Krautkramer DM4 Series

Operating Manual

DM4E, DM4, DM4 DL

Technical Reference and Operating Manual

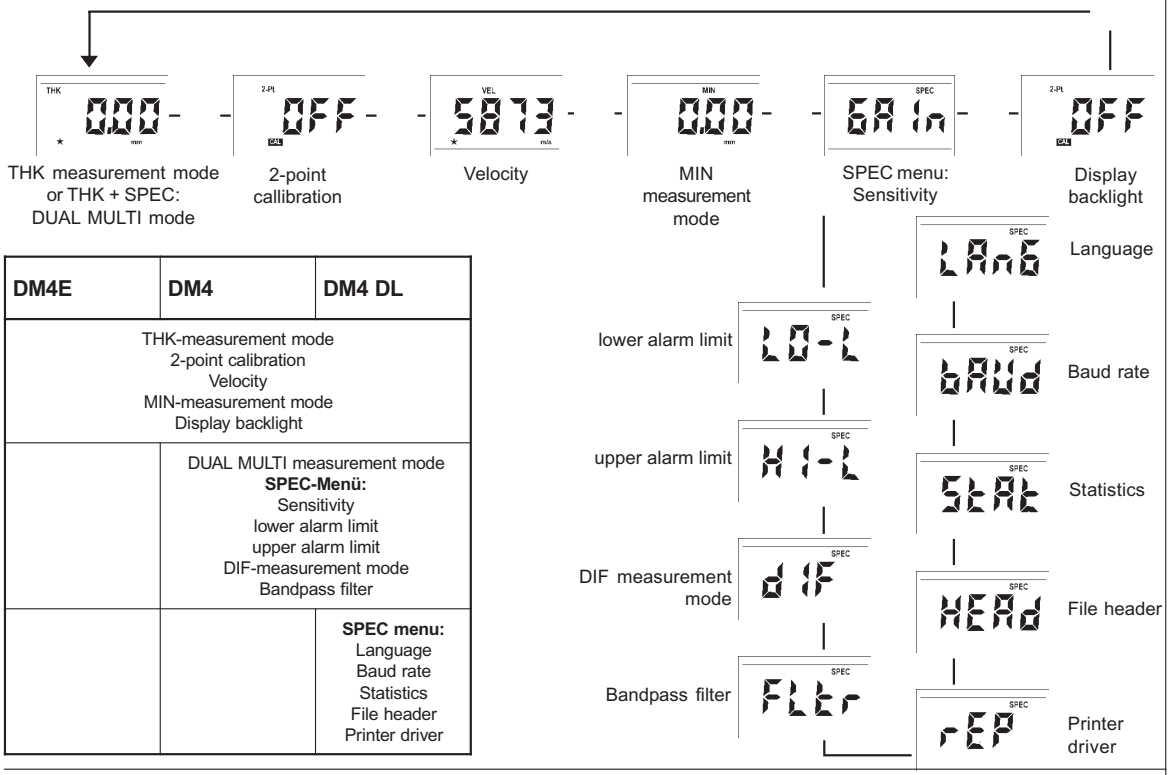
Ident-Nr. 28 593
084-028-593

You will find a function overview of the DM4E, DM4 and DM4 DL as well as an illustration of the instrument display including all display symbols and their meaning.

This will help you to find information a great deal faster when reading the operating manual.

This issue 05, 01/01 applies to the following software version:

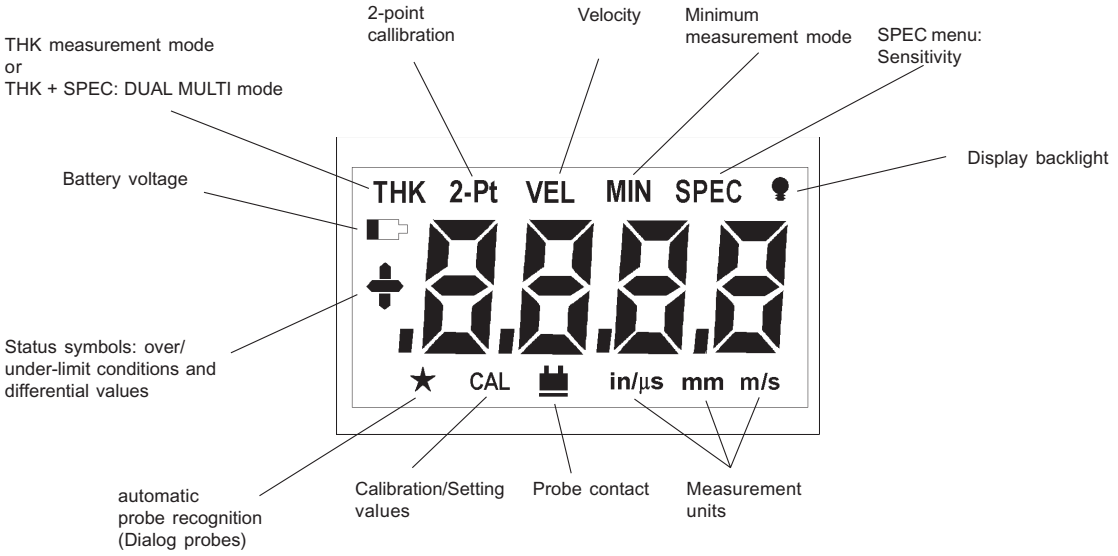
V 4.16



DM4E	DM4	DM4 DL
THK-measurement mode 2-point calibration Velocity MIN-measurement mode Display backlight		
	DUAL MULTI measurement mode **SPEC-Menü:** Sensitivity lower alarm limit upper alarm limit DIF-measurement mode Bandpass filter	
		SPEC menu: Language Baud rate Statistics File header Printer driver

