
Copper	0.183	4660
Diamond	0.709	18000
Glycerin	0.076	1920
Inconel®	0.229	5820
Iron, Cast (slow)	0.138	3500

Table I - 1 (cont.)
Sound Velocities of Various Materials
(Longitudinal Wave Velocity)

Material	V(in./ μ sec)	V(m/sec)
Iron, Cast (fast)	0.220	5600
Iron oxide (magnetite)	0.232	5890
Lead	0.085	2160
Lucite®	0.106	2680
Molybdenum	0.246	6250
Motor oil (SAE 20/30)	0.069	1740
Nickel, pure	0.222	5630
Polyamide (slow)	0.087	2200
Nylon, fast	0.102	2600
Polyethylene, high density (HDPE)	0.097	2460
Polyethylene, low density (LDPE)	0.082	2080
Polystyrene	0.092	2340
Polyvinylchloride, (PVC, hard)	0.094	2395
Rubber (polybutadiene)	0.063	1610
Silicon	0.379	9620

**Table I - 1 (cont.)
Sound Velocities of Various Materials
(Longitudinal Wave Velocity)**

Material	V(in./μsec)	V(m/sec)
Silicone	0.058	1485
Steel, 1020	0.232	5890
Steel, 4340	0.230	5850
Steel, 302 austenitic stainless	0.223	5660
Steel, 347 austenitic stainless	0.226	5740
Tin	0.131	3320
Titanium, Ti 150A	0.240	6100
Tungsten	0.204	5180
Water (20°C)	0.0580	1480
Zinc	0.164	4170
Zirconium	0.183	4650

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