

GE

Sensing & Inspection Technologies

DM5E

Operating Manual

Ultrasonic



imagination at work

P/N 1259551 Rev. 1
February 2009

DM5E

Corrosion Thickness Gauge

Operating Manual

P/N 1259551 Rev. 1
February 2009



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Important Notice

The following information must be read and understood by any user of a GE Sensing & Inspection Technologies ultrasonic thickness gauge. Failure to follow these instructions can lead to errors in thickness measurements or other test results. Decisions based on erroneous results can, in turn, lead to property damage, personal injury or death.

General Warnings

Proper use of ultrasonic test equipment requires three essential elements:

- Selection of the correct test equipment
- Knowledge of the specific “test application requirements”
- Training on the part of the instrument operator

This operating manual provides instruction in the basic setup and operation of the thickness gauge. There are, however, additional factors which affect the use of ultrasonic test equipment. Specific information regarding these additional factors is beyond the scope of this manual. The operator should refer to textbooks on the subject of ultrasonic testing for more detailed information.

Operator Training

Operators must receive adequate training before using ultrasonic test equipment. Operators must be trained in general ultrasonic testing procedures and in the setup and performance required by a particular test. Operators must understand:

- Sound wave propagation theory
- Effects of the velocity of sound of the test material
- Behavior of the sound wave where two different materials are in contact
- Areas covered by the sound beam

More specific information about operator training, qualification, certification, and test specifications is available from various technical societies, industry groups, and government agencies.

Testing Limitations

In ultrasonic testing, information is obtained only from within the limits of the sound beam. Operators must exercise great caution in making inferences about the test material outside the limits of the sound beam. For example, when testing large materials it may be impossible or impractical to inspect the entire test piece.

When a less-than-complete inspection is to be performed, the operator must be shown the specific areas to inspect. Inferences about the condition of areas not inspected, based on data from the evaluated areas, should only be attempted by personnel fully trained in applicable statistical and probability techniques. In particular, materials subject to erosion or corrosion, in which conditions can vary significantly in any given area, should only be evaluated by fully trained and experienced operators.

Sound beams reflect from the first interior surface encountered. Because of part geometry and overlapped flaws or overlapped surfaces, thickness gauges may measure the distance to an internal flaw rather than to the back wall of the material. Operators must take steps to ensure that the entire thickness of the test material is being examined.

Ultrasonic Thickness Measurement Critical Operating Procedures

The following operating procedures must be observed by all users of ultrasonic thickness gauges in order to minimize errors in test results.

1. *Calibration of Sound Velocity*

The principle of operation of an ultrasonic thickness gauge is that the instrument measures the time of flight of an ultrasonic pulse through the test piece and multiplies this time by the velocity of sound in the material. Thickness measuring error is minimized by ensuring that the sound velocity to which the instrument is calibrated is the sound velocity of the material being tested. Actual sound velocities in materials often vary significantly from the values found in published tables. In all cases, best results are obtained if the instrument is calibrated on a velocity reference block made from the same material as the test piece; this block should be flat and smooth and as thick as the maximum thickness of the test piece.

Operators should also be aware that the sound velocity may not be constant in the material being tested; heat treating, for example, can cause significant changes in sound velocity. This must be considered when evaluating the accuracy of the thickness provided by this instrument. Instruments should always be calibrated before testing, and the calibration should be checked after testing, to minimize testing errors.

2. *Probe Zero Procedure*

Before performing calibration with a contact probe, the probe zero procedure must be performed first. If the zero procedure is not performed or if it is performed improperly, inaccurate thickness readings will result.

Ultrasonic Thickness Measurement Critical Operating Procedures (cont.)

3. *Effects of Temperature on Calibration*

Temperature variations change the sound velocity of materials and transducer delay lines and, therefore, calibrations. All calibrations should be performed on-site and with test blocks at the same temperature as the test piece, to minimize errors due to temperature variations.

4. *Transducer Selection*

The transducer used in testing must be in good condition, without noticeable wear of the front surface. Badly worn transducers will have a reduced effective measuring range. The specified range of the transducer must include the complete range of thicknesses to be tested. The temperature of the material to be tested must be within the transducer's temperature range.

5. *Use of Couplants*

Operators must be familiar with the use of ultrasonic couplants. Testing skills must be developed so that couplant is used and applied in a consistent manner to minimize variations in couplant layer thickness and errors in test results. Calibration and actual testing should be performed under similar coupling conditions, using a minimum amount of couplant and applying consistent pressure on the transducer.

Ultrasonic Thickness Measurement Critical Operating Procedures (cont.)

6. *Doubling*

Ultrasonic thickness gauges will, under certain conditions, display readings which are twice (or in some cases, three times) the actual material thickness being measured. This effect, commonly known as “doubling,” can occur below the minimum specified range of the transducer. If the transducer being used is worn, doubling is possible at a thickness greater than the minimum of the specified range.

When using a new transducer, any reading which is less than twice the minimum specified range of the transducer may be a “doubled” reading, and the thickness of the material being tested should be verified by the use of other methods. If the transducer shows any sign of wear, doubling may occur at a second echo, or other echo signal combinations may produce a readable signal. The instrument reading and apparent thickness are up to about twice the actual value, resulting in a thickness greater than twice the minimum of the specified range. This thickness should be determined by calibrating the instrument/transducer combination on reference blocks that represent the complete range of possible thicknesses that may be encountered in testing. This is particularly important when a test piece is being ultrasonically measured for the first time or in any case where the history of thickness of the test specimen is unknown.

Safety Information

IMPORTANT: *The DM5E is an instrument for materials testing. Any use for medical applications or other purposes is not allowed. The DM5E may only be used in industrial environments.*

IMPORTANT: *For battery operation of the DM5E, two “AA” size batteries are needed. You should only use the products recommended by us for battery operation. Use of well-known battery brands is highly recommended.*

IMPORTANT: *Disposal of all components of the DM5E and its batteries must be done in compliance with all applicable regulations. See Appendix B, Regulatory Compliance, for detailed information.*

Software

According to the current state of the art, software is never completely free from errors. Before using any software-controlled test equipment, please make sure that the required functions operate perfectly in the intended combination.

Defects/Errors and Exceptional Stresses

If you have reason to believe that safe operation of your DM5E is no longer possible, you must disconnect the instrument and secure it against unintentional reconnection. Remove the batteries if necessary.

Safe operation is no longer possible if conditions such as the following exist:

- The instrument shows visible damages
- The instrument no longer operates perfectly
- The instrument has been subjected to prolonged storage under adverse conditions such as exceptional temperatures and/or especially high air humidity, or corrosive environmental conditions
- The instrument has been subjected to heavy stresses during transportation

Service

Every effort has been made to provide you with a reliable product. However, should service become necessary, GE Sensing & Inspection Technologies, has established a number of *Factory Trained Service Centers*. For the location of the nearest facility, see the back cover of this manual.

Chapter 1. General Information

The DM5E is an ultrasonic corrosion thickness measurement device. The instrument is available in three versions:

- DM5E Basic
- DM5E with Dual Multi functionality
- DM5E DL with Dual Multi and Data Recorder

This chapter introduces the key features of the DM5E, and the next chapter explains the keypad functions and display-menu contents. Closely reviewing the material in these two chapters will help you make better use of the more detailed information found in subsequent chapters of this manual.

1.1 Supplying Power to the DM5E

The instrument is powered by two “AA” size batteries, providing up to approximately 100 hours of service life. To install the batteries, remove the battery-compartment cover as shown in *Figure 1 on page 2*.

IMPORTANT: *You cannot charge or power the DM5E through its USB port.*

1.1 Supplying Power to the DM5E (cont.)

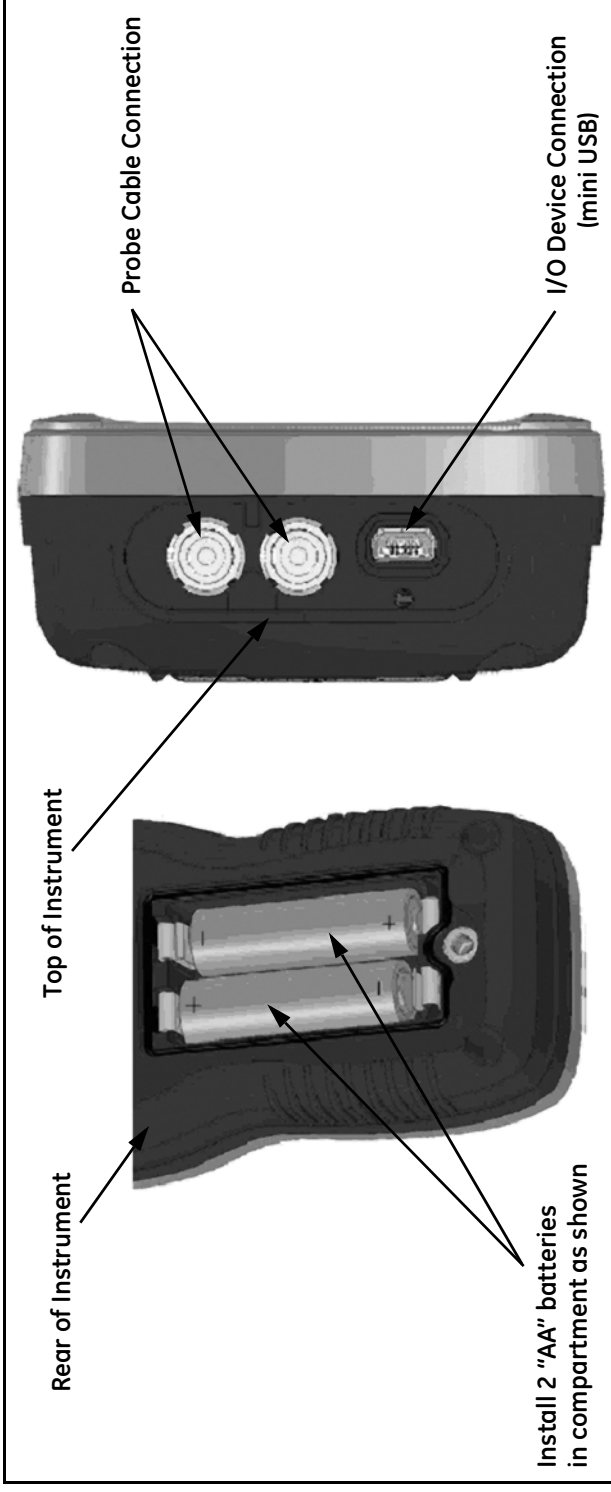



Figure 1: DM5E Connections and Batteries (shown with battery cover removed)

1.1 Supplying Power to the DM5E (cont.)

When the battery indicator is in the last quarter, as indicated by the display-screen symbol , replace the batteries as soon as possible. The DM5E automatically shuts OFF when the batteries are too weak for reliable operation. However, your settings are saved and restored when the instrument is turned ON again. When testing in remote locations, always carry spare batteries.

1.2 Powering the Instrument ON and OFF

Power the instrument ON by pressing  and holding until the instrument display activates. Press  and hold while the instrument is ON to turn it OFF.