Function overview

Function overview



Display overview

Introduction 1

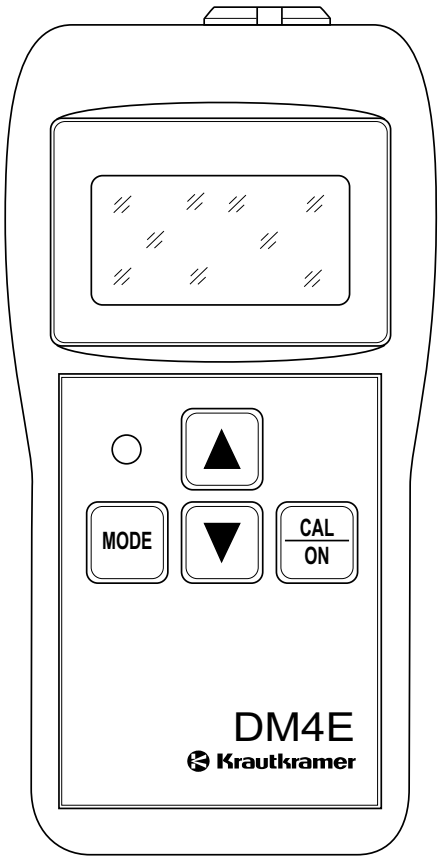
1.1 DM4E, DM4 and DM4 DL

Instruments belonging to the DM 4 family are thickness gauges which are light, compact and easy to use. They are suitable for measuring wall thicknesses and remaining wall thicknesses, especially on parts which are susceptible to corrosion and erosion (tubes, pressure vessels etc.). The great advantage with this thickness gauge is that the test object need only be accessible from one side.

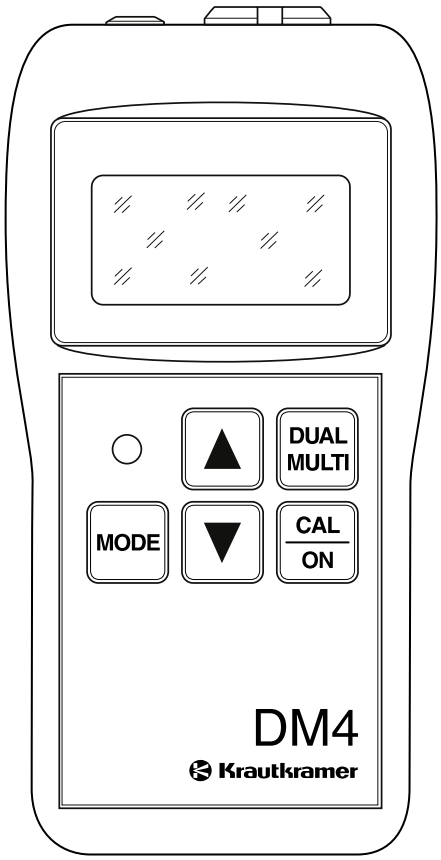
There are three versions of the DM4:

- DM4E
- DM4
- DM4 DL

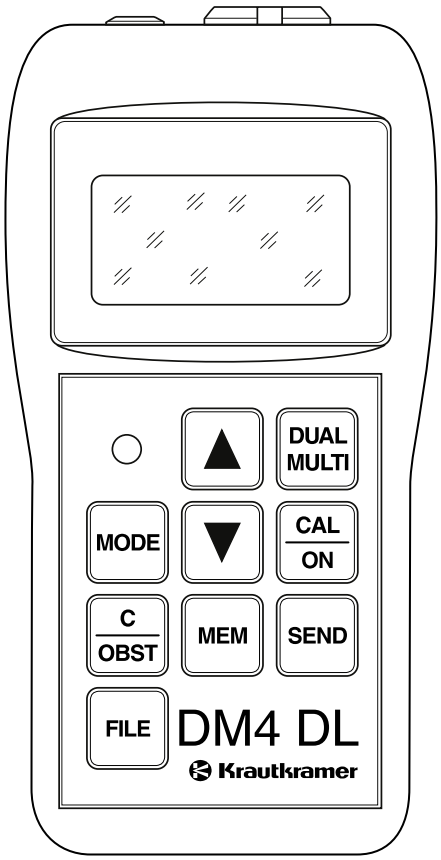
The DM4E and DM4 have different keypads and functions; as opposed to the DM4E the DM4 has extended functions. The DM4 DL is additionally equipped with a data logger which enables storage and transfer of measurement data.



DM4E
(with 4 keys)



DM4
(with 5 keys)



DM4 DL
(with 9 keys)

Special features of all three versions (DM4E, DM4, DM4 DL):

- Automatic probe recognition; with DIALOG probes optimum setting and performance of the instrument; especially for a higher measurement accuracy by individually stored correction data in the probe
- Automatic probe zero for quick calibration
- Automatic V-path correction for measurement linearity over the complete measurement range
- Digital resolution of 0.01 mm (for thicknesses up to 99.99 mm) and 0.1 mm (for thicknesses > 99.99 mm)
- MIN mode with increased pulse repetition frequency for detection of the smallest measurement value
- Up to 200 hours operation with AlMn batteries
- Automatic gain adjustment
- Large, easy to read digital display with switchable backlight
- Lightweight, ergonomic and rugged housing

Extended functions for DM4 and DM4 DL:

- Operating mode DUAL MULTI - measurement through coatings
- Manual gain adjustment
- Programmable minimum and maximum limits with LED alarm
- Difference mode for comparing the measured thickness with a variable nominal value

Special features of the DM4 DL (Data Logger):

- Integrated Data Logger with a capacity for 5390 values which can be divided into 999 files
- Access to the individual measurement values and files (viewing, editing and deleting),
- RS 232 interface for data transfer to a printer or PC (with special software)

1.2 Information about this manual

In the following you will find information about how to use this manual. Please read these instructions carefully in order to operate all DM4 functions quickly and reliably.

