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**DM4E**

**DM4**

**DM4 DL**

Operating Manual



**Operating Manual**  
for  
**Ultrasonic Thickness Gauge**  
**Models DM4E, DM4 and**  
**DM4 DL** with On-board data Logger

Manual Part No. 021-002-073 REV. S

 **Krautkramer**  
*Ultrasonic Systems*

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**Important Notice**

The following information must be read and understood by any user of a Krautkramer 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 set up and operation of the Krautkramer 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 set up and performance required by a particular test. Operators must understand:

- Soundwave 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 qualified and trained in applicable standards of statistical evaluation. 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**

The probe zero procedure must be performed as described in this manual. The probe zero block should be clean, in good condition and without noticeable wear. Failure to properly perform the probe zero procedure will cause inaccurate thickness readings.

**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

## ***Important Notice***

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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 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 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 the 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.

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### Warranty

When used in accordance with the manufacturer's written instructions and under normal operating conditions, the Krautkramer DM4E, DM4, and DM4 DL test instruments are conditionally guaranteed to be free from defects in material and workmanship for a period of two (2) years from date of shipment.

All repair work will be made FOB Lewistown, Pennsylvania, or at a Factory Trained Service Center as advised by Agfa NDT Inc., provided the defective unit is returned properly packed with all transportation charges prepaid. Any and all equipment replacement will be at the sole discretion of Agfa NDT Inc.

This warranty shall not apply to equipment subjected to misuse or abuse, improper installation, alteration, neglect, or accident. Excluded from this warranty are expendable items such as transducers, interconnecting cables, and batteries. Accessory items such as printers, etc. will be covered under the original manufacturer's warranty as given to Agfa NDT Inc.

This warranty is limited to the original purchaser and is not transferable. No other warranty, expressed or implied, is

### Service

Every effort has been made to provide you with a reliable product. However, should service become necessary, Agfa NDT Inc. has established a number of Factory Trained Service Centers. For the location of the nearest facility, refer to Chapter 7 or contact:

Agfa NDT Inc.  
Krautkramer Ultrasonic Systems  
Manager of Customer Service  
50 Industrial Park Road  
Lewistown, PA 17044

# 1. Introduction

## 1.1 How To Use This Manual

This manual describes the features and operation of the DM4E, DM4, and DM4 DL (with on-board data logger) Ultrasonic Thickness Gauges.

If you are a first time user of the instrument, review Chapter 1 of this manual to become acquainted with its general capabilities.

Follow the instructions in Chapter 2 to prepare the instrument for operation and perform thickness measurements.

If you are using a model DM4 DL, Chapter 3 provides detailed information and operating instructions for the on-board data logger.

Chapter 4 describes how to interface model DM4 DL with a variety of external devices, such as a printer or personal computer, via the serial I/O interface.

Chapter 5 provides important specifications, particularly Section 5.2, which lists compatible probes (transducers) and their capabilities.

All users should read "Important Notice" at the beginning of the manual and Chapter 6, "Application Notes", for important information on operator qualification, test conditions, and procedures that affect measurement results.

## 1.2 DM4E, DM4, DM4 DL Features

The DM4E, DM4, and DM4 DL Ultrasonic Thickness Gauges are hand-held, microprocessor controlled instruments designed for general thickness measurements on a variety of equipment having access to one side only. It is especially applicable to the measurement of remaining wall thickness on tubes, pipes, pressure vessels, and other parts subject to wall thickness loss due to corrosion or erosion.

The on board Data Logger of the DM4 DL improves the reliability of recording thickness readings by avoiding the errors of misread and misrecorded data. A total of 5390 readings can be stored in up to 999 separate data files. Displayed readings are recorded by simply pressing the SEND key or an optional remote hand or foot switch. Measurement, statistical and instrument data can be transmitted via the Serial I/O port, in 80 column format, to a serial printer or personal computer for documentation, storage and analysis.

### *Features of the DM4E, DM4, and DM4 DL:*

- Rugged, sealed case and keypad for reliability
- Lightweight, ergonomically designed case
- 200 hours on two AA alkaline batteries
- Five keys (nine keys on DM4 DL) control all functions for simple operation.

- Automatic probe zero for fast calibration
- Automatically recognizes DIALOG Intelligent Transducers.
- Automatic V-path error correction compensates for non-linearity of dual element probes.
- Resolution of .001 in, .01 in, .1 mm, or .01 mm
- Large, easily read display with backlight
- Automatic gain adjustment
- Measures a wide range of materials
- Minimum Capture mode captures thinnest reading

### *Advanced Features of the DM4 and DM4 DL:*

- Manual gain adjustment
- Dual Multi "Through Coating (Paint)" Measurement Mode
- Programmable HI/LO thickness limits with LED alarm
- Differential mode displays the difference between measured thickness and user-set nominal thickness value.
- Band Pass Filter selection to match the frequency of the probe for best performance.

### *DM4 DL Data Logging and Communications Features:*

- Stores up to 5390 readings.
- Memory can be divided into a maximum of 999 separate data files of equal length.
- Individual readings or files can be accessed for reviewing, editing, and clearing data.
- Serial I/O port provides output to a serial printer or IBM compatible personal computer.
- Built-in report format includes instrument, inspector, and probe IDs, settings, statistics, and readings.
- DM4 DL Data Transfer Utility Software transfers data to an IBM compatible PC for viewing, printing transfer to other software.
- UltraMATE® and UltraPIPE® Windows 95/98/NT compatible software programs.

## 1.3 How DM4E, DM4, DM4 DL Measure Thickness

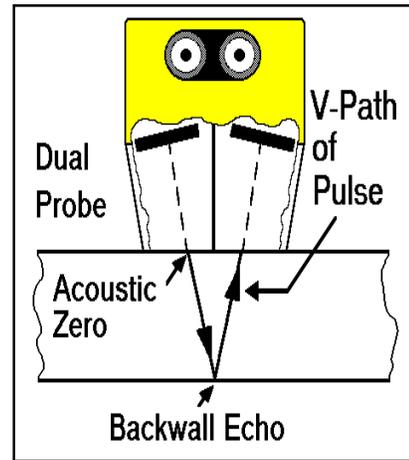
These instruments operate on the ultrasonic pulse-echo principle, similar to sonar. A short ultrasonic pulse is transmitted into the part by a probe (transducer). The pulse travels through the material under test until it encounters an interface, that is a material with substantially different physical characteristics, such as air or liquid, at the back surface of the part. At the interface, the pulse is reflected back to the probe.

## 1.0 Introduction

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The time needed for the pulse to make this round trip is divided by two and multiplied by the velocity of sound in the material under test. The result is the thickness of the material.

The figure at right illustrates the pulse-echo principle of ultrasonic thickness measurement.



*Dual Element Thickness Measurement*

## 2. Operation

### 2.1 Battery Installation

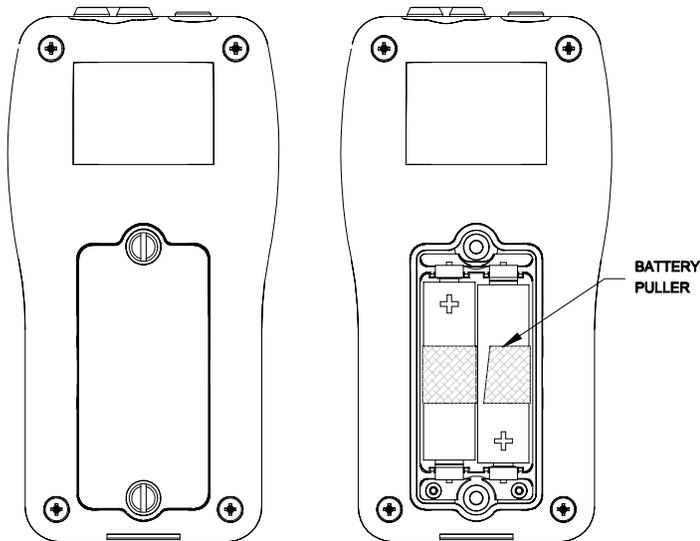
**NOTE: When low battery indicator lights (below), replace batteries as soon as possible. Automatic shut-off occurs when batteries are too weak for reliable operation. Settings are saved and restored when turned on. When testing in remote locations, always carry spare batteries.**

Low battery indicator: 

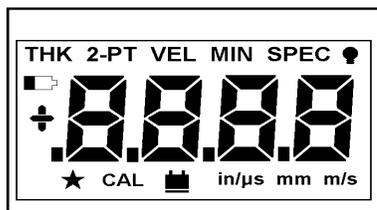
To install batteries, loosen the two battery cover screws on the back of the instrument and remove the battery cover.

Insert two “AA” alkaline batteries as shown at right. The instrument is protected against incorrect battery installation. If the batteries are installed with polarity reversed, no damage will occur, but the instrument will not operate.

After batteries have been installed, replace the battery cover and tighten the screws.



### 2.2 Displays Symbols



**THK** Thickness measurement and standard 1-point calibration mode.

**THK SPEC** Dual Multi “Through Coating (paint)” measurement mode.

**2-PT** 2-point calibration mode.

**VEL** Velocity display and calibration mode.

**MIN** Minimum capture mode

**SPEC** Special modes (DM4, DM4 DL) (Sections 2.10 through 2.13 and 2.18)

 Display backlight control.

 Low battery indicator. Replace batteries when indicator illuminates as shown.

 In dIF mode, reading is greater than nominal. If HI thickness limit is on, reading exceeds limit. (DM4, DM4 DL)

 In dIF mode, reading is less than nominal. If LO thickness limit is on, reading violates limit. (DM4, DM4 DL)

 DIALOG Intelligent Transducer automatically recognized

**CAL** Flashes when CAL key is pressed. Scrolling keys are enabled to adjust displayed value or control parameter.

 Coupling indicator lights when satisfactory acoustic coupling between the probe and test piece has been achieved.