1.3 Key Features of the DM5E

- Large hollow/filled thickness digits
- Alarm bar graph
- Standard and custom parameter setups
- Supports new set of DA5xx probes
- Alphanumeric naming of data files (DM5E DL)

1.3 Key Features of the DM5E (cont.)

- Lockout feature with password access
- Large LCD display with backlight and adjustable contrast
- Importing of data recorder files directly into Microsoft Excel (DM5E DL)
- Approximately 100 hours of operation with 2 “AA alkaline batteries
- Easy-to-use, single-level menu system
- Multiple display screen languages
- User-selectable measurement resolution to 0.001 inch (0.01 mm)
- Normal (thickness), MinScan, MaxScan, and Differential/Rate of Reduction Measurement modes are standard
- Timed B-Scan
- Optional Dual Multi function (DM5E and DM5E DL)
- Optional data recorder (DM5E DL) stores up to 50,000 thickness measurements in data recorder file
- Field upgrades available
- Compatible with UltraMATE[®] and UltraMATE LITE[®] software programs

1.3.1 DM5E Corrosion Thickness Measurement Base Instrument

1.3.1a Contents of the DM5E Base Instrument

- DM5E instrument
- 2 “AA” batteries
- Plastic carrying case
- Couplant sample
- Upgrade Utility Program on CD-ROM (requires mini-USB to PC cable)
- Operating manual in CD-ROM
- Operating instruction card
- Certificate of conformity

Note: *A mini-USB to PC cable is only included with the DM5EDL version. This cable can be purchased separately for use with the DM5E Basic or DM5E version.*

1.3.1b Instrument Versions

- DM5E Basic
- DM5E with Dual Multi functionality
- DM5E DL with Dual Multi and Data Recorder

1.4 Contents of this Manual

This *DM5E Operating Manual* is divided into eight chapters and one appendix. All chapters apply to all instrument versions, except for two functions:

- *Data Recorder*, which is described in *Chapter 5*, applies only to the DM5E DL version
- *Dual Multi* mode applies only to the DM5E with Dual Multi functionality and to the DM5E DL

Note: *Any DM5E can be retrofitted to incorporate the above functions.*

Chapter 2. Understanding the Keypad, Menu System & Displays

The DM5E's display, keypad, and functional commands are easy to interpret and use. In this chapter, you'll find a brief explanation of all display and keypad features. You'll also find references to manual sections where more detailed information is available.

Note: *The DM5E's display screen contents varies depending on the optional features installed and the operational settings selected. The display screens shown in this chapter are typical of those found in all the instrument configurations.*

2.1 Keypad Features

The instrument's keypad includes a combination of dedicated keys and virtual function keys. The key functions, as illustrated in Figure 2 on page 8, are as follows:

- **Arrow Keys** - Use to adjust the value of the selected parameter and for on-screen navigation.
- **Function Keys** - Use to activate any functional control shown in the display directly above the key.
- **Cal/On Key** - Press once to launch the calibration process or to make on screen selections. Press and hold to power the instrument ON and OFF.
- **Mode Key** - Press to activate the standard display modes and any optional display modes that are installed.

2.1 Keypad Features (cont.)

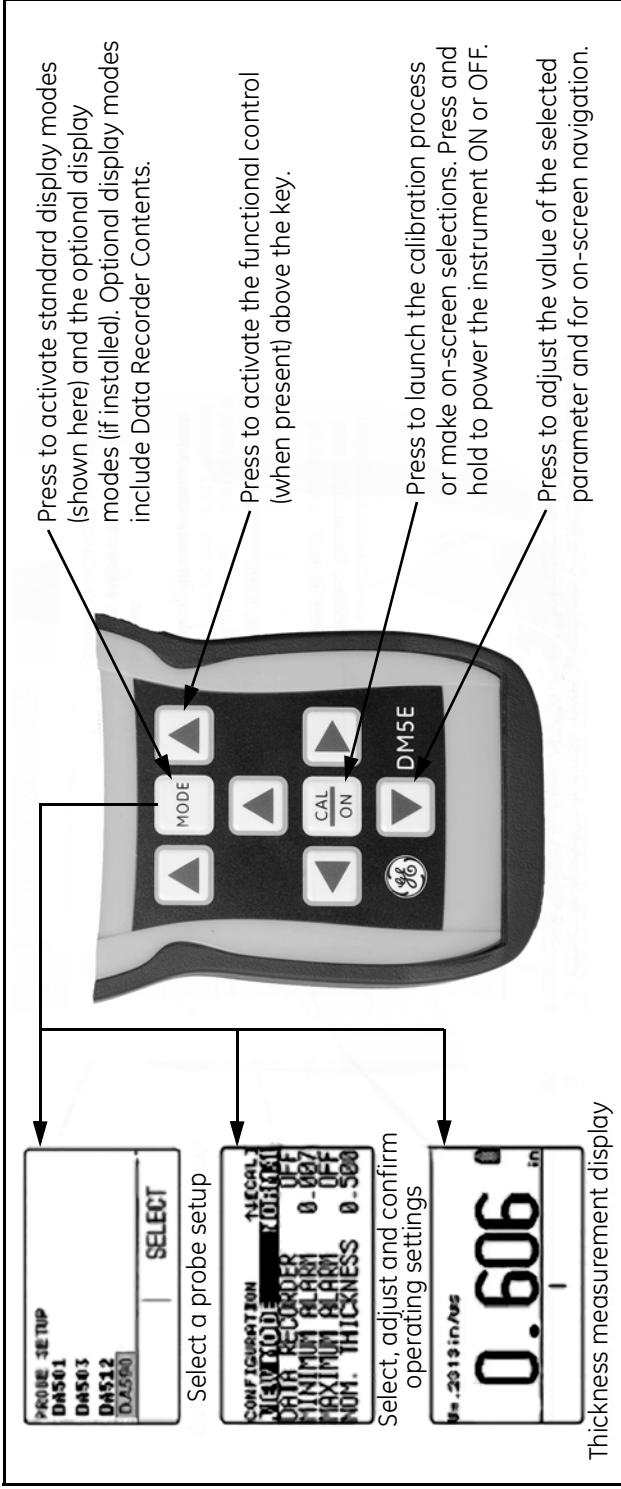


Figure 2: DM5E Keypad and Key Functions

2.2 Interpreting the Display Screens

This section describes the layout of the DMSE's primary display modes including:

- **Measurement Display Mode** - Indicates measured thickness, contains status icons, displays data recorder location and file name (when this option is installed and activated). *Figure 3 on page 10* shows four representative display screens. The display's appearance varies based on the installed instrument options as well as instrument display settings. Additional measurement view modes are available when the Dual Multi or Data Recorder options are installed.
- **Probe Setup Display Mode** - Allows the user to select a standard preloaded instrument setup, each of which is matched to a specific probe model (see *Figure 4 on page 11*).
- **File Display Mode** - Allows the user to create and store thickness readings in data recorder files. This feature is only available when the data recorder option is installed and activated (see *Figure 5 on page 12*). When installed and activated, the data recorder option allows users to create data recorder files, store thickness readings, and navigate through file contents.
- **Configuration Display Mode** - Instrument controls are accessed through this screen. The controls listed on the configuration display screen vary depending on the installed options (see *Figure 6 on page 13*). The contents of the Configuration display depends on the instrument's installed-option configuration.

2.2 Interpreting the Display Screens (cont.)

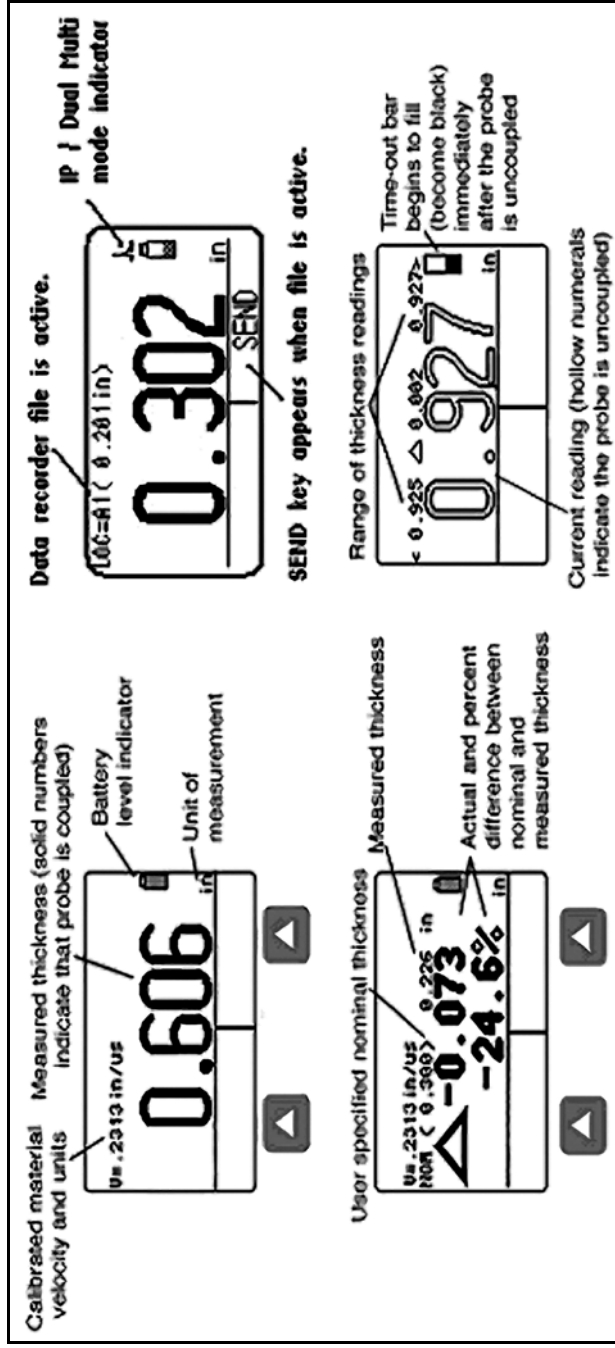


Figure 3: Measurement Display Mode

2.2 Interpreting the Display Screens (cont.)

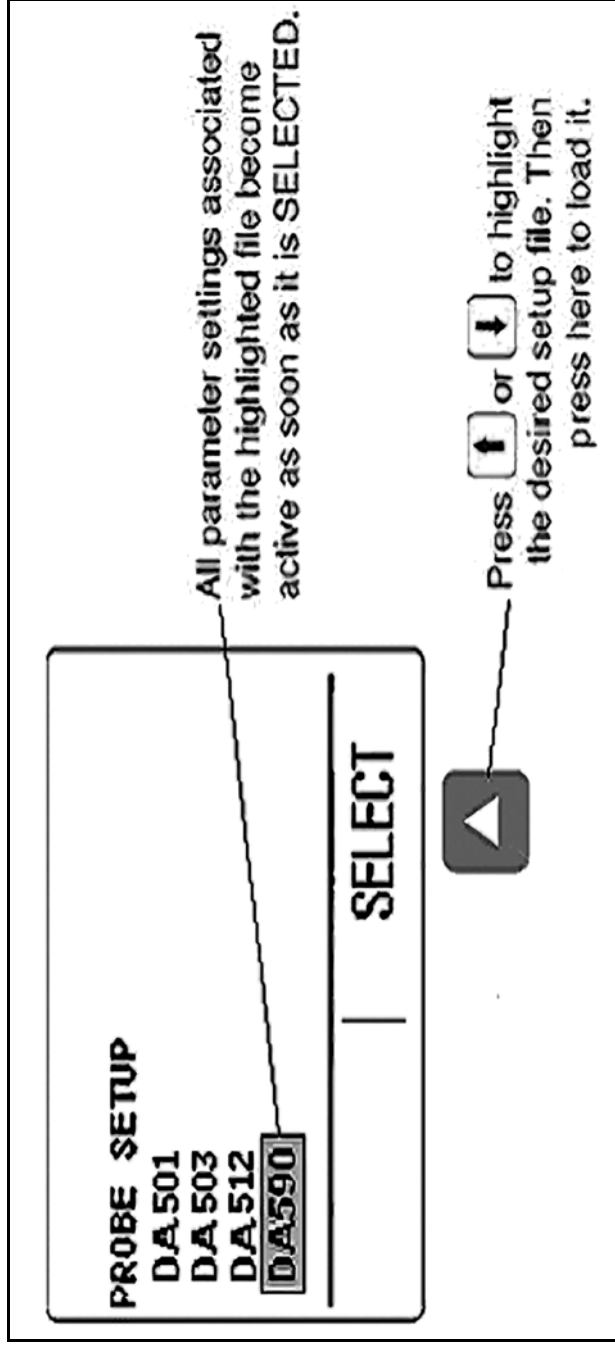



Figure 4: Probe Setup Display Mode

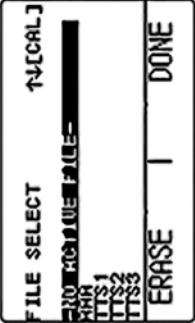
2.2 Interpreting the Display Screens (cont.)