This will enable you to take full advantage of the instruments function range. At the same time, you will also avoid malfunction and operating errors which, in turn, would cause incorrect test results. In the long run, these errors could lead to injuries to persons or material damage.

Important information

Even if you have experience in ultrasonic testing it is imperative that you observe the information contained in Chapter 1.4. Here you will find important limitations and general conditions for thickness testing (training, knowledge of the special testing requirements, selection of the most suitable test setup). In addition to this you will find information about ultrasonic testing with the DM4 in Chapter 1.5 which must be observed so that correct readings can be guaranteed.

Please always look up in Chapter 12 to see if there are any current changes. This chapter describes corrections which have been added at short notice and which are not yet included in the general manual. If there are no additional corrections, the chapter remains empty.

Instrument operation is easy and quick to learn. In order to use the instrument as quickly as possible, you should become acquainted with the preparation as well as with the basic functions. Therefore, carefully read the following chapters:

Chapter 3 *Preparations for operation*

Here you will find all the preparatory steps necessary for the application of the instrument.

Chapter 4 *Basics of operation*

This gives you an overlook into the operation concept of the instrument as well as about the basic operation.

Chapter 5 *Operation*

This shows you the adjustments you can carry out and the operation steps necessary for the measurement. It also shows further possibilities and functions offered by the DM4 instruments.

Chapter 6 *Operation of the Data Logger (DM4 DL only)*

The DM4 DL has the same functions as the DM4. However, it has a Data Logger (data storage) in addition to offering extra functions. Here you will learn how to store as well as to view, change and delete stored data.

Chapter 7 *Documentation of measurement readings (DM4 DL only)*

You can document the measurement readings via a printer or, using a normal terminal program, transfer them to a PC and evaluate them. There are various possibilities available for your report.

Additional information about the DM4 DL interface can be obtained in Chapter 10. The appendix (Chapter 11) contains application information as well as sound velocity tables for materials and the distribution of files in the Data Logger.

1.3 Layout and presentation of this manual

In order to make things easier for you to use this manual, the operation steps, notes etc. are always put in the same form. In this way you will be able to quickly find individual information.

Operation steps

The operation sequences are always explained in steps so that you will be able to immediately work with the function you require.

The operation steps are presented as shown in the following example:

– Select the function DIF with MODE.

– ...

– ...

Note and Attention symbols

⚠ Attention:

The **Attention** symbol indicates peculiarities and special aspects in the operation which could affect the accuracy of the results.

☞ Note:

Note contains e.g. references to other chapters or special recommendations for a function.

1.4 Important remarks about thickness testing

⚠ Attention:

Please read the following information before you use your thickness gauge. It is very important that you understand and observe this information in order that you do not make any errors during thickness measurement which could lead to wrong measurement readings. Decisions based on wrong measurement readings can cause injury to people and damage to property.

Conditions for application of ultrasonic thickness gauges

This operating manual provides you with essential information for operation of the Thickness Gauge. In addition to this there are a series of factors which effect the measurement readings. Description of these factors would go beyond the bounds of an operating manual. Therefore only the three most important con-

ditions are listed for a reliable thickness measurement:

- Operator training
- Knowledge of the special technical requirements and limits of testing
- Selection of the most suitable test setup

Operator training

For operation of an ultrasonic measurement instrument adequate training is required in the field of ultrasonic thickness measurement. Appropriate training includes, for example, knowledge of the following:

- Theory of sound propagation in materials
- The effects of material sound velocity
- Behavior of sound waves at interfaces between different materials
- Propagation of the sound beam in the material
- Effect of the materials surface quality.

Insufficient knowledge of the above mentioned fields can cause incorrect test results and could thus have unforseeable consequences. Information about existing possibilities with regard to ultrasonic operator training as well as qualifications and certificates can be obtained from the national NDT organizations, e.g. in Germany: the **Deutschen Gesellschaft für Zerstörungsfreie Prüfung e.V.**, Motardstrasse 54, D-13629 Berlin; or from Krautkrämer GmbH & Co., Training Department.

Krautkrämer holds courses at regular intervals for training specialists in the field of ultrasonic testing. Dates will be given on request.

Limits of ultrasonic testing

The ultrasonic test information only concerns the area of the test object which is covered by the sound beam of the probe being used. Therefore care should be taken in case conclusions from the results of the tested area are drawn from the untested areas of the test object. Such conclusions are normally only allowed when extensive experience exists with regard to the test object and proven methods of statistical data acquisition are available.

Interfaces within the test object can completely reflect the sound beam so that deeper reflection positions, e.g. backwall of the test object, can no longer be reached by the sound beam. Therefore it must be ensured that the area to be tested is able to be covered by the sound beam.

Ultrasonic thickness measurement

Each thickness measurement with ultrasonics is based on a time of flight measurement of the sound pulse in the test object. The condition for exact measurement results is therefore a constant sound velocity in the test object. Normally this condition is fulfilled with steel objects, even with different alloy contents. The sound velocity changes so little that it is only noticeable with precision measurements. In other materials, e.g. nonferrous heavy metal or plastics, the sound velocity is subject to greater changes. Due to this, the measurement accuracy can be effected.

Influence of the test material

If the material is not homogeneous different sound velocities can exist in various areas of the test object. Therefore an average sound velocity is to be taken into account when calibrating the instrument.