**in** Unit of measure of displayed value is inches (in/μs in VEL mode).

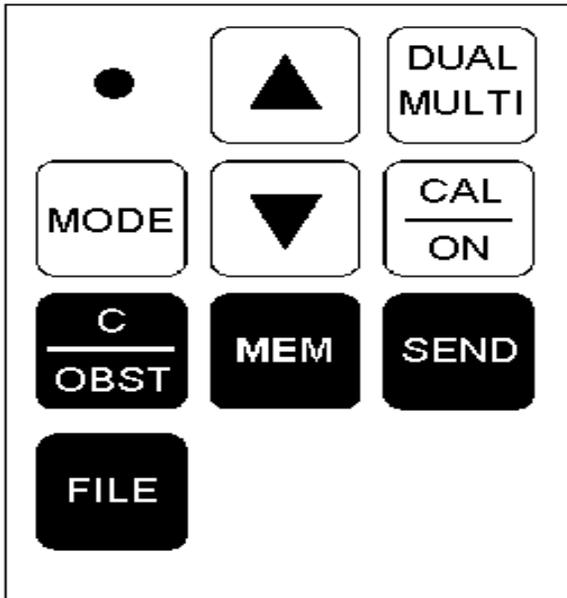
**Mm** Unit of measure of displayed value is millimeters (m/s in VEL mode).

**Note:** To change the unit of measure and display resolution refer to Section 2.14.

## 2.0 Operation

### 2.3 Keyboard Controls

**NOTE: SEND, C/OBST, MEM, and FILE keys are DM4 DL only.**



#### Instrument Control Keys



Turns on the instrument. When on, activates **CAL** (calibration) mode and enables scrolling keys



Selects the operating mode - THK, 2-PT, VEL, MIN, SPEC, and  $\bullet$ . Multiple presses activate modes from left to right, and from  $\bullet$  back to **THK**.



The **SCROLLING** keys, when enabled by the **CAL** key, change the displayed value or instrument control option.



When enabled by the **FILE** key, they are used to set the number of Data Logger files and select files.

When enabled by the **MEM** key, they are used to select file locations and review readings stored in memory.

**NOTE:** The scrolling keys are also used to change the resolution and unit of measure by pressing both keys simultaneously in **THK** mode (**CAL** indicator must be off)

#### DM4 DL Data Logging and Communication Keys



Activates the scrolling keys to select a file (File Select) or, if Data Logger memory is clear, setting the number of files. Setting number of files can only be performed when the entire memory is clear.



Transmits data to the on board Data Logger, or to an external device via the Serial I/O port. The function of the **SEND** key is dependent upon the type of cable connected to the Serial I/O port:

No connection - **SEND** is active in all measurement modes. Displayed thickness is sent to the on board Data Logger, if configured.

DR1 Data Recorder connected - **SEND** is active in THK (Thickness), and MIN (Minimum Capture) modes. Displayed thickness is sent to the DR1.

RS232C peripheral connection (PC/software, printer, data logger, etc.) - Pressing **SEND** in any measurement mode transmits the displayed value. Pressing **SEND** during the File Select function transmits the displayed file or all files. Second push of **SEND** aborts the transmission.

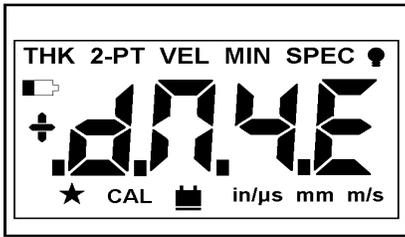


Provides access to the selected file of the on-board Data Logger for selecting locations and reviewing stored thickness readings.

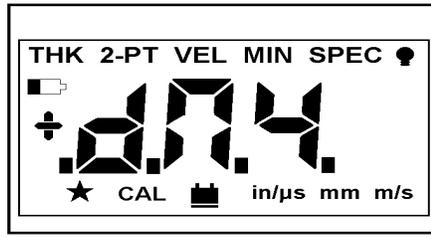
Clears the data logger readings, files, or entire memory. Displays "OBSTRUCT" value, when probe is uncoupled, to be sent to active data logger location. Refer to Chapter 3 for detailed instructions.



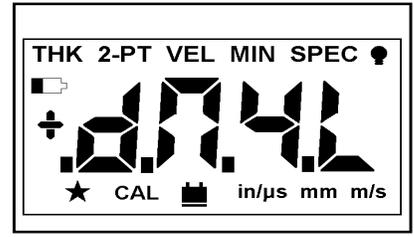
Sets the Dual element Multi-echo mode for through coating measurements. A second press turns off Dual-Multi mode and returns the instrument to conventional thickness measurement mode.



Model DM4E



Model DM4



Model DM4 DL

2.4 Getting Started

Read “Important Notices” at the beginning of this manual, and Chapter 6, “Application Notes,” for important information on test conditions that affect measurement results.

Select a suitable probe (Section 5.2) and connect it to the probe connector on the top panel. See Section 4.3 to select a report language other than English.

Press  to turn on the instrument. The model and display annunciators are briefly displayed as shown above, followed by the current software revision number. Then, the operating mode and settings from the last session are restored. NOTE: If using a NON-DIALOG KBA560 Family Probe (i.e. KBA560, KBA560-WR, KBA560-V) or DA301

Probe, either P560 or P301 may be displayed. If this occurs, the user must tell the instrument which probe is connected by toggling with the Up and Down arrow keys to select P560 for a KBA560 style probe or P301 for the DA301 probe, and press the CAL/ON key to perform the probe zero procedure and operate the instrument.

Automatic shut-off occurs after 3 minutes of inactivity. Coupling probe or pressing a key restarts the timing.

To change the unit of measure or select a different display resolution setting refer to Section 2.14.

If low light makes the display difficult to read, refer to Section 2.15 for instructions on using the backlight.

Before taking measurements, perform 1-point calibration (Section 2.5) or 2-point calibration (Section 2.6).

**NOTE:** DM4E, DM4 and DM4 DL feature automatic probe zero for standard probes and automatic probe recognition for DIALOG Intelligent Transducers.

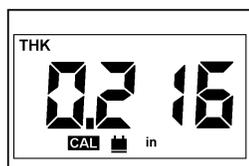


Figure 2-3

2.5 Calibration to a Known Thickness, 1-Point

**NOTE:** A calibration standard of the same material and velocity of sound as the material to be measured is required. For best results, the thickness of the calibration standard should be equal to, or slightly greater than the thickest part to be measured.

**NOTE:** Wipe face of probe clean before turning on instrument or connecting probe to instrument for best Automatic Probe Zero results.

1-point calibration can only be performed if 2-PT mode is OFF (Section 2.6).

If necessary, press  until THK is displayed.

Press . All symbols and “PO” are briefly displayed. Take no action until “PO” disappears indicating Automatic Probe Zero is complete. With CAL flashing, couple the probe to the calibration standard. Be sure the coupling indicator () lights and the reading is stable, as in Figure 2-3. The displayed value may not match the known thickness of the calibration standard at this point. You may keep the probe coupled or uncouple the probe and wipe the excess couplant from the probe face.

Use  and  to adjust the displayed value to match the thickness of the calibration standard. Scrolling speed accelerates as the key is held. If a key is released for less than 1 second, scrolling will resume at the same speed. Figure 2-4 shows how the display should appear with a 0.200 inch calibration standard.

Press  again to end the calibration procedure.

Proceed to Section 2.8 for normal thickness measurement (THK mode) procedure.

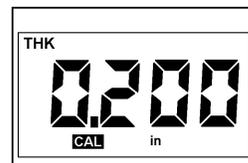


Figure 2-4

## 2.0 Operation

### 2.6 Calibration to a Known Thickness, 2-Point

**NOTE:** Requires two calibration standards (or one standard with two thicknesses) of the same material, velocity, and curvature as the material under test.

For best results, the thicker standard should be equal to, or slightly greater than the maximum thickness to be measured. The thickness of the thin standard should be as close as possible to the lower end of the expected measurement range.

If necessary, press **MODE** until **2-PT** (2-point calibration mode) is displayed.

Press **CAL ON** to display current status, On or Off.

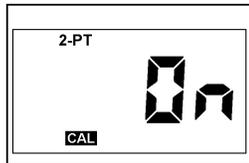


Figure 2-5

Use **▲** or **▼** to enable **2-PT** (On as in Figure 2-5).

Press **CAL ON** again. The **2-PT** indicator now flashes and the prompt to couple to the “LO” (thin) calibration standard appears, as shown in Figure 2-6.

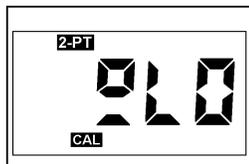


Figure 2-6

Couple the probe to the thin calibration standard. Be sure the coupling indicator (  ) lights and the reading is stable. You may keep the probe coupled or uncouple and wipe the excess couplant from the probe face.

Use **▲** and **▼** to adjust the displayed value to match the thickness of the thin calibration standard.

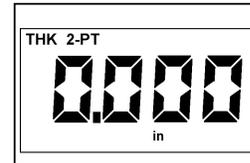


Figure 2-7

Press **CAL ON** again. The prompt to couple to the “HI” (thick) calibration standard is displayed - **HI**!

Couple the probe to the thick calibration standard. Again, be sure the coupling indicator (  ) lights and the reading is stable.

Use **▲** and **▼** to adjust the displayed value to match the thick calibration standard.