Press **[left]** to access the CONFIGURATION display, then press **[right]** to access the File Listing / Creation display – then turn the DATA RECORDER on

Press **[left]** to access the File Listing / Creation display – then press **[right]** below CREATE to display this screen

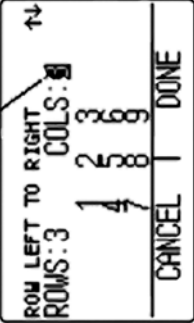


Press **[left]** to access the File Listing / Creation display – then press **[right]** below FILES to display this list



Press **[left]** to access the File Listing / Creation display – then press **[right]** below FILES to display this list

Defines the size of the newly created file



Active file location. When a thickness reading is stored here, the location below this will become the next active location as dictated by the ADVANCE DIRECTION setting.




Figure 5: File Display Mode

2.2 Interpreting the Display Screens (cont.)





Figure 6: Configuration Display Mode

2.3 Working with the Configuration Display


By repeatedly pressing , you can access the *Configuration* display and you can adjust the following DM5E settings:

- **VIEW MODE** - In base-model units this parameter offers five settings. See *Section 4.1 on page 36* to select the view to be displayed.
- **DATA RECORDER** - When the optional data recorder is installed, setting this parameter to ON activates the file recording capability and the data recorder file display.
- **MINIMUM ALARM** - Enables and sets the minimum alarm value (see *Section 3.4 on page 30*).
- **MAXIMUM ALARM** - Enables and sets the maximum alarm value (see *Section 3.4 on page 30*).
- **UNITS** - Sets the units of measurement to inches or millimeters (see *Section 3.2 on page 21*).
- **NOMINAL THICKNESS** - Sets the nominal thickness value that is then used to calculate and the differential and rate of reduction measurement values when selected by the *VIEW MODE* parameter (see *Section 3.2.3 on page 25*).
- **RESOLUTION** - Controls the format (number of decimal places) of the thickness measurement that is displayed and stored in a Data Recorder file.
- **UPDATE RATE** - Sets the rate at which the measurement reading is updated (see *Section 3.2.2 on page 24*).

2.3 Working with the Configuration Display (cont.)

- **BACKLIGHT** - Turns the display backlight feature to ON, OFF, or AUTO (AUTO switches backlighting ON whenever a key is pressed or the probe is connected).
- **CONTRAST** - Select this control and then press  or  to adjust the display contrast level.
- **LANGUAGE** - Sets the instrument display language (see *Section 3.2 on page 21*).
- **BSCAN MINIMUM** - Sets the minimum value that can be drawn when BSCAN is processing (see *Section 3.2.1 on page 23*).
- **BSCAN MAXIMUM** - Sets the maximum value that can be drawn when BSCAN is processing (see *Section 3.2.1 on page 23*).
- **DUAL MULTI** - Used to switch between Dual Multi and IP test modes, when Dual Multi option is allowed (see *Section 3.2 on page 21*).
- **READING HOLD** - Can be set to hold the last measurement value when the probe is uncoupled in measurement mode (see *Section 3.2 on page 21*).

2.3 Working with the Configuration Display (cont.)

- **TIME** - Used to set the current time (see *Section 3.2 on page 21*).
- **DATE** - Used to set the current date (see *Section 3.2 on page 21*).
- **GAIN** - Used to select a different level of gain (LOW/HIGH/AUTO/DEFAULT) (see *Section 3.2.1 on page 23*).
- **RADIX** - Selects a period (.) or comma (,) to be used as a decimal point (see *Section 3.2 on page 21*).
- **AUTO POWER DOWN** - When set to ON, this control conserves battery life by powering the instrument OFF if no key presses or measurements occur for the set number of minutes. When set to OFF, the instrument is only powered OFF when  is pressed and held.

Chapter 3. Setting Up the DM5E

Prior to measuring thickness, the instrument must be properly setup. This chapter explains the steps that must be taken prior to measurement, to ensure that the display appearance, ultrasonic settings, and measurement mode match the desired configuration. The steps described in this chapter apply to all instruments, regardless of whether or not they incorporate the Dual Multi or Data Recorder options.

Most fundamental instrument parameters are automatically set to a default value based on the *Setup* file selected by the user. Each instrument is supplied with standard Setup files, and naming these to match the probe is the first step in setting up the instrument.

In preparation for measuring thickness, this chapter explains how to:

- Install a probe and configure the instrument by loading a Setup file (see *Section 3.1 on page 18*).
- Set up the instrument display appearance (see *Section 3.2 on page 21*).
- Set the instrument's Gain and Update Rate (see *Section 3.2 on page 21*).
- Calibrate the instrument/probe combination (see *Section 3.3 on page 26*).
- Set maximum and minimum alarm values (see *Section 3.4 on page 30*).
- Lock and unlock the instrument controls (see *Section 3.6 on page 32*).

3.1 Connecting a Probe and Loading a Setup File

Prior to measuring thickness, you must connect a probe to the instrument (see *Figure 7* below) and select a Setup file that is compatible with the probe.



Figure 7: Top View of Instrument

3.1 Connecting a Probe and Loading a Setup File (cont.)



After a probe is connected, press **MODE** to activate the *Probe Setup* display. The *Probe Setup* display, which is shown in *Figure 8* below, allows the user to select one of the standard Setup files.

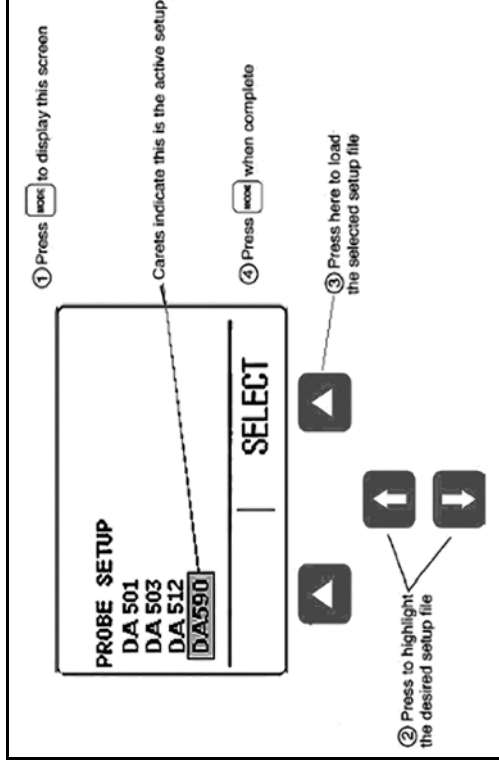


Figure 8: Selecting a Setup File









3.1 Connecting a Probe and Loading a Setup File (cont.)

The following instrument settings are automatically adjusted when the Setup file is activated:

- View Mode
- Gain
- Measured Value display resolution
- Measurement Mode
- Nominal Thickness - when Differential, %RR mode are selected
- Minimum Alarm Setting
- Maximum Alarm Setting

3.2 Configuring the Instrument

Before using the DM5E, the parameters listed on the next page must be programmed at the *Configuration* display (see *Figure 9*) as follows:

1. Press  as many times as necessary to access the *Configuration* display.
2. Press  or  to select the desired parameter to modify.
3. After the desired parameter is highlighted, press  to program that parameter.
4. Press  or  to adjust the parameter value, then press  to confirm the new setting.
5. Repeat steps 2-4 until all remaining parameters have been set. After all of the settings have been configured, press  to return to the measurement display.

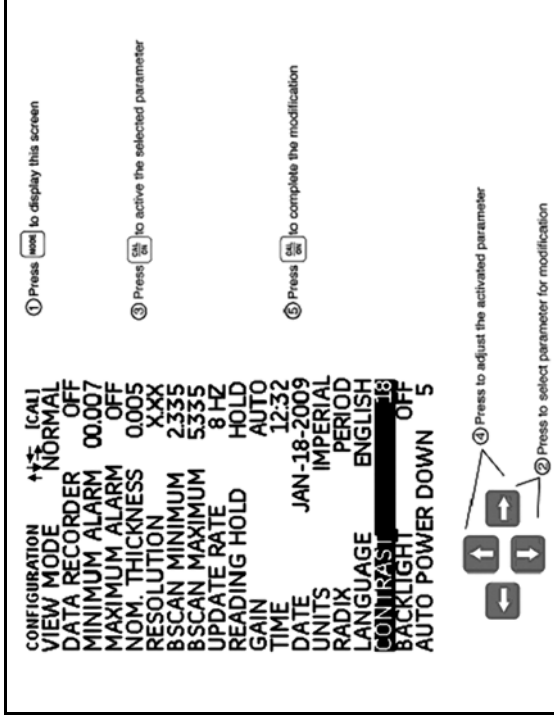


Figure 9: The Configuration Menu






3.2 Configuring the Instrument (cont.)

Using the procedure described on the previous page, configure the following parameters:

- Language - Set the language
- Units - Set the units of measurement to inches or millimeters
- Resolution - Sets the number of decimal places to which thickness measurements are displayed
- Update Rate - Update the displayed measurement at a rate of 4 or 8 Hz
- Radix - Select a period (.) or comma (,) to be used as a decimal point
- Dual Multi - Select ON or OFF
- Reading Hold - Select HOLD or BLANK
- Time - Set time in HH:MM format
- Date - Set date in Month-Date-Year format
- BSCAN MINIMUM - BSCAN display of minimum value
- BSCAN MAXIMUM - BSCAN display of maximum value
- Auto Power Down - Select ON and then choose the desired time to automatically turn the instrument OFF 5/10/15/30 minutes after the last key press (no data will be lost) or select OFF to allow the instrument to remain ON until manually powered OFF.
- Contrast - Adjusts display contrast
- Backlight - Adjusts the display backlighting. A setting of ON increases battery usage, a setting of AUTO causes the backlighting to illuminate and remain on for five seconds after each key press.