The best results are however achieved when the instrument is calibrated on a reference block made of the same material as the test object. This calibration block should have plane-parallel surfaces and have a thickness which corresponds to the thickness of the test object. In addition to this, the operator should understand that changes to the sound velocity occur when material is heat treated. This must be taken into account with the evaluation of the thickness accuracy measured by the instrument.

If substantial sound velocity changes are to be reckoned with then the instrument calibration should be made at shorter intervals to the existing sound velocity. If this is not made, wrong thickness readings will occur.

Effects of temperature changes

The sound velocity in the test object changes with the temperature of the material. Therefore, under certain conditions, larger measurement errors will be produced if instrument calibration is made on a cold reference block and then the thickness measurement carried out on a warm test object. Such measurement errors can be avoided when calibration is made with a tempered reference block or when the temperature effect on the sound velocity is taken into account using a correction table.

Remaining thickness measurement

Measurement of the remaining thickness on the inside of eroded or corroded parts such as tubes, containers or reactors of all types require a suitable measurement device as well as careful handling of the probe. In any case, the operator should be informed about the corresponding nominal thickness as well as the presumed thickness losses.

Probe selection

The probe used for the measurement must be in a good condition, i.e. it should not have any appreciable coupling or delay line surface wear. The measurement range (application range) stated in the probe data sheets must cover the total thickness range to be tested. The temperature of the test object must be within the permitted limits for the selected probe.

Application of couplant

The operator must be conversant with the application of couplant so that it is applied in the same way for each measurement. This avoids variations in the layer thickness of the couplant and the resulting measurement reading errors. The calibration of the instrument and the actual thickness measurement should be carried out under the same coupling conditions. In doing this, small amounts of couplant are to be used and a constant pressure applied to the probe.

With curved coupling surfaces, e.g. tubes, the dual probe used for the measurement is coupled so that its acoustic separation layer forms an angle of 90° to the curvature axis (longitudinal axis of the tube).

Doubling of measurement readings

A dangerous measurement error occurs when a thickness measurement is carried out whilst below the specified application range (operation range) for the probe being used. In this case, the first backwall echo is too small for an evaluation but the second backwall echo has a sufficient amplitude height and is therefore evaluated by the instrument. This results in the displayed thickness reading being double that of the real thickness value. In order to avoid such an error, the operator must additionally carry out a test measurement with another probe when measuring on the limit of the application range.

In critical cases, a test measurement with a screen instrument is recommended because the echo shape can give important additional information when viewed.

1.5 Important notes on thickness testing with the DM4

⚠ **Attention:**

In the following you will find most important test requirements that you always have to comply with to ensure correct measurements with the DM4.

Probe Zero Adjustment

High temperature changes

If there are high differences of the ambient temperature between storage and test place it is necessary to wait approx. 2 minutes after connecting the probe before carrying out any measurement.

Temperatures below -10 °C

Probe Zero Adjustment with ambient temperatures < -10° C is not always correct. To ensure correct measurements carry out 2-point-calibration and repeat it in the case of high temperature changes.
For 2-point-calibration please refer to page 5-7.

Couplant rests

To ensure correct probe zero adjustment remove any remaining couplant before carrying out a further measurement.

Measurement precision

Be aware that the measurement precision is not identical with the display resolution.

Measurement precision depends on several factors such as:

- temperature
- probe delay line
- constancy of material velocity
- surface continuity of the test object

Probes

Please note that only the probes specified in chapter 2 *Scope of supply and accessories* are admitted for the DM4. These probes are recognized by the DM4 and the corresponding probe type number is displayed after probe zero. Only the following probe type numbers are specified for the actual DM4 version:

- 2 for HT 400
- 3 for DA 301, DA 305, DA 311, DA 401, DA 411
- 4 for DA 303, DA 315, DA 403
- 5 for DA 312, DA 312 B16, DA 319, DA 412
- 7 for DA 0.8G, DA 408

DM4 DL Data Logger

The DM4 DL's Data Logger only saves measurement readings and not instrument settings.

Printing the measurement report

⚠ **Attention:**

- Please note that header data and statistic information contained in the report printout relate to the DM4's current instrument settings and not those stored.
- Each dialog probe is marked with an individual internal number in order to increase documentation reliability. Therefore please observe the following: The information in the file header under *PROBE* and *PROBE ID* relating to dialog probes is only printed when the same probe, as used with measurement value recording, is connected during the printout. If the probe is changed during measurement value recording within a file, then the probe is changed then the fields already mentioned remain empty as well.

Scope of supply and accessories 2

Scope of supply and accessories

This chapter gives information about accessories for the DM4E, DM4 and DM4 DL.

It describes

- Accessories in the scope of supply
- Accessories required for operation
- Recommended accessories

2.1 Scope of delivery

Product name	Description	Order No.
DM4E	Thickness Gauge with automatic probe recognition Basic instrument and plastic case	34 440 17 493
	or	
DM4	Thickness Gauge with automatic probe recognition Basic instrument and plastic case	34 283 16 855
	or	
DM4 DL	Thickness Gauge with automatic probe recognition and integrated Data Logger Basic instrument and plastic case	34 284 16 856
	including	
	1 Sample of couplant ZG-F (100 g)	29 017
	2 × 1.5 V AA batteries (AlMn)	06 563
	Operating manual, German	28 576
	or	
	Operating manual, English	28 593

2.2 Required accessories

Product name	Description	Order No.
DA 401	Dialog probe, 5 MHz	58 637
DA 231	Probe cable for DA 301, DA 303, DA 401, DA 403, DA 408, DA 0.8G	53 616