Press **CAL ON** to exit 2-point calibration mode. The **2-PT** indicator remains illuminated (Figure 2-7) to show that the current calibration is 2-point and that automatic probe zero,

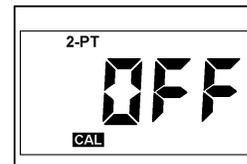


Figure 2-8

1-point calibration, and velocity calibration functions are disabled.

The 2-point calibration procedure is complete and the instrument is ready for thickness measurement (Section 2.8).

To disable **2-PT** calibration mode:

To disable **2-PT** calibration, press **CAL ON** and use **▲** or **▼** to change the status to OFF (Figure 2-8).

The **CAL** and **2-PT** indicators are turned off and the instrument returns to **THK** mode.

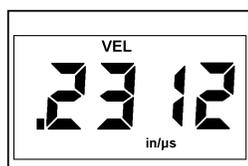


Figure 2-9

## 2.7 Calibration to a Known Velocity

**NOTE:** 2-PT calibration mode must be set to **OFF**.

If you know the velocity of sound of the material to be measured, the instrument can be calibrated to the known velocity without the use of a calibration standard. However, the calibration should always be verified by measuring a known thickness (or calibration standard) of the same material and velocity as the material to be measured.

To calibrate to a known velocity, press  until **VEL** illuminates.

The current velocity setting is displayed, as illustrated in Figure 2-9.

Press  to enable calibration mode.

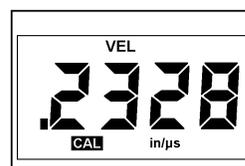


Figure 2-10

With the **CAL** indicator flashing, use  and  to set the displayed velocity to that of the material under test.

Figure 2-10 shows how the display would appear for a calibration of .2328 inches per microsecond.

Press  again to exit velocity calibration mode and return to **THK** mode.

Table 2-1, below, shows typical sound velocities for some common materials. Because processing, exact composition, and temperature affect velocity, the values may not precisely match the velocity in the material to be measured.

**Table 2-1: Typical Sound Velocities in Various Materials** (Longitudinal Wave)

Material	in/μs	m/s	Material	in/μs	m/s
Aluminum	.2500	6300	Nylon	.1000	2500
Brass	.1700	4300	Phenolic	.0560	1400
Cadmium	.1100	2800	Platinum	.1600	4100
Cast Iron	.1800	4600	Plexiglas	.1100	2800
Copper	.1800	4600	Polyethylene	.0700	1800
Epoxy Resin	.1100	2800	Polystyrene	.0930	2400
Glass (Crown)	.2200	5600	Polyurethane	.0700	1800
Glass (Window)	.2700	6800	Porcelain	.2200	5600
Gold	.1300	3300	Rubber (Butyl)	.0730	1900
Inconel	.2200	5600	Rubber (Vulc.)	.0900	2300
Lead	.0850	2200	Silver	.1400	3600
Magnesium	.2300	5800	Steel	.2300	5800
Manganese	.1800	4600	Tin	.1300	3300
Molybdenum	.2500	6300	Titanium	.2400	6100
Monel	.2100	5300	Tungsten	.2100	5300
Neoprene	.0630	1600	Zinc	.1600	4100
Nickel	.2200	5600	Zircaloy 2	.1900	4700

NOTE: This information is provided for the convenience of the user and Agfa NDT Inc. assumes no responsibility for inaccuracies. Actual velocities depend on exact composition, temperature, and processing of each material.

## 2.0 Operation

### 2.8 Normal Thickness Measurement - THK Mode

This procedure applies to parts with ambient surface temperatures. Refer to Section 6.2 for information on taking measurements on hot surfaces.

Be sure that the instrument is on and that the appropriate calibration procedures in Section 2.5, 2.6, or 2.7 have been completed for the selected probe type and material to be measured.

If using the alarm feature (DM4 and DM4 DL), make sure the correct LO and HI limits are set and the alarm is on (Sect. 2.11).

Remove any dirt, loose scale, or flaking from the test surface and spread a thin layer of couplant on it.

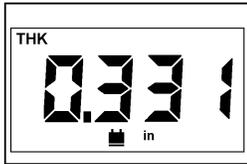


Figure 2-11

Place the probe gently but firmly on the surface. The coupling indicator (■) must light, as in Figure 2-11. Use firm, steady pressure to obtain a stable reading.

The digital thickness reading can be read from the display while coupled, or the probe can be uncoupled and the last reading will be held on the display.

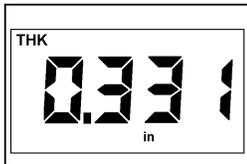


Figure 2-12

If incorrect values occur repeatedly, check probe selection (Sect. 5.2) or contact your Agfa NDT Inc. representative.

**NOTE:** If a reading is not possible due to low signal caused by poor coupling or high material attenuation, or if “doubling” is detected (see page 3), the coupling indicator will not light and the display will not update.

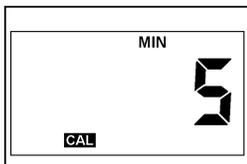


Figure 2-13

### 2.9 Minimum Capture Measurement

To enable the minimum capture mode, press **MODE** until **MIN** illuminates.

**MIN** mode is used to capture the thinnest value during a series of readings or rapid sequence of measurements. The measurement updates at high speed to assure detection of thinnest value during the cycle.

When the probe is uncoupled, the detected minimum is displayed and **MIN** flashes to indicate that the time-out sequence has begun. Recoupling the probe while **MIN** is flashing allows the capture cycle to continue.

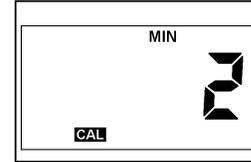


Figure 2-14

To end the capture cycle, uncouple the probe for at least the number of seconds set in the current time-out setting, that is, until **MIN** stops flashing. Coupling the probe begins a new minimum capture cycle.

#### Setting MIN Time-Out:

The **MIN** time-out is adjustable from 1 to 5 seconds. With the instrument in **MIN** mode, press **CAL ON** to display the current time-out setting in seconds (Figure 2-13). Use **▲** or **▼** to select a new setting (Figure 2-14).

Press **CAL ON** again to activate the new time-out setting and return to **MIN** mode for minimum capture measurement.

### 2.10 Receiver Gain Control (DM4, DM4 DL)

The DM4 and DM4 DL have four gain setting options, Automatic, High, Medium, and Low. The default is Automatic, which automatically selects a gain setting based on the velocity value.

To change the gain setting, press **MODE** until **SPEC** illuminates.

Press **▲** or **▼** until **6A In** appears in the display.

Press **CAL ON** to display current setting:

<b>AUTO</b>	Automatic gain
<b>H I</b>	High gain
<b>MED</b>	Medium gain
<b>LO</b>	Low gain

Use **▲** or **▼** to select a new setting.

Press **CAL ON** again to exit the gain select function.

When the instrument shuts off, current setting is saved and restored when the instrument is turned on again.

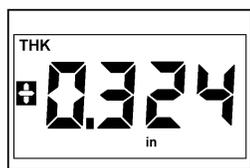


Figure 2-15

### 2.11 Using LO / HI Thickness Limits (DM4, DM4 DL)

**WARNING:** If a file containing normal thickness (THK) data is currently active, changing the **LO** or **HI** limit replaces any settings previously stored in the file.

**LO** and **HI** limits identify readings that violate user set lower and upper limits. When **LO** and/or **HI** limits are set, a reading that violates either causes the red LED (front panel) to light.

A flashing plus sign (Figure 2-15) indicates the reading exceeds the **HI** limit. A flashing minus sign (Figure 2-16) indicates a reading that is less than the **LO** limit.

To set and enable **LO** and **HI** limits press **MODE** until **SPEC** illuminates.

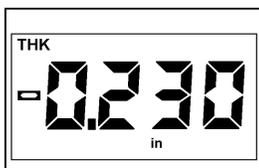


Figure 2-16

Press **▲** or **▼** until **L 0 - L** (lower limit) or **H 1 - L** (upper limit) appears in the display.

Press **CAL ON** to display current status, **On** or **Off**. Use **▲** or **▼** to turn either alarm mode **On** or **Off**.

Setting **LO** and **HI** Limits:

With the desired alarm mode **On**, press **CAL ON** to display the current limit setting. Use **▲** or **▼** to set the limit (0.020 to 20.00";

0.5 to 500 mm). Press **CAL ON** again to return to **L 0 - L** or **H 1 - L** display. Press **MODE** to return to **THK** mode.

### 2.12 Differential Measurement (DM4, DM4 DL)

Differential measurement mode displays the difference between the measured thickness and a nominal value set by the user. To

enter dIF mode, press **MODE** until **SPEC** illuminates.

Then press **▲** or **▼** until **d IF** appears in the display.

Press **CAL ON** to display current status, **On** or **Off**. Use **▲** or **▼** to turn differential mode **On** and **Off**.

Setting the Nominal Value:

Press **CAL ON** to display the current nominal value setting.

Use **▲** or **▼** to set the desired value. Press **CAL ON** again to return to **d IF** display.

To perform differential measurement, with dIF mode **On**, return to **THK** mode **MODE** and follow the measurement procedure in Section 2.8.

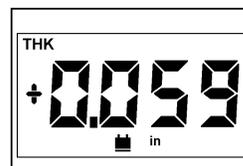


Figure 2-17

Figure 2-17 shows a differential reading that is 0.059 inch greater than (+) the user set nominal value. In Figure 2-18 the actual measurement is 0.003 inch less than (-) the nominal.

To disable differential measurement, follow the procedure at the beginning of this section.