3.2.1 Setting the Instrument Gain

The instrument *gain level* may set to AUTO, DEFAULT, HIGH, or to a noise-reducing LOW setting. To select the instrument gain setting:

1. Press .
2. Select the GAIN control.
3. Press  to activate the control, then use  or  to adjust the selected value and use  or  to select the cursor position.
4. Press  after the adjustment is complete.

3.2.2 Setting the Update Rate

Measurements are updated at a rate of 4 or 8 Hz, as selected by the user. To select the measurement update rate:

1. Press .
2. Select the UPDATE RATE control.
3. Press  to activate the control, then use  or  to adjust the setting.
4. Press  after the adjustment is complete.

3.2.3 Specifying the Nominal Thickness

When the VIEW parameter is set to DIFF/RR%, the displayed thickness includes two differential values (in the instrument's units and as a percentage) that represent the variation from user specified nominal thickness (see Section 4.4). To manually input or modify the nominal thickness:

1. Press .
2. Select the NOM THICKNESS control.
3. Press  to activate the control, then use  or  to adjust the selected place value and  or  to select a different value.
4. Press  after the adjustment is complete.

3.3 Instrument Calibration

Before using the DM5E, the instrument and the connected probe must be calibrated using one or more standards of known thickness. It is important that the Setup file corresponding to the probe be selected prior to launching the calibration process. Then, the user can select either 1pt, 2pt, or AUTO calibration mode in the LOCKOUT menu. To complete the calibration, follow the instructions on your instrument's display screen and in *Figure 10 on page 27* (1pt mode), *Figure 11 on page 28* (2pt mode) or *Figure 12 on page 29* (Auto mode).

Note: *Proper calibration is essential for accurate operation of the instrument. The instrument should be calibrated if there is a change in the type or temperature of the material being tested, if the attached probe is changed, after performing any parameter adjustment, or at intervals specified in your test procedures.*

3.3 Instrument Calibration (cont.)

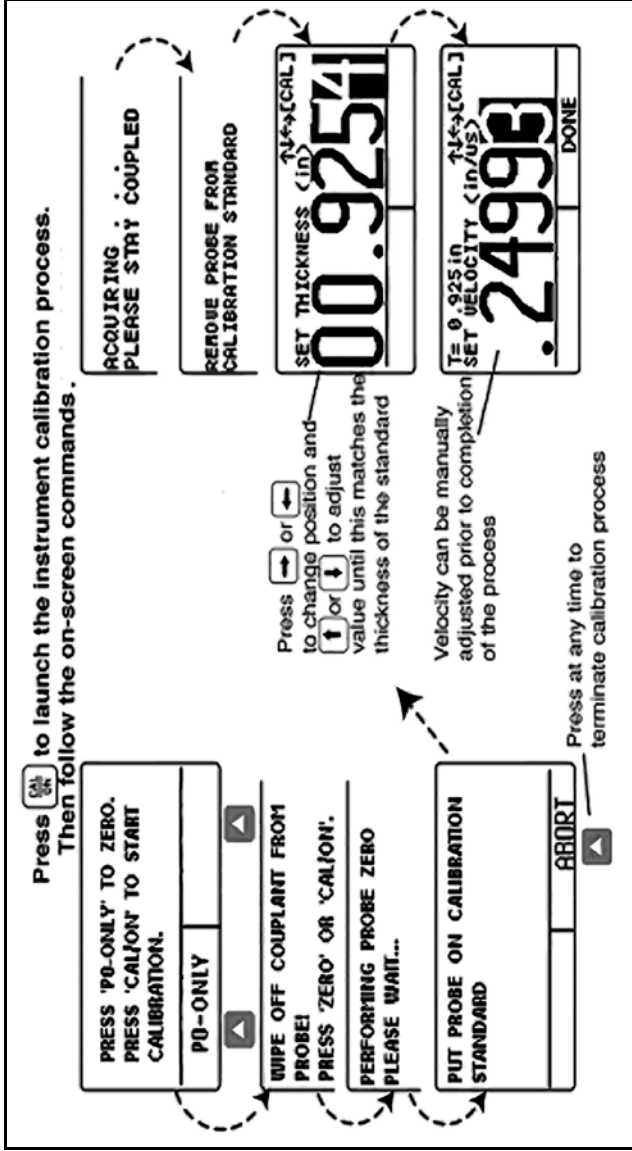


Figure 10: Instrument Calibration Procedure (1pt Mode)

3.3 Instrument Calibration (cont.)

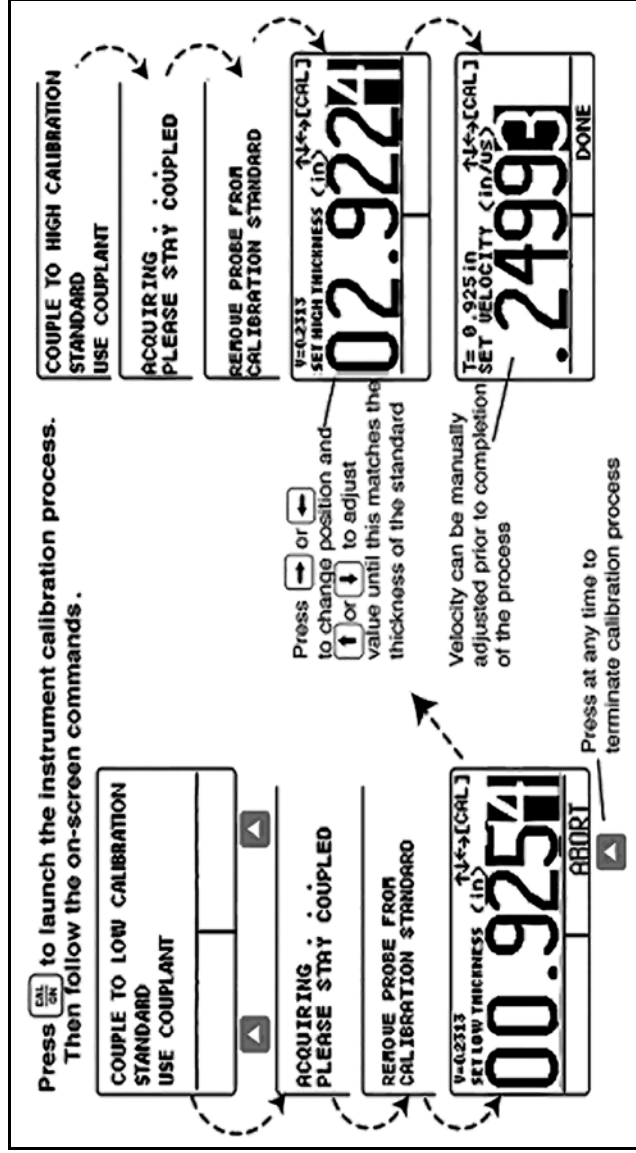


Figure 11: Instrument Calibration Procedure (2pt Mode)

3.3 Instrument Calibration (cont.)

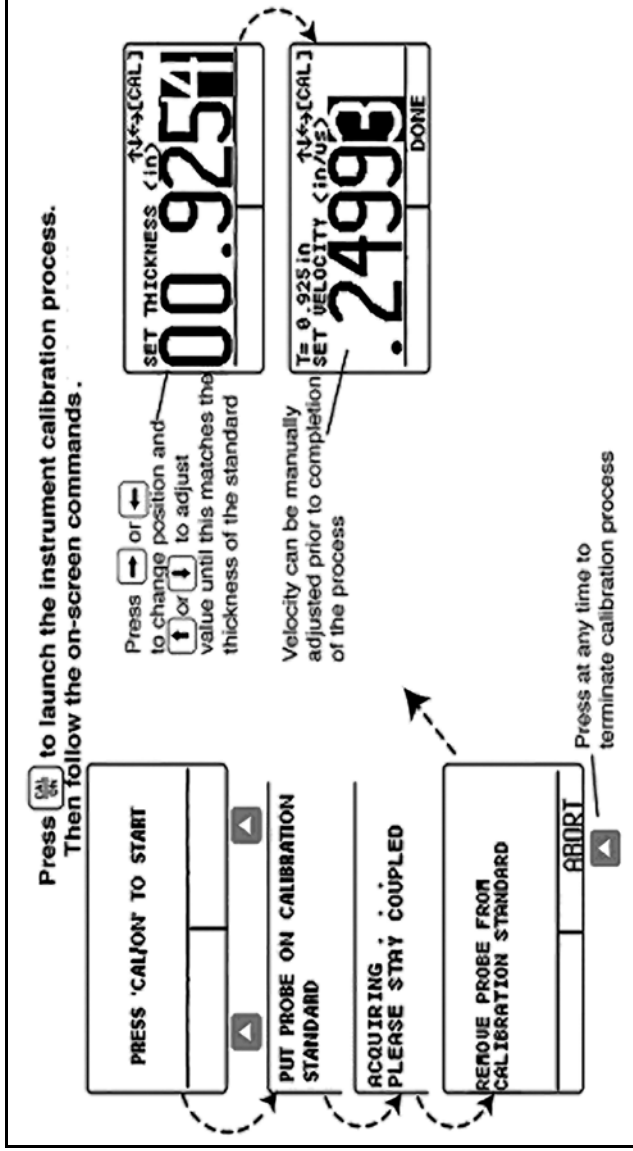













Figure 12: Instrument Calibration Procedure (Auto Mode)

3.4 Setting the Maximum and Minimum Alarms

When the thickness measurement value exceeds either the minimum or maximum alarm setting, the measurement value alternates between solid and hollow font type displays, except in B-SCAN mode. When an alarm appears in B-SCAN mode, the measurement value flashes ON and OFF in 1/2 second intervals.












To input a minimum or maximum alarm thickness:

1. Press  to access the *Configuration* display (see *Figure 9 on page 21*).
2. Press  or  to select either MINIMUM ALARM or MAXIMUM ALARM.
3. When the desired parameter is highlighted, press  to activate it.
4. Press  or  to change the selected position in alarm thickness and then press  or  to adjust the value of the selected position. To switch the alarm setting to OFF from any other value, simultaneously press  or .
5. Press  after the alarm thickness has been set to the desired value.

3.5 B-SCAN Display Range

The default BSCAN display range is 0-20 inch. We highly recommend adjusting the range according to the target, because setting an appropriate range will display a clearer scan graph. To adjust the range, complete the steps below.

Note: *If the BSCAN value exceeds the preset range, that point will be graphed as equal to the range limit.*

1. Press  to access the *Configuration* display (see *Figure 9* on page 21).
2. Press  or  to select either BSCAN MINIMUM or BSCAN MAXIMUM.
3. When the desired parameter is highlighted, press  to activate it.
4. Press  or  to change the selected position in alarm thickness and then press  or  to adjust the value of the selected position. To switch the alarm setting to OFF from any other value, simultaneously press  or .
5. Press  after the alarm thickness has been set to the desired value.

3.6 Locking and Unlocking Instrument the Controls

The DM5E allows operators to lockout specific functions by using the lockout display, which is only accessible from the measurement screen. Follow the instructions in *Figure 13* on page 33 to access this display and lockout (or enable) some or all of the function keys.

Note: The DATA RECORDER and DUAL MULTI functions are optional and are only available with advanced instrument versions. However, an upgrade of the basic version is possible by purchasing a license key.