2.3 Recommended accessories

DA 301	Standard probe, 5 MHz	56 904
DA 303	Standard probe, 2 MHz	56 905
DA 305	High temperature probe, 5 MHz	56 911
DA 311	Standard probe, 5 MHz, connector on top	57 566
DA 312	Standard probe, 10 MHz	56 906
DA 312 B16	Standard probe, 10 MHz, with reduced contact face	66 934
DA 315	High temperature probe, 2 MHz, temperatures up to 200 °C /392 °F	57 167
DA 317	High temperature probe, 5 MHz, temperatures up to 200 °C /392 °F	57 168

Product name	Description	Order No.
DA 319	High temperature probe, 10 MHz, temperatures up to 200 °C / 392 °F	57 169
DA 403	Dialog probe, 2 MHz	58 639
DA 408	Dialog probe for strong sound attenuative materials, 0.8 MHz	58 644
DA 411	Diaolg probe, 5 MHz, connector on top	58 857
DA 412	Dialog probe, 10 MHz	58 638
DA 0.8G	Special probe for strong sound attenuative materials, 0.8 MHz, 1.5 m / 59"	54 374
HT 400	High temperature probe, 5 MHz, temperatures up to 540 °C /1000 °F	14 775
KBA 536	Probe cable for HT 400, standard version, 1.5 m / 5"	14 772
KBA 535	Probe cable for HT 400, special steel sheathing, 1.5 m / 59"	14 773
ET-104	Extension tube for HT 400	14 770
HT-B	Grip for HT 400	14 771

Product name	Description	Order No.
ZG-F	Couplant (5 bottles)	54 558
ZGT	Couplant up to 250 °C / 482 °F	50 472
ZGM	High temperature couplant	56 567
DM4-RUC	Detachable rubber protector and belt	17 422
Only for DM4 DL:		
TGDL/PC	Data transfer cable for serial interface	13 647
GCH1	Adapter (Gender Changer) for connection of the TGDL/PC-cable to a printer with serial interface	13 648
GCH3	Adapter (Gender Cahnger) for connection of the TGDL/PC-cable to a printer Seiko DPU 414	34 797

2.4 Recommended outside products

Epson FX	Matrix printer with integrated serial and parallel interface for mains operation	17 995
Seiko DPU 414	Thermo printer with integrated serial and parallel interface for mains and battery operation	17 993

Preparation for operation 3

3.1 Battery supply

DM4 instruments are operated with two non-rechargeable dry cells (AlMn, type AA). These are contained in the delivery.

⚠ Attention:

Only use batteries supplied by us or batteries having the same high performance data. Leaking batteries can destroy the instrument!

☞ Note:

Take the batteries out of the instrument if you are not going to use it for a longer period.

The following symbol appears on the screen when the battery voltage is too low.

Exchange the batteries immediately in this case. If the battery voltage is too low, the instrument is automatically switched off in order to ensure a reliable operation only if the batteries are sufficiently charged.

All settings and stored measurement readings are retained and are immediately available.

Take a set of spare batteries if you carry out on-site measurements.

☞ Note:

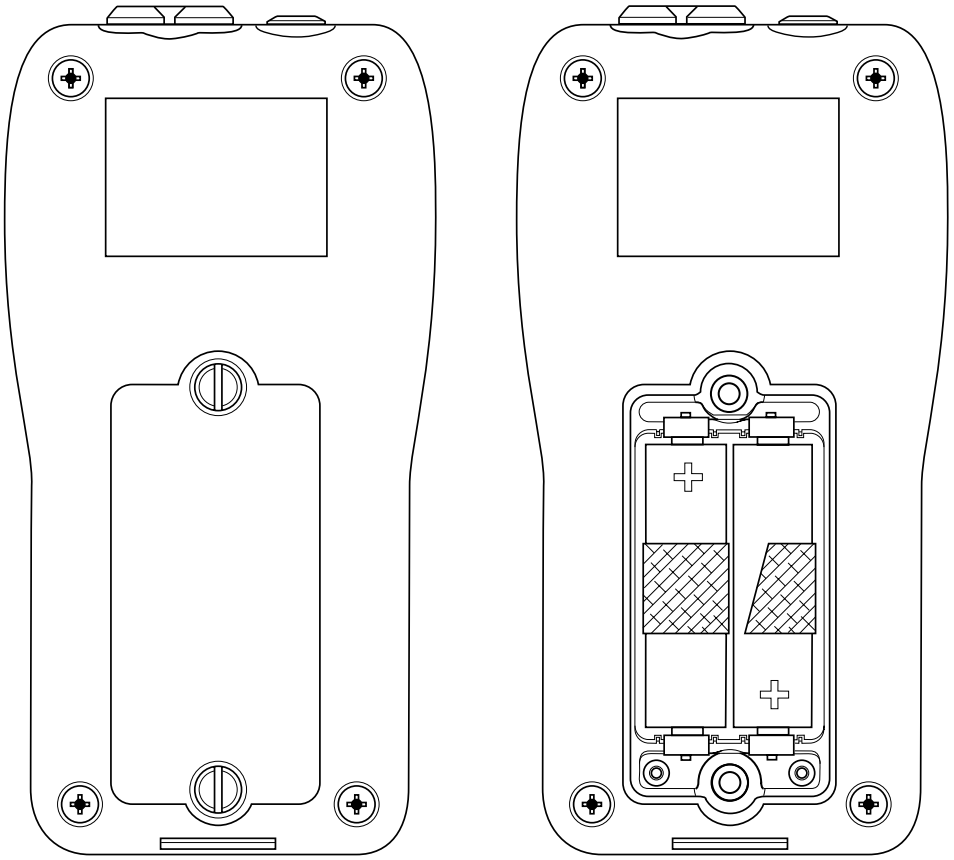
Used or defective batteries are special refuse and must be disposed of according to statutory regulations!