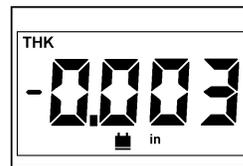


Figure 2-18

## 2.0 Operation

### 2.13 Band Pass Filter Control (DM4, DM4 DL)

The Band Pass Filter control of the DM4 and DM4 DL sets the band pass of the instrument receiver for the frequency of the connected probe. The default setting is HI for probes of 2 MHz to 10 MHz frequency.

To change the Band Pass Filter setting, press  until SPEC illuminates.

Press  or  until **FILT** appears in the display.

Press  to display current setting:

**HI** High - 2 MHz to 10 MHz

**LO** Low - 300 KHz to 2 MHz

Use  or  to select the desired setting.

Press  again to exit the gain select function.

When the instrument shuts off, the current Band Pass Filter setting is saved and restored when the instrument is turned on again.

### 2.14 Display Resolution and Unit of Measure

Four display resolution settings are available, two in inch units and two in metric units, as shown below.

Inch Settings:

**0.000** (Default)

**000**

Metric Settings:

**000**

**00**

To change display resolution or unit of measure, press both

 and  at the same time. Keep pressing both keys until the desired setting is displayed.

In VEL mode, with CAL off, simultaneously pressing  and

 switches between inch and metric units. Velocity will be displayed in the newly selected units.

When the instrument shuts off, the resolution setting is saved and restored when the unit is turned on.

### 2.15 Display Backlight

Three available backlight options are:

**OFF** Backlight disabled; maximum battery life

**On** Backlight is on continuously; less battery life

**AUTO** Automatic Backlight; backlight activates when probe is coupled or key is pressed and remains on for 5 seconds

To change the backlight setting, press  until  illuminates.

Press  to display the current setting.

Use  or  to select a new setting.

Press  again to exit the backlight function.

When the instrument shuts off, the current backlight setting is saved and will be restored when the instrument is turned on again

### 2.16 Disabling/Enabling Functions

Specific instrument functions and modes can be disabled so that they are not available during normal operation. They can also be enabled again.

The following functions can be disabled/enabled:

**2-PT** 2-point calibration

**VEL** Velocity mode

**Min** Minimum capture mode

**SPEC** Entire SPEC menu (DM4, DM4 DL)  
Gain function (DM4, DM4 DL)

**LO-L** Low limit alarm mode (DM4, DM4 DL)

**HI-L** High limit alarm mode (DM4, DM4 DL)

**dIF** Differential mode (DM4, DM4 DL)

**FILT** Band Pass Filter Control (DM4, DM4 DL)

To disable or enable one or more of the above, press  and

 simultaneously while the instrument is off and hold both keys for 3 seconds..

After briefly displaying the instrument version and display indicators, the first mode is displayed: 

Use  or  to scroll through and select the function or mode to be disabled or enabled.

When the desired function or mode is displayed, press  to display the current setting, On or OFF.

Use  or  to disable (OFF) or enable (On) the displayed function or mode.

Press  again. The function or mode that has been acted upon will be displayed.

Use  or  to scroll through and select another function

or mode to be disabled or enabled or press  to end the procedure.

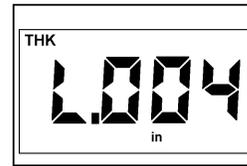


Figure 2-20

When a reading is sent to an empty file, the current settings of the HI/LO limits are saved with the file. Selecting an existing file automatically activates the limits saved with the file. The settings may be changed (Section 2.11). However, the previously saved settings will be replaced in the file by the new ones.

When a differential reading (Section 2.12) is sent to an empty file, the current setting of the nominal value is saved with the file. Selecting a file with differential readings automatically activates differential measurement mode and restores the saved nominal value. The nominal value saved in a file may not be changed.

**2.18 Dual Multi Measurement Mode (DM4, DM4 DL)**

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 backwall reflections of the metal.

The Dual-Multi mode works with the following standard probes:

- KBA560 Family, DA312, DA301, DA311, DM401

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 metal.

To activate or deactivate the Dual-Multi mode, press .

The THK and SPEC annunciators will illuminate to indicate that the DUAL MULTI mode is activated. See figure 2-21. NOTE: The SPEC annunciator will not illuminate unless one of the above compatible probes is attached. If the DUAL MULTI key is pressed when a non-compatible probe is connected, "nO" will briefly be displayed and then the instrument will return to the standard (THK) thickness mode.

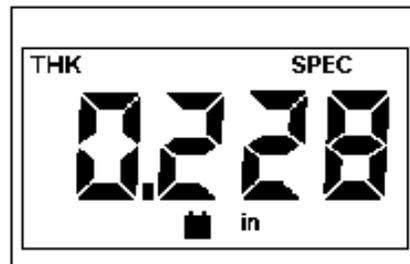


Figure 2-21

**NOTE:** Disabled modes and functions will automatically be set to their default settings.

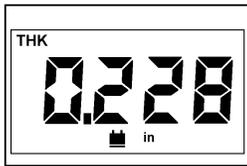


Figure 2-19

**2.17 Recording Measurements (DM4 DL)**

Displayed thickness readings are sent to the on-board Data Logger of the DM4 DL and most external recording devices by pressing . See Chapter 4 for details on connecting external devices to the DM4 DL.

To record readings in the on-board Data Logger, follow the instructions in Chapter 3 to set up the Data Logger.

To record a reading, first perform the measurement. When the coupling indicator () lights (Figure 2-19) and the reading is stable, uncouple the probe and wipe the excess couplant from the probe face.

Press . The location where the reading has been stored is displayed briefly (Figure 2-20). After a displayed reading has been sent, the SEND key is disabled until a new reading is taken. Zero values cannot be recorded.

## 2.0 Operation

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The coupling indicator (  ) will illuminate only when two backwall echoes are detected.

In the event two backwall reflections are NOT detected:

The coupling indicator (  ) will not illuminate.

A row of dashes will be displayed.

The red LED will flash.

If a Dual-Multi measurement is not obtainable, the operator must return the instrument to the standard thickness measurement

mode by pressing  and/or remove the coating.

**Note:** Complete removal of the coating may not be necessary. First try smoothing the surface and removing any loose top layers.

**NOTE:** If two backwall echoes are attainable on the calibration standard, a 1-Point Calibration can be performed in the DUAL MULTI Mode. Press the DUAL MULTI key, verify that both THK and SPEC are illuminated in the display, and refer to section 2.5 ( 1-PT Calibration) beginning with “Press CAL/ON KEY.”

### 2.19 DA3 Operating Mode

This mode is characterized by the implementation of “on-block zero”. This means that the acoustic zero point is dynamically adjusted during the measurement process, compensating for wear and “growth” during measurements.

This mode may offer advantages for certain applications such as high temperature measurements.

The use of a DIALOG Intelligent Probe automatically selects either the standard “AUTO” or “DA3” mode.

To select the DA3 mode when using non-dialog probes or to override the last selection:

Press  to turn the instrument on.

The model and display annunciators are briefly displayed (see section **2.4 Getting Started**), followed by the current software revision number. Then, the operating mode used from the last session is displayed. It will flash for approximately 3 seconds.

While the display is flashing, press  to toggle between AUTO mode and DA3 mode.

Press any other key to start instrument operation using the selected mode. If no key is pressed within 3 seconds, the instrument will go into operation with the last selected zero mode.

**CAUTION:** Only DA Series Probes are to be used in the DA3 Operating Mode.

## 3. Data Logger Operation

### 3.1 The DM4 DL Data Logger

The DM4 DL on-board Data Logger provides a simple, reliable way to record thickness measurements. Readings are stored in one or more files by pressing the **SEND** key. A file is a number of Data Logger memory locations that have been grouped together for storing readings, one reading per location, and reporting measurement data.

File size is determined automatically when the operator sets the desired number of files, up to a maximum of 999. The DM4 DL divides the total memory capacity, 5390 readings, by the number of files specified and creates the maximum number of files, of equal size, that Data Logger capacity allows.

The first reading is stored in each file starting with location number 1, unless the operator selects a different starting location. Subsequent readings are stored sequentially until the last location has been filled or another file is selected to receive readings.

Location numbers and stored readings can be viewed and edited in the display. Individual file locations, entire files, or entire memory can be cleared. Single files, or all files, can be transferred via the Serial I/O port to a printer or IBM compatible PC. Report format is compatible with most serial printers. A utility program is available from Agfa NDT Inc. for transferring data to a PC (Section 4.5). Individual readings and velocity can be sent to the Krautkramer DR1 Data Recorder. Refer to Chapter 4 for information on connecting external devices.

Stored readings are retained indefinitely in the memory of the DM4 DL, even when the batteries are removed. However, backup is recommended whenever possible.

The following Data Logger operations are described in Sections 3.2 through 3.10:

<b>Setting Number of Files</b>	<b>Section 3.2</b>
<b>Selecting a File</b>	<b>Section 3.3</b>
<b>Logging Readings into Memory</b>	<b>Section 3.4</b>
<b>Selecting Locations</b>	<b>Section 3.5</b>
<b>Reviewing Stored Readings</b>	<b>Section 3.6</b>
<b>Clearing and Replacing Readings</b>	<b>Section 3.7</b>
<b>Clearing Selected Files</b>	<b>Section 3.8</b>
<b>Clearing Entire Memory</b>	<b>Section 3.9</b>
<b>Permanent Storage</b>	<b>Section 3.10</b>

### 3.2 Setting Number of Files

Readings can not be stored until the desired number of files has been set and one file has been selected to receive readings. Follow the procedure in this section to set the number of files and the size of each.

Setting number of files can only be done when entire memory is clear. To check memory status, press **FILE**. **C.ALL** (Figure 3-1) indicates memory is clear. If memory is not clear, refer to Section 3.9 for instructions on clearing memory.