In the *Lockout* menu, the operator can set the probe zeroing and calibration mode (CAL/ZERO MODE) by selecting 1pt, 2pt or AUTO. One of the following calibration reminder styles can also be selected:

- **REMIN TIME** - The calibration reminder is displayed after a preset elapsed time from the last thickness calibration. The setting indicates the preset time value.
- **CAL READINGS** - The calibration reminder is displayed after the user presses the SEND function the number of times indicated by the setting value.
- **CAL POWER ON** - The calibration reminder is displayed each time that the instrument is powered ON when the value is set to ON.

3.6 Locking and Unlocking Instrument the Controls (cont.)

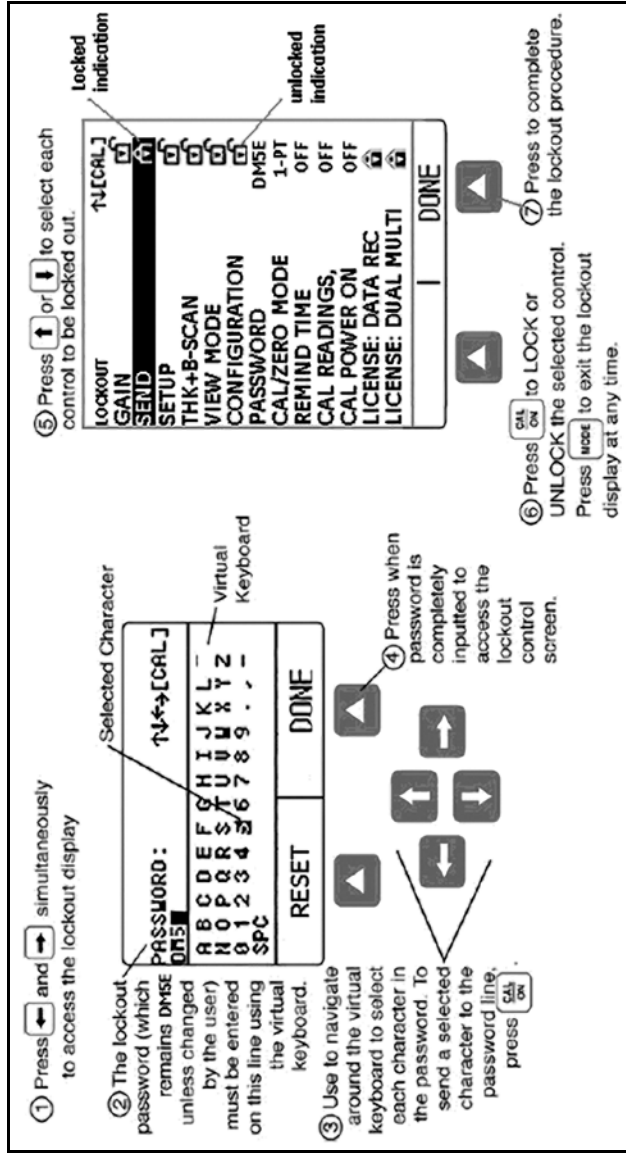


Figure 13: Locking and Unlocking the Function Keys

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Chapter 4. Measuring Thickness

After setting up the instrument as described in *Chapter 3*, additional adjustments can be made by selecting the type of measurement made and the way in which it is displayed. You will also find information related to configuring and working with the BSCAN mode. The specific topics include how to:

- Select the measured value to view (see *Section 4.1 on page 36*)
- Work with Normal measurement mode (see *Section 4.2 on page 39*)
- Use the Min Scan and Max Scan measurement modes (see *Section 4.3 on page 40*)
- Interpret the Differential/Rate-of-Reduction measurement mode (see *Section 4.4 on page 41*)
- Work with the B-Scan measurement mode (see *Section 4.5 on page 42*)
- Use the Dual Multi measurement mode (see *Section 4.6 on page 43*)


Note: *Load a Setup file corresponding to the connected probe prior to making the adjustments described in this chapter: Loading a Setup file after these adjustments are made will force certain settings back to the default value stored in the file.*

4.1 Selecting the Displayed View Mode

Base model DM5E instruments offer four display modes. In addition, two more display modes are available depending on the installed options. These display modes include:

- **NORMAL (Thickness Only)** - The thickness value appears as large digits in the center of the display.
- **MIN SCAN (Minimum Thickness Scan)** - Allows the user to continuously evaluate material thickness, provided the probe remains coupled or is uncoupled only briefly. After the evaluation period is complete, the minimum material thickness is displayed. During the evaluation period, the thickness is displayed along with the minimum and maximum observed thickness values and the calculated difference between the two. The display also includes a time-out bar, which begins to fill as soon as the probe is uncoupled. Recoupling the probe before the time-out period expires allows the user to continue with the same evaluation period. After the evaluation period is complete, as indicated by the filling of the time-out bar, the minimum thickness observed during the evaluation period is displayed.
- **MAX SCAN (Maximum Thickness Scan)** - Allows the user to continuously evaluate material thickness, provided the probe remains coupled or is uncoupled only briefly. After the evaluation period is complete, the maximum material thickness is displayed. During the evaluation period, thickness is displayed along with the minimum and maximum observed thickness values and the calculated difference between the two. The display also includes a time-out bar, which begins to fill as soon as the probe is uncoupled. Recoupling the probe before the time-out period expires allows the user to continue with the same evaluation period. After the evaluation period is complete, as indicated by the filling of the time-out bar, the maximum thickness observed during the evaluation period is displayed.

4.1 Selecting the Displayed View Mode (cont.)








Note: During the placement of a very sensitive probe on the part surface, excess couplant may cause erroneous results. To eliminate the effect of excessive couplant, couple the probe firmly to the part, then press  under HOME. This restarts the scanning session while the probe is properly in contact with the part.

- **DIFF/RR%** (Differential/Rate-of-Reduction) - The currently measured and user-specified nominal thicknesses appear along the top of the display, while the difference between these two values (measured minus nominal values, expressed in percentage and dimensional terms) appears in the middle of the display.
- **B-SCAN** (B Scan) - Allows the user to continuously evaluate material thickness by graphing 1 point per second. During the evaluation period, the measured thickness value is displayed along with the minimum and maximum observed thickness values. The display has a hidden 5-second time-out bar, which starts as soon as the probe is uncoupled. Recoupling the probe before the time-out period expires allows the user to continue with the same evaluation period. Pressing the SEND key stores the minimum thickness value after the evaluation period is complete, as indicated by the filling of the time-out bar.

Note: *The displayed differences can have either positive or negative values (see Section 4.4 on page 41).*

4.1 Selecting the Displayed View Mode (cont.)

The measurement mode displayed by the instrument may be modified as follows:

1. Press  as many times as necessary to access the *Configuration* menu.
2. Press  or  to select the VIEW MODE parameter.
3. Press  to activate this parameter.
4. Press  or  to scroll through the available modes, then press  to select the highlighted mode.

4.2 Normal Measurement View Mode

When NORMAL view mode is active, the display shows only a thickness reading, as shown in Figure 14 below.

Note: *If the Data Recorder file is active, the data location and stored value will be displayed at the top left corner of the display, instead of the material velocity value.*

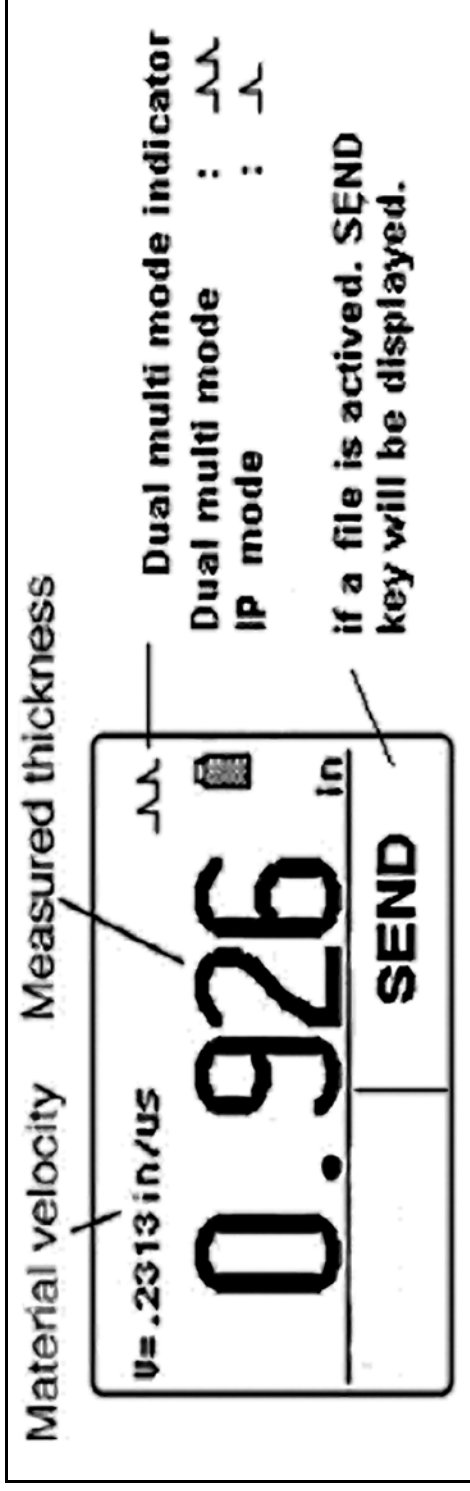


Figure 14: NORMAL Measurement View Mode

4.3 Min Scan and Max Scan Measurement View Modes

The MIN SCAN and MAX SCAN modes allow the user to continuously evaluate material thickness then, after the evaluation period is complete, display the extreme (minimum or maximum) material thickness observed. During the evaluation period, thickness is displayed along with the minimum and maximum observed thickness values (see *Figure 15* below). A time-out feature allows a momentarily uncoupling of the probe during the evaluation period. In these modes, the instrument will continue to collect and compare readings for as long as the time-out period is not exceeded.

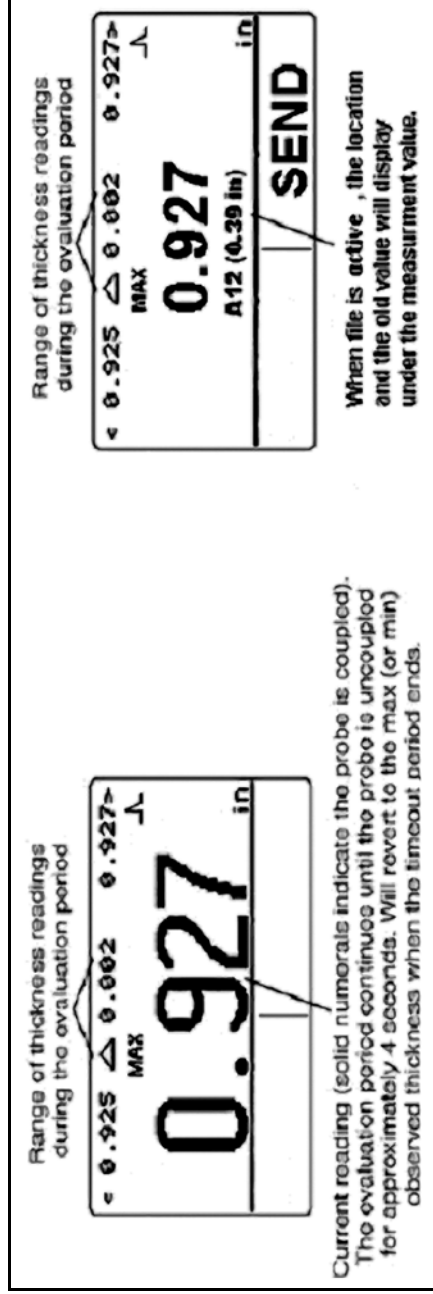


Figure 15: MAX SCAN Measurement View Mode

4.4 Differential/Rate-of-Reduction Measurement View Mode

This view mode (see Figure 16 below) displays both the currently measured thickness and a nominal thickness input by the user, along with the difference between these two values (“measured” minus “nominal”) expressed in percentage and dimensional terms.