Inserting batteries

– Loosen both screws on the battery cover (on the rear side of the instrument) and remove it.

– Place the two AlMn batteries into the battery compartment. Make certain that the poles are the correct way round.

– Replace the cover and tighten the screws.



3.2 Connecting the probe

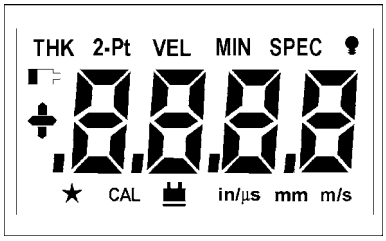
In order to prepare the DM4 for operation you must connect the probe.

Select a probe which is suitable for your application.

Connect the probe cable to the socket on the top of the instrument. Make certain that the “nose” of the cable plug is completely seated into the round cavity on the connection socket.

Basics of operation 4

4.1 Display



Display indications

Symbol	Description
THK	Thickness measurement and 1-point calibration
THK SPEC	DUAL MULTI operation mode: through-coating measurement
2-Pt	2-point calibration
VEL	Displaying and setting the sound velocity
MIN	Minimum operation mode
SPEC	**Only DM4 and DM4 DL:** Special functions, e.g. for setting the RS 232 interface, the alarm limits etc.
	Backlight
	Battery check
+	**Only DM4 and DM4 DL:** Difference mode: Measurement reading above nominal value; above upper alarm limit
-	**Only DM4 and DM4 DL:** Difference mode: Measurement reading below nominal value; below lower alarm limit
★	Automatic probe recognition with Dialog probes
CAL	Flashes when CAL ON is pressed: Activates ▲ ▼ for setting a displayed value or parameter.

Symbol	Description
	sufficient probe coupling
in/µs	in (inch): the set displayed value‘s measurement units in/µs: Units of measure for sound velocity (in the VEL-Mode)
mm	m/s, Millimeter: set displayed value‘s units of measure m/s: set units of measure for the sound velocity(in the VEL-Mode)

☞ Note:

On the foldout page (inside) you will also find a list of all the display indications to which you will have direct access during operation.

4.2 Keys

The following table gives you an overview of key operation for the DM4. Additionally refer to the description of the individual operation steps in Chapter 5.

Key	Description
CAL ON	Switches instrument on and off Selects CAL mode
MODE	Selects Operation Mode/Functions (THK, 2-PT, VEL, MIN, SPEC, 💡) after each other
▲ ▼	Sets values (increment or decrement) and selects parameters (if activated by CAL ON); ▼ ▲ simultaneously: Sets resolution and unit (CAL ON deactivated); **only with DM4 and DM4 DL**: Moving in the **SPEC** function
▲ ▼	**Only with DM4 DL:** Sets the number of files in the Data Logger and selects the files (if activated by FILE); selects measurement location and views the stored value (if activated by MEM)

Key	Description
DUAL MULTI	**Only with DM4 and DM4 DL:** Activates / deactivates DUAL MULTI operation mode (through-coating measurement)

Additional keys on the DM4 DL:

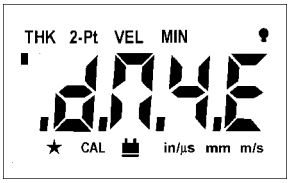
Key	Description
FILE	Sets the number of files in the Data Logger (when the Data Logger is empty); selects file (using ▼ ▲)
MEM	Access to the selected files in the Data Logger; selects measurement location and views measurement value (using ▼ ▲)
C OBST	Deletes measurement values, files or the complete memory of the Data Logger; displays and stores inhibited measurement value
SEND	Stores data in the Data Logger; transfers data to the PC or printer

4.3 Switching the instrument on and off

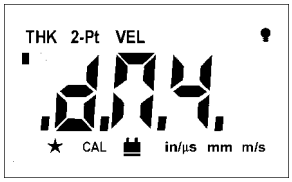
Indications after switching on

– Press CAL ON to switch the instrument on.

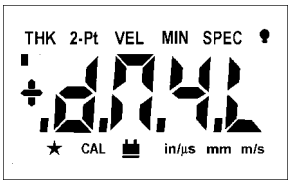
All display symbols and display possibilities appear, then the instrument version appears:



DM4E

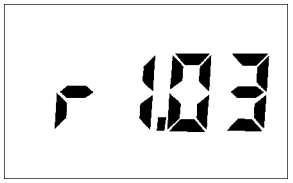


DM4



DM4 DL

After this, the version number for the software appears, for example:

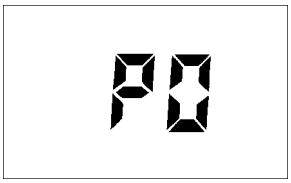


Software version (Release) 1.03

The following indications are dependent on the connected probe.

Dialog probes

If you have connected a dialog probe, the instrument will subsequently carry out the automatic probe zero (refer to Page 4-8). The following display will briefly appear:



The display does not appear with active 2-point calibration (refer to Page 5-7).

After this, the probe type number is displayed (automatic probe recognition, refer to page 4-8). The instrument is then ready for measurement. With initial operation, the **THK** mode (thickness measurement)is displayed, otherwise the last setting which was set.

Non-dialog probes: DA3 mode or AUTO mode

If you are using non-dialog probes, one of the two following displays will appear after the software version number:

DA3 mode

AUTO mode

DA3 mode is the default setting; otherwise the setting that was selected last will appear.