**WARNING:** Clearing memory permanently erases all readings stored in the DM4 DL Data Logger.

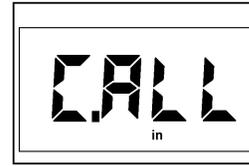


Figure 3-1

While **C.ALL** (Figure 3-1) is displayed, use  or  to set the desired number of files (1 is the minimum): "n.001" = 1 file, "n.002" = 2 files, etc.

Press **FILE** to terminate the procedure. "ConF" is displayed while memory is being configured.

The number of files set determines the size of each file, that is, the number of available locations. Appendix B provides a table showing the number of locations per file based on the number of configured files, 1 through 806.

**NOTE:** DIALOG Intelligent Transducer I.D., **LO** limit, **HI** limit, and **dIF** value are saved with each file.

To log readings a file must be selected (ref. Section 3.3). Default selection is File 1, Location 1.

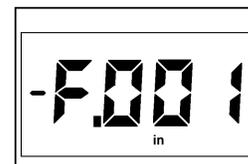


Figure 3-2

### 3.3 Selecting a File

Before measurements can be logged, a file must be selected (Section 3.2). Press **FILE** to display the active file number. If no file has been selected, "-F.001" is displayed (Figure 3-2). If "C.ALL" is displayed, no files exist. Return to Section 3.2.

Use  or  to change the active file number. Scrolling above the highest number loops to ".ALL" (all files) and back to File 1. Scrolling below File 1 loops through ".ALL" to the highest file number.

**-F.nnnn** indicates empty file, no readings.

**F.nnnn** indicates active file with readings but not full.

## 3.0 Data Logger Operation

$\dagger F.nnn$  indicates a full file, no empty locations.

“nnn” (001 to 999) is the number of the selected file.

When the desired file number is displayed, press  again.

The current active location number of the selected file is displayed briefly. Then the DM4 DL returns to measurement mode and is ready to log readings

**NOTES:** When a file containing differential readings is selected the DM4 DL switches to dIF mode and uses the nominal value saved in the file as the current nominal value.

When a file containing HI/LO thickness limits is selected the DM4 DL switches to THK mode and uses the limits saved in the file as the current limits.

When a file contains data collected using a DIALOG Intelligent Transducer, report sent to a printer or computer automatically include the model and serial numbers of the probe.

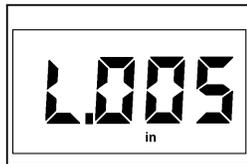


Figure 3-3

### 3.4 Logging Readings into Memory

Measurements taken in **THK** (normal), **dIF** (differential), and **MIN** (minimum capture) modes can be stored in the Data Logger if a file with at least one empty location has been selected (Section 3.3). The Data Logger is disabled when an external recording device is connected to the Serial I/O port (Chapter 4).

A reading is logged by pressing  (Section 2.17). If the current file location is empty, the Data Logger stores the reading and briefly displays the location number, “L.nnn” (Figure 3.3) as confirmation.

After a displayed reading has been sent, the **SEND** key is disabled until a new reading is taken. Unless a valid thickness reading is in the display, no action occurs when **SEND** is pressed. Zero values will not be logged. All readings in a given file should be stored at the same resolution to assure accurate statistics.

**Location Full:**  $\dagger L.nnn$  displays when trying to log to a location that contains a reading. No data is recorded. To select an empty location see Section 3.5.

**File Full:**  $\dagger F.nnn$  displays when **SEND** is attempted to a file with no empty locations. No data is recorded. To select another file, refer to Section 3.3.

### 3.4.1 Recording an OBSTRUCT Value

If a measurement cannot be made or a location is inaccessible, an “OBSTRUCT” value can be logged into the current active location.

While in **THK** or **MIN** mode, press  with the probe uncoupled. The location number,  $\dagger L.nnn$ , where the OBSTRUCT was stored is briefly displayed, followed by **0b5t**.

An “OBSTRUCT” is stored in the current data logger location. When reviewing stored readings (Section 3.6) obstructed locations display **0b5t**.

### 3.5 Selecting Locations

While in **THK** or **MIN** mode, the **MEM** key is used to select file locations and review stored readings.

To select a location in the current file, press .

The current location number is displayed as  $\dagger L.nnn$  (full location, as in Figure 3.4) or  $-L.nnn$  (empty location).

Use  or  to display the desired location.

To review stored readings, proceed to Section 3.6.

To select the displayed location and return to **THK** or **MIN** mode, press  two times.

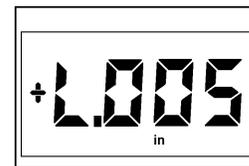


Figure 3-4

### 3.6 Reviewing Stored Thickness Readings

While a location number is displayed, as in Figure 3-4, press

 a second time to display the reading. Readings are displayed in the current unit of measure.

Use  or  to view readings at other locations.

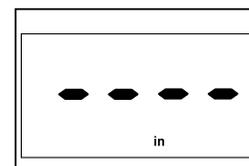


Figure 3-5

A row of dashes (Figure 3-5) indicates an empty location.

**ObSt** indicates an obstructed location. A flashing plus sign indicates the reading exceeds the **HI** limit stored with the file. A flashing minus sign indicates a reading that is less than the **LO** limit. "Err" (unlikely to occur) indicates that the reading has been corrupted in memory and must be retaken.

Press **MEM** again to return to measurement mode.

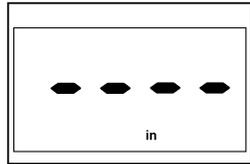


Figure 3-6

#### 3.7 Clearing and Replacing Readings

While a stored thickness reading is displayed (Section 3.6), the C/OBST key (C = Clear) can be used to erase the reading from that location.

To clear a stored reading, display the reading to be cleared (Sect. 3.5 and 3.6) and press **C/OBST**. When the reading has been cleared, dashes appear (Figure 3.6).

Press **MEM** to return to measurement mode. A new reading can now be logged to the cleared location.

**NOTE:** "Obstructed" locations do not need to be cleared. Sending a thickness value automatically overwrites the stored **ObSt**.

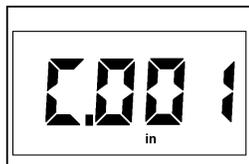


Figure 3-7

#### 3.8 Clearing Selected Files

**WARNING:** This operation will permanently erase all readings in the cleared file.

Press **FILE** while in **THK** or **MIN** mode. The active file is displayed (Section 3.3). Use **▲** or **▼** to select the file to be cleared.

Press and hold **C/OBST** for 3 seconds. DM4 DL briefly displays "C.nnn" (Figure 3-7). "nnn" is the cleared file number. Then "-F.nnn" is displayed (empty file, Figure 3-2 on page 31).

Press **FILE** to return to measurement mode, or use **▲** or **▼** to select another file.

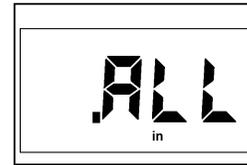


Figure 3-8

#### 3.9 Clearing Entire Memory

**WARNING:** This operation permanently erases all readings stored in the Data Logger of the DM4 DL.

To clear and reset memory, press **FILE** while in **THK** or **MIN** mode. Use **▲** or **▼** to display ".ALL" (Fig. 3-8).

Press and hold **C/OBST** for 3 seconds. When memory is clear, the display changes to "C.ALL" (Figure 3-9).

Data Logger memory is now clear. Readings can not be recorded until new files have been configured.

Follow the procedure in Section 3.2 to create new files and prepare the Data Logger to record readings.



Figure 3-9

#### 3.10 Permanent Storage

Stored readings are retained in memory indefinitely, even when the batteries have been removed. However, data could be lost or corrupted if the DM4 DL were damaged or exposed to extreme environmental conditions.

For extended storage, files should be transferred to a computer for storage on disk or tape. The DM4 DL Data Transfer Utility program is available for this purpose. Contact your local Agfa NDT Inc. representative for information.

Chapter 4 provides information needed to interface the DM4 DL with an external device, such as a printer or computer, for file storage.



*Selecting Printer Driver:*

Before printing, the appropriate printer driver must be selected.

Press **MODE** until **SPEC** illuminates.

Press **▲** or **▼** to select **REP** (Figure 4-2), then **CAL ON** to display the current setting.

Use **▲** or **▼** to select:

- EP5n** - Epson FX 850 with 8148 serial interface
- DP U** - Seiko DPU 411
- 24-C** - 24 column DATAMATE format
- SP-d** - Spreadsheet

Press **CAL ON** again to exit.

*Printing File Header Information:*

To print file header information with the file, with **SPEC** illuminated, press **▲** or **▼** to select **HEAD**, then **CAL ON** to display the current setting, **On** or **OFF**.

If **OFF**, press **▲** or **▼** to set file header **On**.

Press **CAL ON** again to exit.

*Printing Statistics:*

To print statistics with the file, with **SPEC** illuminated, press **▲**

or **▼** to select **STAT**. Press **CAL ON** to display the current setting, **On** or **OFF**.

If **OFF**, press **▲** or **▼** to set file statistics **On**.

To print files DM4 DL must be in **THK** or **MIN** mode.

Press **FILE** and use **▲** or **▼** to select the file to report per Section 3.3, or scroll to **.ALL** to print all files that contain data.

Press **SEND** to start printing. The DM4 DL displays **5nnn** (sending file nnn) or **5ALL** (sending all files). Empty files and file locations will not be printed.

After printing, press **FILE** to return to measurement mode or use **▲** or **▼** to select another file to report.

To abort the transmission, press **SEND** while readings are being printed. The DM4 DL displays **Abor**.

If the printer is accidentally disconnected during transmission, follow the procedure in Section 4.7 to avoid losing data. When printing is done, press **FILE** to exit or use **▲** or **▼** to select another file.