Note: *The displayed differences can have either positive or negative values.*

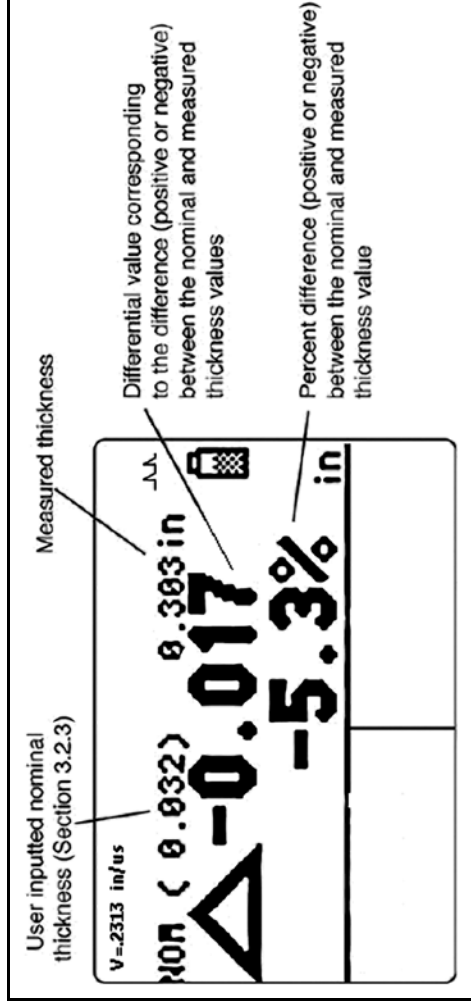


Figure 16: DIFF/RR% Measurement View Mode

4.5 B-SCAN Measurement View Mode

The B-SCAN mode (see *Figure 17* below) allows the user to continuously display the material thickness in a graphical mode. During the evaluation period, the thickness measurement is displayed along with the minimum and maximum thickness values. A time-out feature allows a momentarily uncoupling of the probe during the evaluation period. In this mode, the instrument will continue to collect and compare readings for as long as the time-out period is not exceeded. Pressing the SEND key will store the minimum value in the active file.

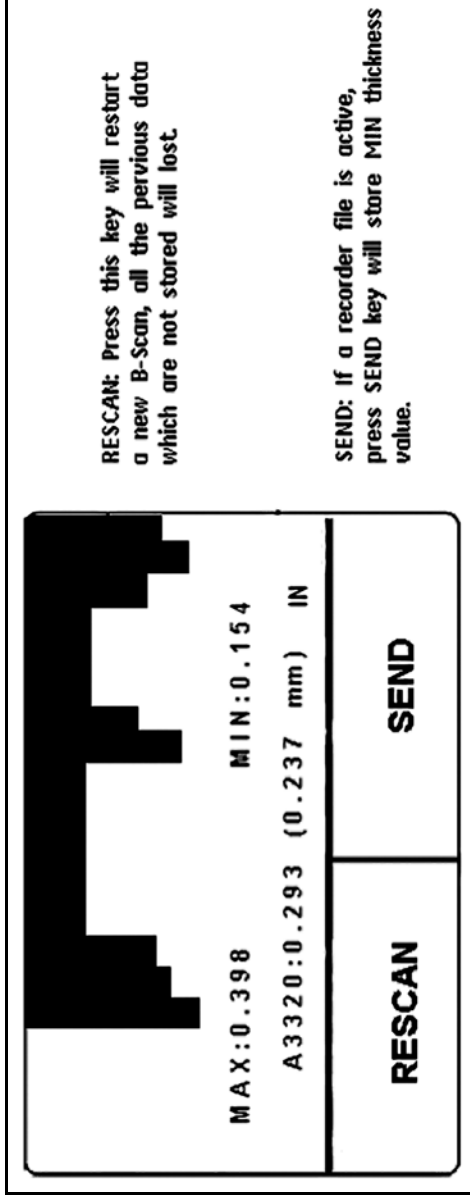





Figure 17: B-SCAN Measurement View Mode

4.6 Dual Multi Measurement View Mode

Protective coatings, including paint, contribute significant error to the thickness measurement of the underlying metal when using conventional measurement techniques. The Dual-Multi mode eliminates coating layers from the measurement by measuring between successive back wall reflections of the metal. The measurement range for each probe will vary depending upon the type and thickness of the coating, the thickness of the metal, and the quality of the bond between the coating and the metal.

To activate or deactivate the Dual-Multi mode, you can either use the Configuration menu or press and hold  for 1.5 seconds while in measurement mode. A *single-peak icon* () above the battery icon indicates Dual Multi mode (see *Figure 18 on page 44*). A *dual-peak icon* () above the battery icon indicates Dual Multi mode.

Note: *The Basic version of the DM5E does not have the Dual Multi function. Only specially-equipped DM5E and DM5E DL versions offer the Dual Multi function.*

4.6 Dual Multi Measurement View Mode (cont.)

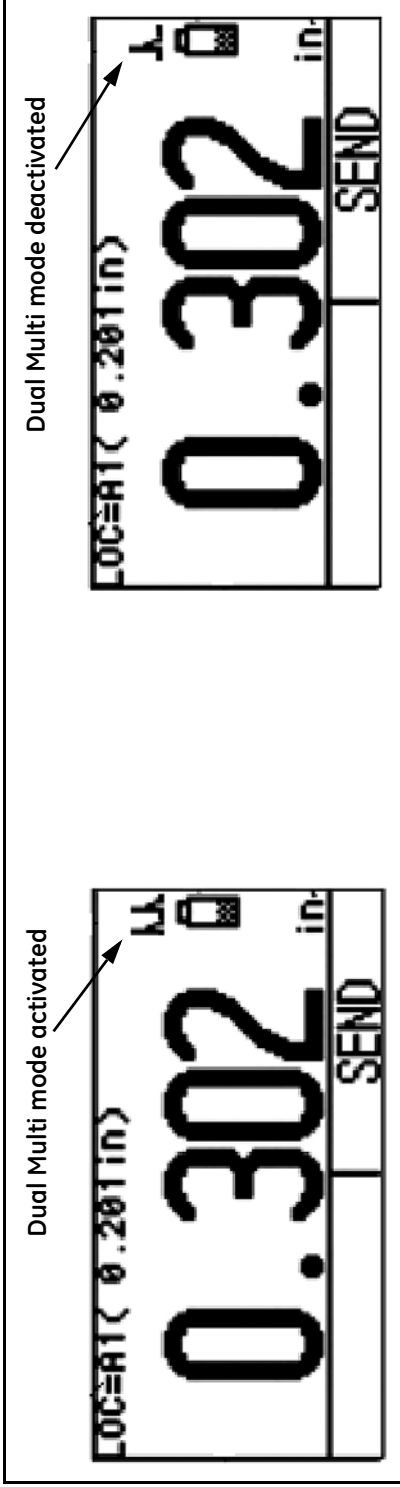


Figure 18: DUAL MULTI Measurement View Mode

Chapter 5. Using the Optional Data Recorder

Note: *The instructions in this chapter apply only to instruments equipped with a Data Recorder.*

When installed and activated, the Data Recorder option allows users to create Data Recorder files, store thickness readings (and the accompanying B-SCAN, when desired), and navigate through file contents. In this chapter you will learn how to:

- Create Data Recorder files (see *Section 5.1 on page 46*)
- Recall and erase Data Recorder files (see *Section 5.2 on page 49*)
- Store thickness readings in Data Recorder files (see *Section 5.3.1 on page 51*)
- Navigate Data Recorder file locations to store or replace readings (see *Section 5.3.2 on page 51*)

5.1 Creating a New Data Recorder File

To create a new Data Recorder file, you need only specify a file name. In most cases, however, you will wish to enter additional information. Parameters that can be adjusted during the file-naming process include:

- The numbers of ROWS and COLUMNS in the Data Recorder file (see *Figure 20 on page 48*).
- The ADVANCE DIRECTION (see *Figure 20 on page 48*).
- NOTES related to the data file

Note: *Once created, the file name, size and ADVANCE DIRECTION parameters cannot be edited. Only the NOTES contents can be modified. To accomplish this, first select the file then activate and modify the parameter.*

Follow Steps 1 through 5 in *Figure 19 on page 47* to create a new Data Recorder file.