This is a case of two different operating modes that you can choose from.

DA3 mode

You should preferably use this mode in cases where there are large variations or differences between the test object's surface temperature and the ambient temperature.

The **DA3** mode is especially suitable whenever you are using the probes from the **DA3** series.

Note:

Exception: Please operate the probe **DA 0.8G** in the **AUTO** mode.

The probe **DA 312 B16 must** be operated in the **DA3** mode.

Auto mode

The **AUTO** mode offers advantages with test objects having a rough sufrace and with probes showing considerable wear.

The two operating modes are always suitable for normal applications.

Note:
Due to improved sensitivity, HT400 probes require 2-point calibration for best reading and accuracy. Use of the automatic zero feature could cause measmeant inaccuracies of up to 0.2 mm (0.008").

Operation:

– The DA3 or AUTO display appears and flashes for 3 seconds.

– Within this time, you can toggle between the two operating modes using "mode" to select the required setting.

– Just press a key to continue the operation using the displayed setting. Otherwise the instrument will take over the setting after 3 seconds and switch to stand-by-mode.

– The selected setting is kept and also displayed next time the instrument is switched on or a probe is exchanged.

Switching the instrument off

You switch the instrument off by pressing "CAL" and keeping it pressed for about 3 seconds.

4.4 Automatic instrument switch-off

The DM4 has an automatic instrument switch-off.

This automatic switch-off activates if the instrument has not been used after 3 minutes (no key activation, no coupling or decoupling of the probe, no interface activity with the DM4 DL).

By doing this, the current consumption is decreased and you do not waste any battery operation time.

4.5 Operation concept

Note:

In the foldout you will find an overlook of operating levels enabling quick orientation.

Selecting operation modes/functions

Select the individual instrument operation modes/functions consecutively with MODE. The selected function will appear at the top of the display. The operation modes/functions available are dependent on the instrument version.

- **THK**
- **2-PT**
- **VEL**
- **MIN**
- **SPEC** (DM4 and DM4 DL only)
- **THK** and **SPEC** (DM4 and DM4 DL only)
- 💡

After the last function 💡, the function **THK** appears when MODE is pressed.

Changing settings/values

For access to the corresponding setting possibilities of selected functions press CAL ON.

The **CAL** indication below in the display flashes.

Using ▲ ▼ you are able to change the settings.

Press CAL ON to store the settings.

Exception: SPEC

The **SPEC** menu has an additional operating level which is directly accessible with ▼ ▲.

Further functions appear whose settings are then changed as normal (press CAL ON, change with ▼ ▲ and press CAL ON again).

Accelerated setting

If, when setting, you have to span large ranges (e.g. when setting the sound velocity), you can accelerate this:

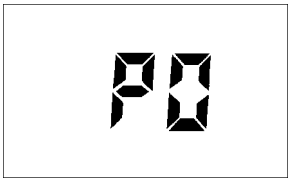
– Press ▼ or ▲ and keep pressed.

The setting is accelerated.

4.6 Automatic probe zero adjustment

With the DM4 you do not need to adjust the zero point for the connected probe because the instrument automatically carries out probe zero adjustment when the probe is connected.

When using dialog probes, the probe zero adjustment is continuously carried out even in the uncoupled state (provided the contact face is clean). The active probe zero adjustment is displayed by the following message after the instrument is switched on:



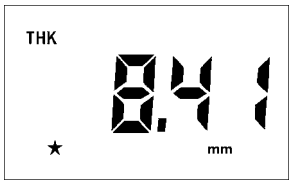
When using non-dialog probes, the probe zero adjustment is continuously carried out in the coupled state during measurement.
With an active 2-point calibration, the automatic probe zero adjustment is deactivated. Refer to Chapter 5.2.

4.7 Automatic probe recognition

When you work with one of our DIALOG probes, the correction data stored in the corresponding probe is automatically recognized. By doing this, a higher measurement accuracy is achieved as well as an optimum setting and DM4 performance.

The automatic probe recognition of all specified DM4 probes is indicated after the P0 display; the corresponding probe type number is displayed for a short time (for probe type numbers refer to page 1-13).

In the measurement mode the recognition of DIALOG probes is indicated as a star in the display, e.g.:



If you work with other probes, e.g. the DA 3 series (refer to Chapter 2, *Scope of supply and accessories*), the star does not appear in the display. The instrument operates with general settings.

4.8 Handling the probe

In order to carry out error-free measurements you should observe a few rules when handling the probe:

– Connect the probe to the socket on the top of the housing and switch the instrument on.

– If the thickness mode(**THK**) is not displayed keep pressing MODE until **THK appears.**

– Apply a small amount of couplant (the size of a small pea) to the surface of the test object.

– Couple the probe to the reference block. Place the probe onto the surface, applying a constant, slight pressure. Make certain that the probe is completely positioned on the reference block.

When there is sufficient coupling, the coupling symbol appears on the display and the measured thickness is displayed immediately.

Make certain that the indicated measurement value is stable.

When you couple the probe the measurement value is displayed further.

Operation 5

5.1 Basic settings

Setting the display backlight

You can switch the display backlight on and off. You can also select an automatic backlight. With this, the display backlight is switched on when you couple the probe or when a key is pressed. The display blanks 5 seconds after the last instrument activation.

Operation:

– Keep pressing MODE until 💡 is displayed.

– Press CAL ON.

– Select the required setting with ▼ ▲

OFF
On
AUtO

– Press CAL ON again to exit the function.

The selected setting is retained when you switch the instrument off.

Setting the units of measure and resolution

You can determine which units of measure you wish to use as well as the resolution of your instrument.