Printed files remain in memory after printing has been completed. Individual readings can be sent to a printer simply by pressing **SEND** when the desired thickness value is displayed.

**4.5 Sending Data to a Personal Computer**

Stored thickness data can be transmitted to an IBM compatible computer. Files are transmitted as ASCII text files. Once saved on disk, data can be viewed on screen, printed, or transferred to standard word processing, data base, spreadsheet, and applications software. The ASCII format also simplifies the transfer of data for users who wish to use standard communications software or write their own.

The DM4 DL Data Transfer Utility Program is available to simplify the transfer of data to the PC. This simple utility can be used with any IBM PC, XT, or AT compatible computer with at least 256K of available memory and DOS version 3.3 or higher. Contact Agfa NDT Inc. or your local representative for information.

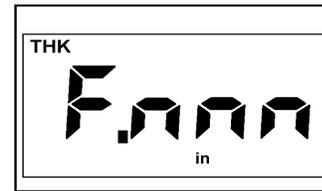


Figure 4-3

Connect the DM4 DL to PC cable, available from Agfa NDT Inc., to the I/O port and to the serial port of the PC. If necessary, follow the procedure in Section 4.2 to set baud rate to that of the serial port.

To include file header and/or statistical information, see Section 4.4 to enable header and statistics.

Press **FILE** and use **▲** or **▼** to select a file (Fig. 4-3) or **.ALL** (Fig. 4-4) to transmit all non-empty files.

Press **SEND** to send file(s). When done, press **FILE** to return to measurement mode or use **▲** or **▼** to select another file to report. Abort and accidental disconnect procedures are identical to those at the end of Section 4.4.

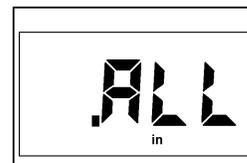


Figure 4-4

## 4.0 Serial I/O Interface

---

### 4.6 Importing Data Into a Spreadsheet

Stored thickness data can be transferred to an IBM compatible computer and saved on disk in a format that can be imported into spreadsheet programs, such as LOTUS 1-2-3™ and Microsoft EXCEL™.

**NOTE:** Refer to the operating manual of your spreadsheet program for file import instructions.

Follow procedures in Sections 4.5 and 4.2 to connect the DM4 DL to the computer and set baud rate.

To enable statistics see Section 4.4. File header information is included regardless of **HEAD** setting.

Press **MODE** until **SPEC** illuminates.

Press **▲** or **▼** to select **REP**, then **CAL ON** to display the current setting.

Use **▲** or **▼** to select **SPrd**. Press **CAL ON** to exit.

Select the file or **.ALL** files and transfer them to the PC by following the procedure at the end of Section 4.5.

### 4.7 Interrupted Transmission Procedure

If a faulty or disconnected cable, or other problem, causes an interruption while data is being transmitted to an external device, the DM4 DL will resume transmission if the connection is restored within 15 seconds. When the interrupted transmission has been completed, review the transmitted data carefully to be sure that no data has been lost or corrupted, or repeat the entire transmission as a precaution.

If the connection is not restored within 15 seconds, DM4 DL will abort the transmission, briefly display Abor, and return to the currently selected file number.

In this case, the entire transmission must be repeated by following the procedure in Section 4.4, if printing data, or Section 4.5

## 5. Specifications

### 5.1 Instrument Specifications

Operating Principle:	Ultrasonic, pulse-echo measurement
Probe Zero Adjustment:	Automatic or 2-point calibration
Probe Recognition:	Automatic for DIALOG Intelligent Transducers
V-Path Correction:	Automatic, microprocessor controlled
AUTO Mode Linearity:	$\pm 0.002$ inch ( $\pm 0.05$ mm) when calibration point < 1 inch (25 mm); $\pm 0.003$ inch ( $\pm 0.075$ mm) when calibration point > 1 inch (25 mm)
DA3 Mode Linearity:	$\pm 0.004$ inch ( $\pm .1$ mm)
Measuring Range:	.020 to 20.00 inch (.5 to 500 mm) depending on probe and material
Dual Multi Measuring Range:	.080 to 1.00 inch (2 to 25 mm) depending on probe, coating and material
Displayed Resolution:	.001 or .01 up to 9.999 inches, .01 above 9.999 inches; .01 or .1 up to 99.99 mm, .1 above 99.99 mm
Measurement Rate:	4 Hz; 25 Hz in Minimum Capture mode
Material Velocity Range:	.0394 to .3937 in/ $\mu$ s; 1000 to 9999 m/s
Receiver Gain Level:	Three options, selectable via the keypad: Automatic: High gain enabled for material velocities up to 246,000 in/s (6,248 m/s). Low gain enabled for velocities over 246,000 in/s. Manual Low: Low gain enabled over the entire velocity range. Manual High: High gain enabled over the entire velocity range.
Receiver Bandwidth:	300 KHz to 10 MHz
Reading Stability:	Nominal measured value $\pm 0.001$ inch ( $\pm 0.025$ mm) over the operating temperature range of the instrument
Data Logger Capacity:	5,390 readings maximum; 999 readings if number of files is set to 1 through 5; readings are stored sequentially
Number of Data Files:	1 - up to 999; see Appendix B for number of readings per file based on number of configured files.
Serial Protocol:	1200, 2400, 4800, or 9600 baud; 8 data bits; 1 stop bit; no parity
Data Transfer:	Via <b>SEND</b> key
Report Languages:	English, German, French, Italian, Spanish, Russian, and Japanese
Memory Retention:	Typically 10 years
Display Type:	Four digit, 0.5 inch (12.7 mm) high, Liquid Crystal Display with electroluminescent backlight

## 5.0 Specifications

Power Requirements:	2 each 1.5 volt, AA alkaline cells
Battery Life (Operating Time):	200 hours at 25% duty cycle, without backlight, with steel velocity and .001 inch displayed resolution
Automatic Shut-off:	3 minutes after last probe couple or last press of any key
Operating Temperature Range:	+10°F to +120°F (-10°C to +50°C)
Storage Temperature Range:	-40°F to +140°F (-40°C to +60°C) without batteries -40°F to +125°F (-40°C to +50°C) with alkaline batteries
Dimensions (L x W x D):	5.75 " (146.0 mm) x 3.00" (76.2 mm) x 1.35" (34.3 mm) at thickest part of case
Weight:	9 ounce (255 grams) with batteries
Probe Connector:	Dual Lemo #00 located on top panel
RS232 Serial I/O Connector:	7 pin, Lemo #0B located on top panel

**NOTE:** *Instrument specifications are subject to change without notice.*

### 5.2 Probe Specifications

Model	Probe Description	Nominal Frequency	Contact Diameter	Measurement Range (Steel)	Temp. Range
<b>DIALOG Intelligent Transducers</b>					
FH2E-D	High Sensitivity Fingertip	8 MHz	.38" 9.6 mm	.030" to 2.0" .75 to 50 mm	<130°F <54°C
KBA560-D	General Purpose	5 MHz	.625" 15.9 mm	.060" to 8.0" 1.5 to 200 mm	<250°F <121°C
DM401/411	GP	5 MHz	.700" 17.8 mm	.060" to 8.0" 1.5 to 200 mm	<300°F <148°C

**NOTE:** *DIALOG Intelligent Transducers are recognized automatically for optimum performance*

#### STANDARD PROBES:

FH2E	High Sensitivity Fingertip	8 MHz	.38" 9.6 mm	.030" to 2.0" .75 to 50 mm	<130°F <54°C
KBA560	General Purpose	5 MHz	.625" 15.9 mm	.060" to 8.0" 1.5 to 200 mm	<450°F <230°C
HT400	High Temperature	5 MHz	.500" 12.7mm	.030" to 10.0" .75 to 250 mm	<1000°F. <538°C

**NOTE:** *HT400 actual measurement range depends upon surface condition and couplant. HT400 temperature cycling required with surface temperatures above 400°F per Krautkramer instruction card.*

Model	Probe Description	Nominal Frequency	Contact Diameter	Measurement Range (Steel)	Temp. Range
DP-104	High Penetration	1 MHz	1.25" 31.8 mm	.200" min 5.0 mm min	<130°F <54°C
DA301	General Purpose	5 MHz	.475" 12.1 mm	.060" to 8.0" 1.5 to 200 mm	<130°F <54°C
DA303	High Penetration	2 MHz	.635" 16.2 mm	.200" min 5.0 mm min	<130°F <54°C
DA312	Thin Materials	10 MHz	.30" 7.6mm	.025" to 1.0" .6 to 25 mm	<130°F <54°C
DA312B16 *	Small Footprint	10 MHz	.120" 3 mm	.025 to .5" .63 to 12.7mm	<130°F <54°C
KB550BTH *	Boiler Tube	5 MHz	.375" 9.5 mm	.060" to 2.0" 1.5 to 50 mm	<130°F <54°C
KB550FH *	Fingertip	5 MHz	.375" 9.5 mm	.060" to 2.0" 1.5 to 50 mm	<130°F <54°C
FH2E-WR	High Sensitivity Fingertip Wear Resistant	8 MHz	.550" 14.0 mm	.030" to 2.0" .75 to 50 mm	<130°F <54°C
KBA560-WR	General Purpose Wear Resistant	5 MHz	.700" 17.8 mm	.060" to 8.0" 1.5 to 200 mm	<450°F <230°C
KBA525	Small Footprint	10 MHz	.200" 5 mm	.025" to 1.0" .63 to 25.4 mm	<130°F <54°C

**NOTE:** Probe specifications are subject to change without notice.

5.3 Dual Multi "Through Coating" Mode Probe Specifications

Model	Description	Nominal Frequency	Contact Diameter	Through Coating Measurement Range	Temp. Range
KBA560-D	Dialog-General Purpose	5 MHz	.625" 15.9mm	.120" to .800" 3 to 20 mm	<250°F <121°C
KBA560	General Purpose	5 MHz	.625" 15.9mm	.120" to .800" 3 to 20 mm	<450°F <230°C
KBA560-WR	General Purpose Wear Resistant	5 MHz	.700" 17.8mm	.120" to .800" 3 to 20mm	<450°F <230°C
DA312	Thin Materials	10 MHz	.30 " 7.6mm	.080" to .50" 2 to 13 mm	<130°F < 54°C
DA301/DA311	General Purpose	5 MHz	.475" 12.1mm	.120" to .800" 3 to 20 mm	<130°F < 54°C
DM401-GP	General Purpose	5 MHz	.700" 17.8mm	.120" to .800" 3 to 20 mm	<300°F <150°C

**NOTE:** The Auto Mode Linearity for the DA301 probe is ± 0.005 inch (± 0.13 mm)

**NOTE:** Actual "Through Coating" measurement will vary depending upon the type and thickness of the coating, the thickness of the metal and the quality of the metal and the quality of the bond between the coating and the metal.