5.1 Creating a New Data Recorder File (cont.)

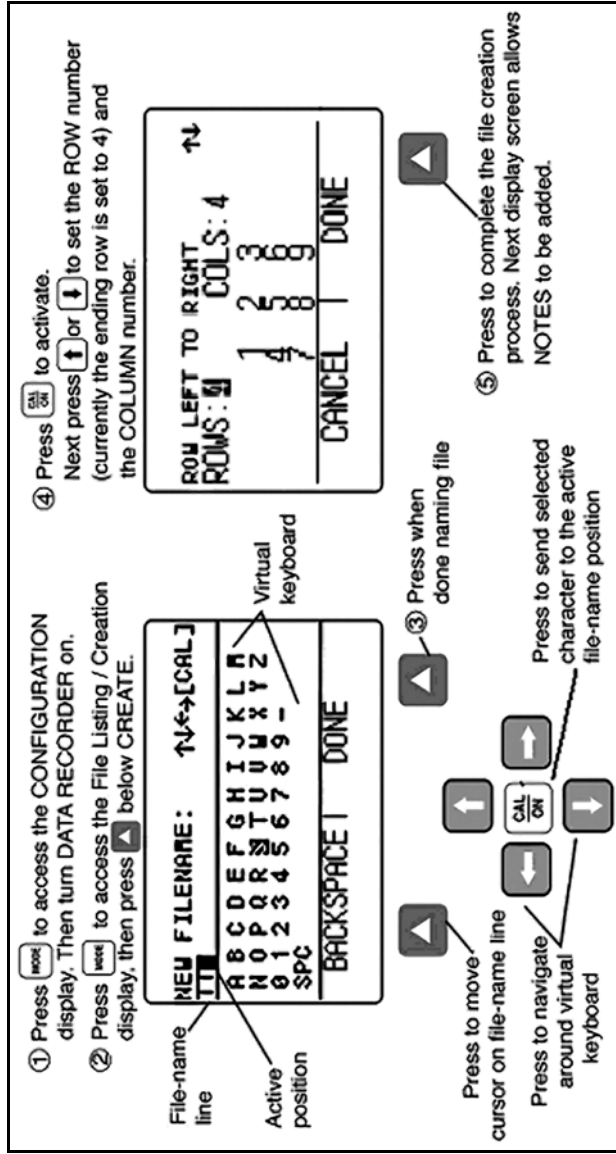


Figure 19: Creating a New Data Recorder File

5.1 Creating a New Data Recorder File (cont.)

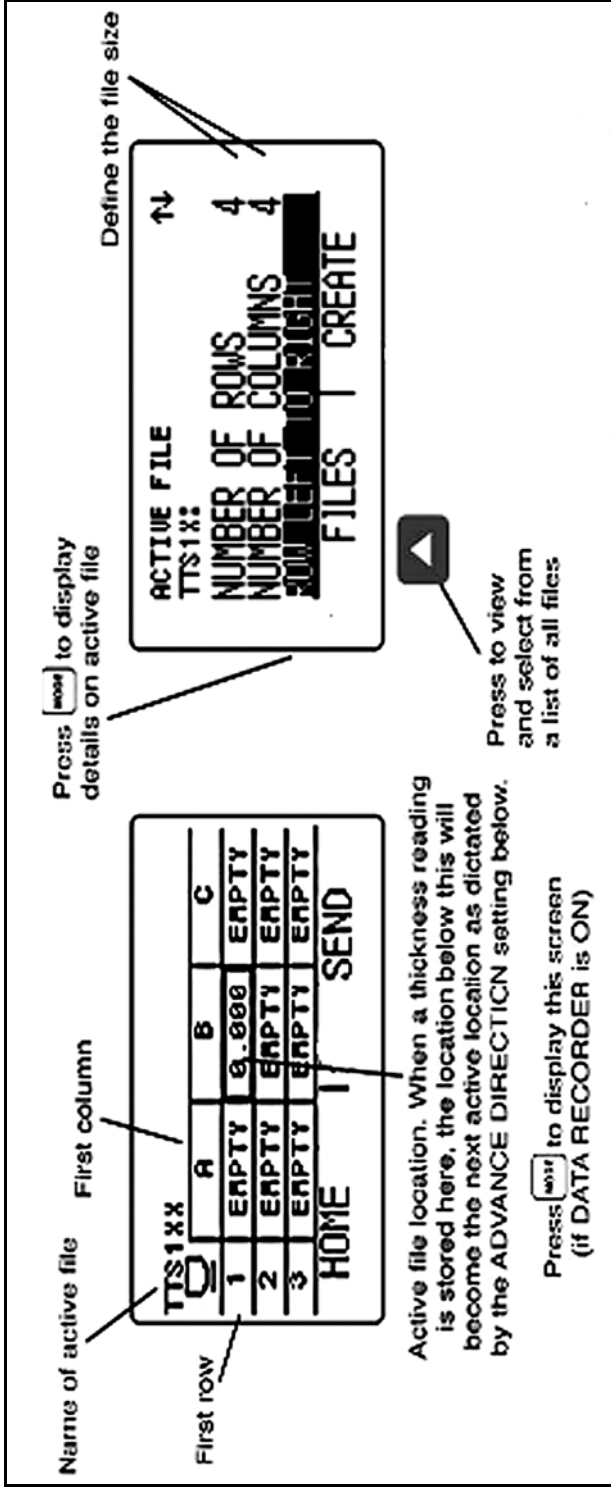








Figure 20: Defining the Size and Advance Direction of a Data Recorder File






5.2 Recalling and Erasing Stored Data Recorder Files

Stored Data Recorder files can be recalled or erased at any time. Once recalled, thickness measurements can be stored in available file locations, but the advance direction cannot be changed.

5.2.1 Recalling a Data Recorder File

1. Press  as many times as necessary to access the Configuration display and then set DATA RECORDER to ON.
2. Press  again to launch the File Display mode.
3. Activate the file selection function by pressing  below FILES. A file list will appear on the display.
4. Press  or  to select the stored file you wish to recall, then press  to confirm the selection.

5.2.2 Erasing a Data Recorder File

1. Press  again to launch the File Display mode.
2. If necessary, press  below FILES to display a list of the stored files.
3. Press  or  to select the stored file you wish to erase, then press and hold  below ERASE.

IMPORTANT: *Once erased, the Data Recorder file and any stored thickness measurements cannot be retrieved.*

5.3 Recording Thickness Measurements in Data Recorder Files


The Data Recorder must be enabled (turned ON) via the CONFIGURATION display. Once the Data Recorder is turned on, the contents of the active Data Recorder file are displayed in the *File Navigation Grid* shown in *Figure 20 on page 48*.



To store a thickness reading in the selected file position, press  below SEND. Remember that the units of the thickness value and the number of decimal places to which the thickness is recorded are determined by the UNITS and RESOLUTION settings as described in *Section 3.2 on page 21*.

5.3.1 Storing Minimum of B-Scan in Data Recorder Files

When in B-Scan mode, the minimum value is stored in the active position of the Data Recorder by pressing  below SEND.

5.3.2 Navigating Through Data Recorder Files

When the Data Recorder is turned ON, the contents of the active Data Recorder file are displayed in the *File Navigation Grid* shown in *Figure 20 on page 48*. After the navigation grid is activated, , , , and  can be used to select any file position. A heavier grid box appears around the selected file position. Once a file position has been selected:

- The current thickness reading can be sent to an EMPTY file position.
- A measurement value can be stored by pressing  below SEND.
- A previously-stored value can be overwritten by pressing  below SEND.

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Chapter 6. I/O Features

Note: *The instructions in this chapter apply to all versions of the DM5E instrument.*

The DM5E can communicate with external devices through its built-in I/O port. A mini-USB to PC cable is available for connection to this virtual COM port (see *Figure 21* below for the location). With the UltraMATE, UltraMATE Lite, or even a simple Excel Macro, a PC can import data recorder files from the instrument.

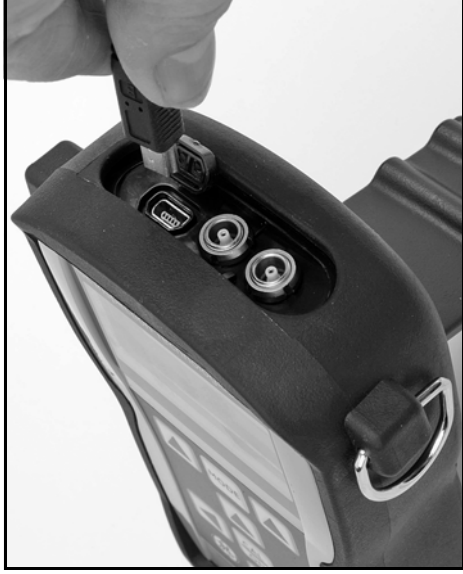


Figure 21: Location of Mini USB COM Port

6.1 Connecting the DM5E to a PC

The instrument's I/O port can be connected to a PC using a mini-USB cable. Be sure to install the virtual COM port driver on the PC before making the connection. Then, follow the instructions on your PC screen to install the new hardware.

Chapter 7. Specifications

This chapter lists the features and specifications of your DM5E including:

- Instrument specifications (see *Section 7.1 on page 56*)
- Features of the optional Data Recorder (see *Section 7.2 on page 60*)
- Probe specifications (see *Section 7.3 on page 61*)

Note: *Also, see “EN15317 Technical Specifications” on page 77.*

7.1 Instrument Specifications

<i>Operating Principle:</i>	Ultrasonic, pulse echo measurement method
<i>Measuring Range:</i>	Depends on probe and material, 0.60mm to 508mm (0.025in to 20.00in) in IP to 1st BW Measurement Mode, 2.00mm to 127.0mm (0.079in to 5.00in) in Dual-Multi Measurement Mode, the coating thickness range shall be 0.3mm to 2.50mm (0in to 0.098in).
<i>Measuring Resolution:</i>	0.001 inch default (selectable 0.001, 0.01 inch) 0.01 mm default (selectable 0.01, 0.1 mm)
<i>Material Velocity Range:</i>	0.0200 to 0.7362 in/msec 0.508 to 18.699 mm/msec
<i>Material Velocity Resolution:</i>	0.0001 in/msec 1 m/s
<i>Units:</i>	inch or millimeter
<i>Calibration:</i>	One-Point Cal, On-Block and Off-Block, Two-Point Cal

7.1 Instrument Specifications (cont.)

<i>Pulser:</i>	<i>Excitation Pulse:</i> Spike Pulser <i>Voltage:</i> 120 V into 50 ohm load, using 20 MHz oscilloscope
<i>Receiver:</i>	<i>Bandwidth:</i> 1.5 MHz to 12 MHz @ -3 dB <i>Gain:</i> Automatic Gain Control
<i>Display Type:</i>	High-resolution graphical LCD, 64 x 128 Pixels, 53.0mm x 27.0mm with backlight and adjustable contrast
<i>Update Rate:</i>	4 Hz or 8 Hz, user selectable, 24 Hz scan mode capture rate
<i>Thickness Value Display:</i>	<i>NORMAL view mode:</i> 5 digit, 0.4" (10.6 mm) high <i>B-SCAN view mode:</i> 5 digit, 0.1" (2.55 mm) high
<i>Display of Last Reading:</i>	Solid filled or hollow digits indicate coupled or uncoupled condition
<i>Setups:</i>	9 standard setups for probes

7.1 Instrument Specifications (cont.)

<i>Alarm Settings:</i>	Minimum and Maximum alarms, Range of 0.010 in to 20.00 in, 0. (0.25 mm to 508 mm) Reading alternates between solid and hollow when alarms are enabled and violated
<i>Power Requirements:</i>	2 "AA" size batteries
<i>Battery Life/Operating Time:</i>	Approximately 100 hours
<i>Instrument Shut-Off:</i>	Selectable ALWAYS ON or AUTO OFF after 5, 10, 15, 30 minutes of inactivity
<i>Language:</i>	Selectable English, German, French, Spanish, Italian, Russian, Japanese and Chinese
<i>I/O Connectors:</i>	<i>Transducer:</i> Dual Lemo 00 (coax) <i>Mini-USB:</i> MINI-B OTG to STD A
<i>Temperature:</i>	<i>Operating:</i> +10°F to +120°F (-10°C to +50°C) <i>Storage:</i> -10°F to +140°F (-20°C to +60°C)
<i>Weight:</i>	0.597 lb (223 g) including batteries

7.1 Instrument Specifications (cont.)

Size: 138mm x 32mm x 75mm

Shock: IEC 68-2-27 Ea, as per Mil Std 810C Method 516.2 Procedure I with a 15g 11ms impulse half sinusoidal wave applied 6 times per axis

Sealing: IEC529 / IP54, Dust proof/dripping water proof as per IEC 529 specifications for IP54 classification

Note: *Instrument specifications are subject to change without prior notice.*

7.2 Data Recorder Option Features

Capacity: 50,000 readings

File Structures: Grid file

Number of Rows: 1 to 50,000

Number of Columns: 1 to 223

File Naming: Up to 16 character alphanumeric name

Optional Software: UltraMATE and UltraMATE Lite

Note: *Instrument specifications are subject to change without prior notice.*

7.3 DM5E Probe/Transducer Specifications

	Model DA501	Model DA503	Model DA512	Model DA590
Frequency:	5 MHz	2 MHz	10 MHz	5 MHz
Probe Style:	standard	standard	fingertip	high-temperature
Operating Temperature Range (continuous):	-10 to 70°C	-10 to 70°C	-10 to 70°C	-10 to 204°C
Contact Diameter:	15 mm (.590")	20 mm (.787")	7.5 mm (.300")	12.7 mm (.500")
IP to First Measurement Range:	1.0 to 200 mm (.040 to 8")	5 to 300 mm (.200 to 12")	0.6 to 60 mm (.020 to 2.4")	1 to 125 mm @20°C (.040 to 5" @68°F) 1.3 to 25.4 mm @204°C (.050 to 1" @400°F)
Minimum Multi-Echo Measurement Range:	3.0 to 25 mm	N/A	2.0 to 10 mm	N/A

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Chapter 8. Maintenance

8.1 Care of the instrument

Clean the instrument housing and display using a soft cloth lightly dampened with water or a mild window-cleaning product. Never use harsh solvents as they could cause the plastic to become brittle or damaged.