Probe specifications are subject to change without notice.

## 6. Application

### 6.1 General Notes

The DM4 is easy to use and will produce reliable, consistent measurements when used correctly and with an understanding of factors that may affect measurement reliability. This section explains some of the more common considerations.

#### 6.1.1 Flaws

If, during testing, the DM4 suddenly reads a value which is much thinner than the apparent thickness of the part, it may be reading the distance to a flaw in the test piece, rather than the distance to the backwall. See Section 1.3, How the DM4 Measures Thickness, for more information. If the cause is unclear, further examination of the part with an ultrasonic flaw detection instrument or other suitable NDT method is recommended.

#### 6.1.2 Surface Conditions

A regular pattern on the surface under test, such as machine grooves, may cause a false thickness reading when using a dual element probe. Higher frequency probes, such as the DA312, are especially sensitive to this condition. The problem can usually be corrected by rotating the probe so that the crosstalk barrier is at a right angle to the grooves, or using the Dual Multi measurement mode.

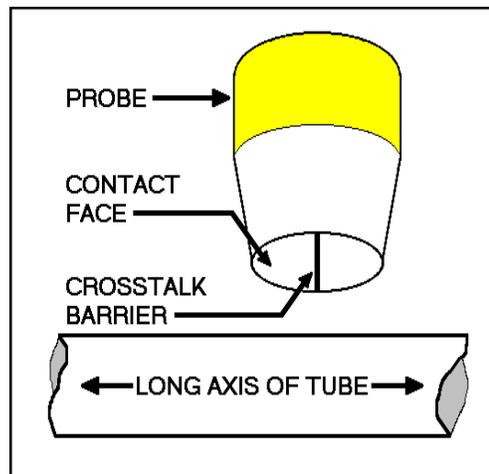
It is possible for the surface of a test piece to be too rough to permit a good reading. Excess couplant could be trapped between the probe and surface under test, causing a false reading. A very rough surface may prevent coupling altogether (no coupling indicator). This problem can be corrected by grinding the surface until it is smooth enough to permit good coupling.

#### 6.1.3 Curved Surfaces

When measuring on curved surfaces, such as tubes or pipes, be sure to keep the probe centered on the part and as stable as possible.

As a rule, smaller diameter probes improve coupling and minimize “rocking” on curved parts. In some cases, special probes with contoured faces to match surface curvature may be needed. Practice may be helpful to develop the proper technique.

When using a flat dual probe, position the crosstalk barrier at a right angle to the long axis of the part, as shown in the following figure



**Crosstalk Barrier Orientation**

### 6.2 Thickness Measurement on Hot Test Pieces

The instrument can be used to measure the thickness of materials with surface temperatures of up to 1,000°F (538°C) with special, high temperature, dual element probe Model HT400. A special couplant, Krautkramer ZGM, and duty cycle are also required for high temperature use. The following procedure is recommended

Calibrate the DM4 according to the appropriate procedure in Section 2.5 or 2.6.

Thoroughly clean the surface to be tested, using a wire

Knead the ZGM high temperature couplant in the tube before using. Then place a drop, about the size of a pea, *on the contact face of the probe, not on the test piece.*

Carefully couple the probe to the surface under test. To prevent damage to the probe face, do not twist the probe while it is in contact with the test surface. On a curved surface with a dual probe, orient the crosstalk barrier as described in Section 6.1.3. Allow 2 or 3 seconds for the ZGM couplant to melt and provide good coupling. At temperatures above 1020°F (550°C), the ZGM couplant may ignite spontaneously. This will not affect the quality of the coupling.

Do not allow the probe to be coupled for more than 5 seconds. If a thickness reading does not appear within 5 seconds, remove the probe and cool it in air. On curved surfaces, gently rocking the probe may help achieve good coupling.

While coupled, readings tend to drift upward as the probe warms. Using **MIN** (minimum capture) mode (Section 2.9) may be helpful in minimizing this problem.

A 100% duty cycle can be employed when taking measurements below 400°F (204°C). No cooling of the probe is required.

If taking thickness readings at temperatures above 400°F, cool the probe in air as follows:

- 15 seconds for temperatures from 400°F to 550°F
- 30 to 120 seconds for temperatures from 550°F to 1,000°F

Before taking another reading, carefully remove the remaining couplant and residue from the probe.

Thickness measurements made at high temperatures must be corrected for the effect of temperature on the material sound velocity. Velocity in steel changes at an approximate rate of -0.5% per 100°F (-1.0% per 100°C).

Some applications may exceed the instrument's capabilities. If high temperature measurements are unsatisfactory after several attempts using this procedure, better results may be achieved by using a high temperature probe with an ultrasonic flaw detection instrument.

## 7. Worldwide Service Centers

### **Agfa NDT GmbH**

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Phone: (49) 2233-6010  
Fax: (49) 2233-601402  
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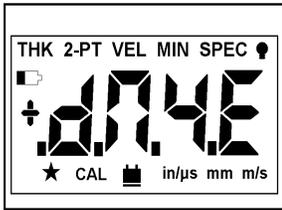
### **Krautkramer UK Ltd**

Millburn Hill Road  
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Fax: (44) 0845 130 5775  
E-Mail: [ndtsales.gb.ng@Agfa.co.uk](mailto:ndtsales.gb.ng@Agfa.co.uk)

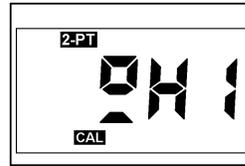
### **Agfa NDT SA**

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Fax: (33) 47-847-5698  
E-mail: [ndt@France.Agfa.com](mailto:ndt@France.Agfa.com)

# Appendix A: Displays, Quick Reference



Initial display, DM4E  
Section 2.4



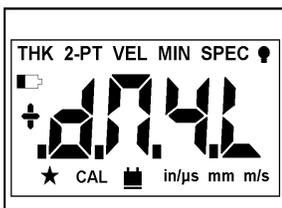
2-point calibration -  
Couple to thick standard.  
Section 2.6



Initial display, DM4  
Section 2.4



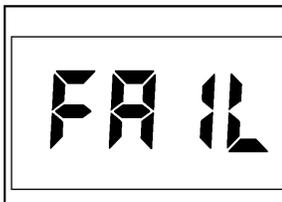
Receiver Gain Control  
(DM4, DM4 DL)  
Section 2.10



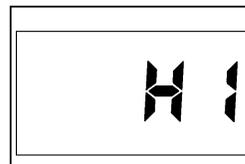
Initial display, DM4 DL  
Section 2.4



Automatic Gain;  
Automatic Backlight  
Sections 2.10, 2.15



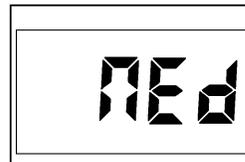
Fatal memory failure!  
Call for service



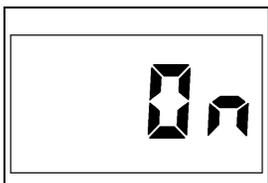
High Gain; High Band  
Pass Filter  
(DM4, DM4 DL)  
Sections 2.10, 2.13



Memory Failure.  
Press MODE key to reset  
instrument operating  
software.  
(All data will be erased)



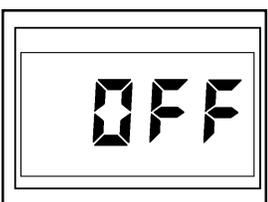
Medium Gain  
(DM4, DM4 DL)  
Section 2.10



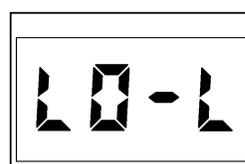
Enable mode or feature;  
Backlight on, Statistics on,  
Header on



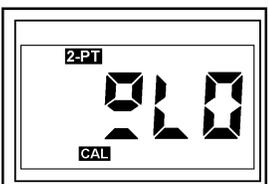
Low Gain; Low Band Pass  
Filter  
(DM4, DM4 DL)  
Sections 2.10, 2.13



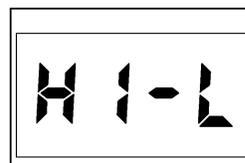
Disable mode or feature;  
Backlight off, Statistics off,  
Header off



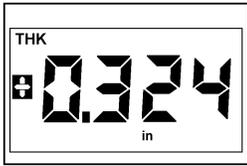
Low limit alarm mode  
(DM4, DM4 DL)  
Section 2.11