8.2 Proper Cable Handling

- Avoid twisting or knotting of the cable.
- Grasp the cable only by the connectors when connecting or disconnecting it from the instrument.

8.3 Batteries

Periodically inspect the batteries for signs of leakage or corrosion. If either occurs, remove and replace ALL the batteries. Take care to properly dispose of the defective batteries (see “*Battery Disposal*” on page 75).

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Appendix A. Supplemental Information



This appendix contains supplementary information, including:

- Resetting the instrument's operating software (see *Section A.1 on page 66*)
- Upgrading the instrument's operating software (see *Section A.2 on page 67*)
- Web site information (see *Section A.3 on page 69*)
- EMC documentation (see *Section A.4 on page 70*)
- Manufacturing and Service Center locations (see *Section A.5 on page 71*)

A.1 Resetting the Operating Software

IMPORTANT: *The following procedure will set all parameters to their factory default values. Any files you wish to retain should be downloaded using the UltraMATE PC software before resetting the operating software. However, any Data Recorder files stored in the instrument will not be deleted during this procedure.*

To reset the instrument's operating software:

1. Turn the instrument OFF.
2. Press and hold . Then press and hold  for approximate 3 seconds, until the display indicates that the reset is complete.
3. A successful reset is acknowledged when the RESET COMPLETE message briefly appears at the bottom center of the display screen.

A.2 Firmware Updates

The DM5E operating software can be upgraded using an internet connection and an upgrade utility program. Each instrument is shipped with a CD containing the DM5E *Upgrade Utility Program*. To perform the update, proceed as follows:

1. Install the *Upgrade Utility Program* on a PC that has an active internet connection.
2. Run the *Upgrade Utility Program* from the Program Menu on your PC. For a typical MS Windows operating system, this is accomplished by clicking the START button, clicking the RUN button, selecting PROGRAMS and then selecting the DM5E Upgrade Utility (see *Figure 22 on page 68*).
3. Select the “*Browse local disk*” button if the new firmware is stored on a local PC drive, or select the “*Download new file*” button to connect to the GE Sensing & Inspection Technologies FTP site (you must be connected to the internet prior to this operation). The program checks the firmware version you have on your machine against the version that is on the FTP site. If the firmware version on the FTP site is newer, the utility will download the updated DM5E operation code.

Note: *If the firmware versions are the same, the utility will not download the code and will exit the download routine.*

4. Turn the DM5E OFF and connect it to the PC.
5. Click on the “*Upgrade The Instrument*” button.

A.2 Firmware Updates (cont.)

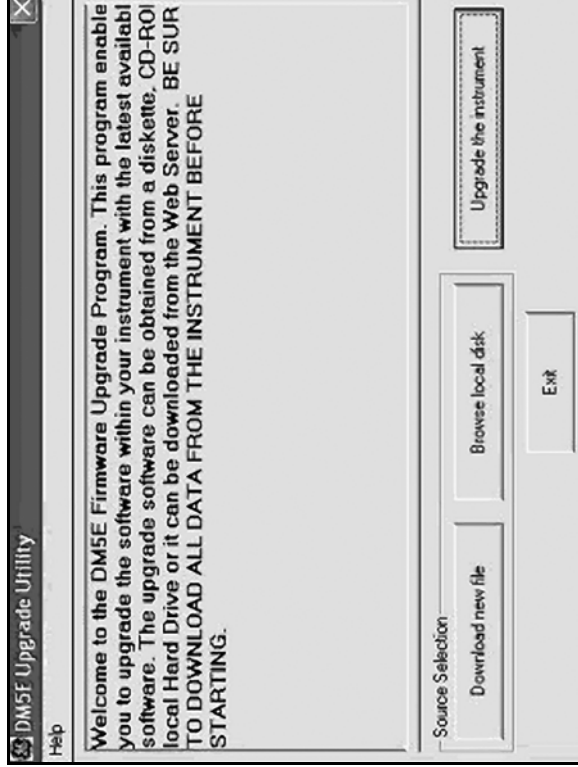


Figure 22: Changing Parameter Settings

A.2 Firmware Updates (cont.)

6. When prompted, press and hold the  and  keys for 3 seconds. The DM5E will enter re-programming mode. When the update has been completed, the DM5E will automatically shut OFF.

IMPORTANT: *All stored custom settings will be lost during the next step. However, stored Data Recorder files will not be affected.*

7. Reset the operating software to purge the instrument's memory.

A.3 Web Site Information

The following information is available on the GE Sensing & Inspection Technologies web site at www.geinspectiontechnologies.com:

- Up-to-date information on operating software
- Latest upgrade utility program
- Specifications
- New features
- Literature
- And much more!

A.4 EMC Documentation

The following is the DM5E Declaration of EMC Compliance:

DM5E Ultrasonic Corrosion Thickness Gauge

Instrument Description: The DM5E is an ultrasonic thickness gauge capable of measuring materials using ultrasonic transducers operating at frequencies from 5 to 15 MHz. This instrument displays a thickness calculated by the measured time of flight in the material at the velocity programmed into the instrument. The instrument is intended for use as a portable thickness gauge in an industrial environment. The instrument is not intended to be part of a closed control loop in an automated process control system.

Compliance Statement:

The DM5E complies with the following EN standards:

- EN55011: 2007
- EN61000-6-2: 2005

A.5 Manufacturing & Customer Service Locations

The DM5E is manufactured according to state-of-the-art methods using high-quality components. In-process testing and a quality management system certified to ISO 9001 ensure optimum quality of instrument conformance. The DM5E is manufactured by:

GE Sensing & Inspection Technologies
China

Q Section, 4th Floor, #185, Tai-Gu Road, Waigaoqiao Free Trade Zone,
Shanghai, China

Should you experience a problem or require technical assistance, visit the product service page accessible at www.geinspectiontechnologies.com to locate your local GE Inspection Technologies representative, or contact one of the *Customer Support Centers* listed on the back cover of this manual.

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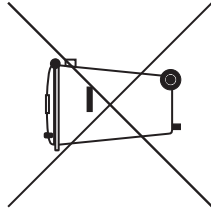
Appendix B. Regulatory Compliance

This appendix contains information on the following topics:

- WEEE Directive (see *Section B.1 on page 74*)
- Battery Disposal (see *Section B.2 on page 75*)
- EN15317 Technical Specifications (see *Section B.3 on page 77*)

B.1 Waste Electrical and Electronic Equipment (WEEE) Directive

GE Sensing & Inspection Technologies is an active participant in Europe's Waste Electrical and Electronic Equipment (WEEE) take-back initiative, directive 2002/96/EC.



The equipment that you bought has required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment.

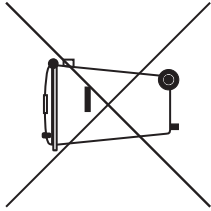
In order to avoid the dissemination of those substances in our environment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. Those systems will reuse or recycle most of the materials of your end life equipment in a sound way.

The crossed-out wheeled bin symbol invites you to use those systems.

If you need more information on the collection, reuse and recycling systems, please contact your local or regional waste administration.

Visit www.ge.com/inspectiontechnologies for take-back instructions and more information about this initiative.

B.2 Battery Disposal



This product contains a battery that cannot be disposed of as unsorted municipal waste in the European Union. See the product documentation for specific battery information. The battery is marked with this symbol, which may include lettering to indicate cadmium (Cd), lead (Pb), or mercury (Hg). For proper recycling return the battery to your supplier or to a designated collection point.

B.2.1 What do the Markings Mean?

Batteries and accumulators must be marked (either on the battery or accumulator or on its packaging, depending on size) with the [separate collection symbol](#). In addition, the marking must include the chemical symbols of specific levels of toxic metals as follows:

- Cadmium (Cd) over 0.002%
- Lead (Pb) over 0.004%
- Mercury (Hg) over 0.0005%

B.2.2 The Risks and Your Role in Reducing Them

Your participation is an important part of the effort to minimize the impact of batteries and accumulators on the environment and on human health. For proper recycling you can return this product or the batteries or accumulators it contains to your supplier or to a designated collection point.

Some batteries or accumulators contain toxic metals that pose serious risks to human health and to the environment. When required, the product marking includes chemical symbols that indicate the presence of toxic metals: Pb for lead, Hg for mercury, and Cd for cadmium.

- **Cadmium** poisoning can result in cancer of the lungs and prostate gland. Chronic effects include kidney damage, pulmonary emphysema, and bone diseases such as osteomalacia and osteoporosis. Cadmium may also cause anemia, discoloration of the teeth, and loss of smell (anosmia).
- **Lead** is poisonous in all forms. It accumulates in the body, so each exposure is significant. Ingestion and inhalation of lead can cause severe damage to human health. Risks include brain damage, convulsions, malnutrition, and sterility.
- **Mercury** creates hazardous vapors at room temperature. Exposure to high concentrations of mercury vapor can cause a variety of severe symptoms. Risks include chronic inflammation of mouth and gums, personality change, nervousness, fever, and rashes.

B.3 EN15317 Technical Specifications

The technical specifications for the DM5E according to EN15317 are listed in *Table 1* below.

Table 1: EN15317 Technical Specifications

Description	Dimension	Min.	Typical	Max.	Comment
Size	mm				138mm x 32mm x 75mm
Weight	g				223 Grams with batteries
Display Type	Pixel				64 x 128 LCD with backlight and adjustable contrast
Display Size	mm				53.0mm x 27.0mm
Display Update Rate	Hz		4		
Power Supply					2 "AA" Alkaline Batteries
Probe Connection					2 "00" LEMO
Through Coating Measurement					Dual Multi Method
Low Battery Warning	Volts	2	2.1	2.2	Battery level shown in a 9 step icon
Battery Operational Time	Hours	45	50	60	
Operational Voltage Range	Volts	2.15		3	

Table 1: EN15317 Technical Specifications (cont.)

Operational Current Range	milliAmps	95		145	Update rate set at 8hz, With USB cable connected to PC
Stability against temperature	oC	-10		50	
Operational Temperature Range	oC	-10		50	
Calibration Methods					2 Point, Off Block Zeroings, Automatic On Block Zeroing
Data Storage					DataLogger 50,000 readings
Data Output					DataLogger connected via USB
Transmitter (Spike)					
PRF	Hz	3.2	4	4.8	Low
PRF	Hz	6.4	8	9.6	High
PRF	Hz	19.2	24	28.8	Min Scan and B Scan Modes
Transmitter Pulse Shape Tr	nSec			30	
Transmitter Pulse Shape Td	nSec	400	500	600	
Transmitter Pulse Shape V ₅₀	Volts	-105.6	-96	-86.4	
Receiver					
Gain Control					Automatic
Frequency Range	MHz	1		12	

Table 1: EN15317 Technical Specifications (cont.)

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Min. and Max. Measureable Thickness	mm	1	200	with DA501	
Min. and Max. Measureable Thickness	mm	5	300	with DA503	
Min. and Max. Measureable Thickness	mm	0.6	60	with DA512	
Min. and Max. Measureable Thickness	mm	1	125	with DA590	
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