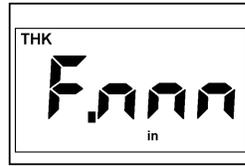
2-point calibration -  
Couple to thin standard  
Section 2.6



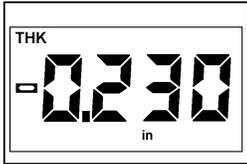
High limit alarm mode  
(DM4, DM4 DL)  
Section 2.11



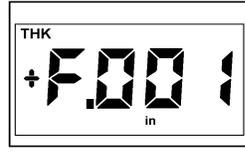
Reading exceeds HI Alarm limit  
(DM4, DM4 DL)  
Section 2.11



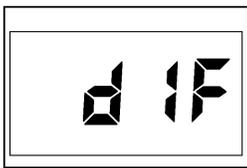
File no. nnn active  
Section 3.3 (DM4 DL)



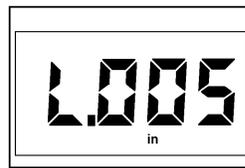
Reading less than LO Alarm limit  
(DM4, DM4 DL)  
Section 2.11



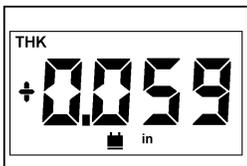
File no. 1 full  
Section 3.3 (DM4 DL)



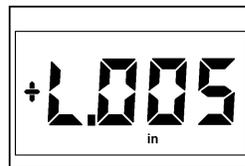
Differential measurement mode  
(DM4, DM4 DL)  
Section 2.12



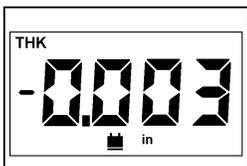
Location no. 5 active  
SEND confirmed  
Section 3.4 (DM4 DL)



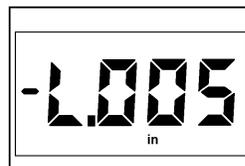
Differential reading exceeds  
nominal by amount shown.  
(DM4, DM4 DL)  
Section 2.12



Location no. 5 full  
Section 3.5 (DM4 DL)



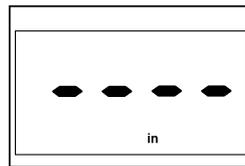
Differential reading less than  
nominal amount shown.  
(DM4, DM4 DL)  
Section 2.12



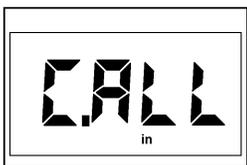
Location no. 5 empty  
Section 3.5 (DM4 DL)



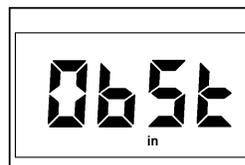
Band Pass Filter control  
(DM4, DM4 DL)  
Section 2.13



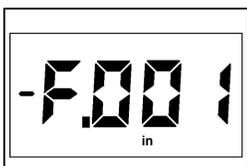
Viewing empty location  
Section 3.6 (DM4 DL) or unable to  
measure in the Dual Multi mode  
Section 2.18.



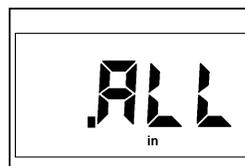
Memory clear  
Section 3.2 (DM4 DL)



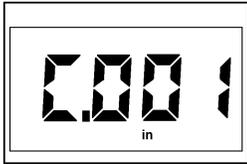
Viewing "obstructed" location  
Sections 3.4.1, 3.6 (DM4 DL)



File no. 1 empty  
File no. 1 empty  
Section 3.3 (DM4 DL)



All files selected  
Ready to transmit or clear  
Sections 3.3, 3.9, 4.4, 4.5  
(DM4 DL)



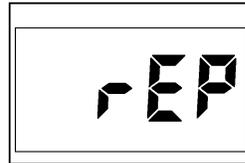
Clear file no. 1  
Section 3.8 (DM4 DL)



Japanese report language  
selected  
Section 4.3 (DM4 DL)



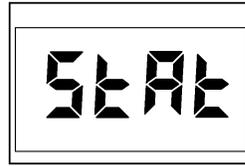
Baud rate selection  
Section 4.2 (DM4 DL)



Report selection  
Section 4.4 (DM4 DL)



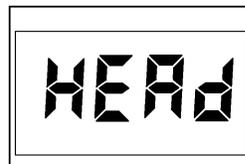
English report language selected  
Section 4.3 (DM4 DL)



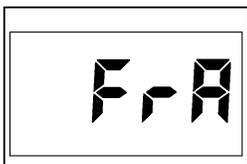
Header for report  
Section 4.4 (DM4 DL)



German report language selected  
Section 4.3 (DM4 DL)



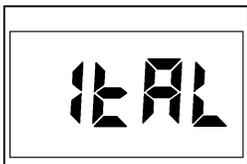
Statistics for report  
Section 4.4 (DM4 DL)



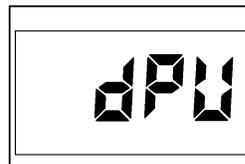
French report language  
selected Section 4.3 (DM4 DL)



Epson FX 850 printer setting  
Section 4.4 (DM4 DL)



Italian report language selected  
Section 4.3 (DM4 DL)



Seiko DPU 411 printer setting  
Section 4.4 (DM4 DL)



Spanish report language  
selected Section 4.3 (DM4 DL)



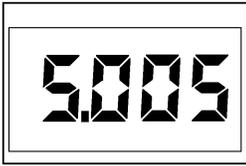
24 column / DATAMATE format  
printer setting  
Section 4.4 (DM4 DL)



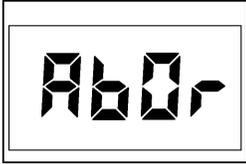
Russian report language  
selected Section 4.3 (DM4 DL)



Sending ALL files  
Transmission in process  
Section 4.4, 4.5 (DM4 DL)



Sending file no. 5  
Transmission in process  
Section 4.4, 4.5 (DM4 DL)



File SEND aborted  
Section 4.4, 4.5 (DM4 DL)



Spreadsheet formatted report  
Section 4.6 (DM4 DL)



Non-compatible probe for Dual  
Multi measurement mode  
Section 2.18

## Appendix B: Locations Per File Based on Number of Files

#Of Files	#Of Loc Per File	Total Readings All Files
1	999	999
2	999	1998
3	999	2997
4	999	3996
5	999	4995
** 6	899	5394
7	770	5390
8	673	5384
9	598	5382
10	537	5370
11	488	5368
12	447	5364
13	412	5356
14	383	5362
15	357	5355
16	334	5344
17	314	5338
18	297	5346
19	281	5339
20	266	5320
21	254	5334
22	242	5324
23	231	5313
24	221	5304
25	212	5300
26	204	5304
27	196	5292
28	189	5292
29	182	5278
30	176	5280
31	170	5270
32	165	5280
33	160	5280
34	155	5270
35	150	5250
36	146	5256
37	142	5254
38	138	5244
39	134	5226
40	131	5240
41	128	5248
42	125	5250
43	122	5246
44	119	5236
45	116	5220
46	113	5198
47	111	5217
48	108	5184
49	106	5194
50	104	5200
51	102	5202
52	100	5200
53	98	5194
54	96	5184

#Of Files	#Of Loc Per File	Total Readings All Files
55	94	5170
56	92	5152
57	91	5187
58	89	5162
59	87	5133
60	86	5160
61	84	5124
62	83	5146
63	82	5166
64	80	5120
65	79	5135
66	78	5148
67	76	5092
68	75	5100
69	74	5106
70	73	5110
71	72	5112
72	71	5112
73	70	5110
74	69	5106
75	68	5100
76	67	5092
77	66	5082
78	65	5070
79	64	5056
80	63	5040
81-82	62	5084
83	61	5063
84	60	5040
85-86	59	5074
87	58	5046
88	57	5016
89-90	56	5040
91	55	5005
92-93	54	5022
94-95	53	5035
96	52	4992
97-98	51	4998
99-100	50	5000
101-102	49	4998
103-104	48	4992
105-106	47	4982
107-108	46	4968
109-110	45	4950
111-112	44	4928
113-115	43	4945
116-117	42	4914
118-121	41	4961
122-123	40	4920
124-126	39	4914
127-129	38	4902
130-132	37	4884
133-135	36	4860

#Of Files	#Of Loc Per File	Total Readings All Files
136-138	35	4830
139-142	34	4828
143-146	33	4818
147-150	32	4800
151-154	31	4774
155-159	30	4770
160-164	29	4756
165-169	28	4732
170-174	27	4698
175-180	26	4680
181-186	25	4650
187-193	24	4632
194-200	23	4600
201-208	22	4576
209-216	21	4536
217-225	20	4500
226-235	19	4465
236-246	18	4428
247-258	17	4386
259-270	16	4320
271-285	15	4275
286-301	14	4214
302-318	13	4134
319-338	12	4056
339-361	11	3971
362-387	10	3870
388-416	9	3744
417-451	8	3608
452-492	7	3444
493-541	6	3246
542-602	5	3010
603-677	4	2708
678-774	3	2322

\*\* Maximum number of Readings

## Appendix C: Operational Software Reset

### WARNING!

Using this procedure completely resets the instruments to its factory default settings for all measurement and data logging parameters.

All readings stored in the on-board data logger will be permanently erased. To prevent loss of data, transfer all files to a computer or printer.

This procedure resets all instrument parameters to their original factory default settings.

While the instrument is off, press  and  simultaneously and hold both keys for 3 seconds while the instrument powers up.

To verify that a successful reset has occurred, switch to **VEL** (velocity) mode and check the displayed velocity value.

The factory default value of .2313 in/ $\mu$ s should be displayed. If it is not, repeat the procedure.

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