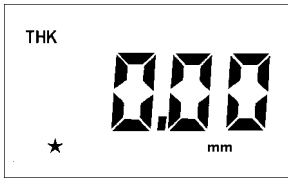
Units of measure: Millimeter or Inch

Resolution: 0.01 mm 0.001 in
0.1 mm 0.01 in

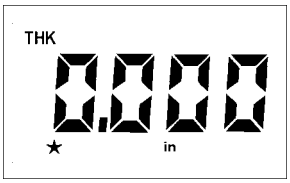
Operation:

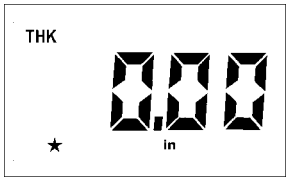
– Make certain that the thickness mode **(THK)** is selected.

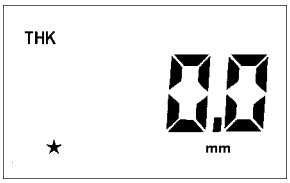
You see the basic setting or the setting last selected:



– If you press ▼ and ▲ simultaneously the following setting possibilities will appear after each other:







– Keep pressing ▼ and ▲ simultaneously until the required setting appears.

Note:

You can change the units of measure and the resolution during the measurement. The displayed measurement value is converted and displayed correspondingly into the new unit or resolution.

If you have already coupled the probe the displayed measurement value will not be converted but set to zero when changing units of measure and resolution.

Setting the unit for sound velocity

The units **m/s** (basic setting) and **in/µs** are available for indication of the sound velocity.

If you set the units of measure to “inch” (or back to millimeter) the sound velocity unit will correspondingly change. As opposed to this, the millimeter or inch unit is converted when you change the sound velocity unit.

You also have the opportunity to directly change the sound velocity unit.

– Press MODE until the function **VEL** is displayed.

– Simultaneously press ▼ ▲.

The unit is switched over. The displayed value is converted.

5.2 Calibrating the instrument

Before you are able to measure the thickness you must calibrate the instrument on the material to be tested.

You have the following possibilities:

- Sound velocity of the material is known; 1-point calibration is automatically carried out
- Sound velolcity is unknown; 1-point calibration with a calibration block of known thickness
- 2-point calibration with precision measurements within a narrow thickness range using a calibraton block having two known thickness steps (or two corresponding calibration blocks).

Note:

You need not calibrate the instrument to the connected probe because the instrument automatically carries out a zero point compensation. This applies to all types of probes in Chapter 2, *Scope of supply and accessories.*

Calibration with a known sound velocity

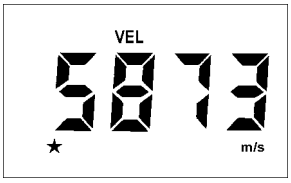
When the sound velocity of a material is known then you only need enter it. A 1-point calibration will automatically be carried out.

You can then quickly carry out a measurement.

Operation:

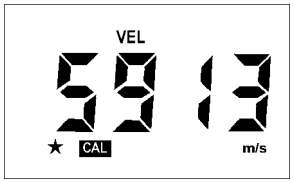
– Press MODE until **VEL** is displayed.

The sound velocity last set will appear in the display, e.g.:



– Press CAL ON.

– Press ▲ or ▼ in order to enter the new value, e.g.:



– Acknowledge the new value with CAL ON.

The new setting remains stored.

The instrument is now calibrated and you can carry out your thickness measurement.

1-point calibration

If the sound velocity is known or if you wish to check calibration, carry out a 1-point calibration.

For this you need a calibration block having a known thickness and made of the same material as the test object

☞ Note:

1-point calibration can only be carried out when the 2-point calibration is switched off.

Operation:

– Make certain that the thickenss mode (**THK**) is displayed.

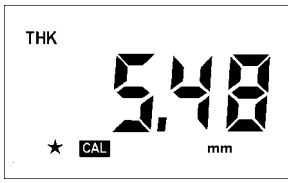
– Press CAL ON.

CAL flashes:

– Couple the probe to the calibration block and make certain that the coupling symbol appears.

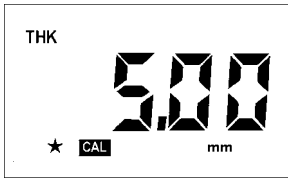
The measurement value appears in the display. Make certain that the indication is stable.

For example:



You can now uncouple the probe because the measurement value will remain after coupling.

– If the measured value does not correspond with the thickness value of the calibration block, correct the value using ▲ or ▼, e.g. with a thickness of 5 mm:



– Acknowledge the new value with CAL ON.

The instrument is now calibrated. You can now carry out thickness measurement.

2-point calibration

The 2-point calibration enables you to carry out an accurate calibration. You should carry out this type of calibration when you are required to carry out measurements within a narrow thickness range.

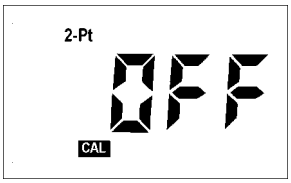
You require a calibration block having two different thicknesses (or two calibration blocks) which approximately correspond to the upper and lower limits of the thickness range to be measured.

Operation:

– Press MODE until the 2-point calibration function (**2-PT**) is displayed. This function is switched of in the basic setting.

– Press CAL ON.

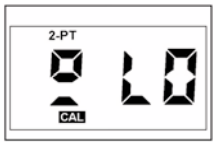
The **CAL** indication now flashes.



– Switch the function on with ▼ or ▲.

– Press CAL ON again.

The following display appears:



– Couple the probe to the step with the lowest thickness on the calibration block. Make certain that the coupling symbol appears and that the indication is stable.

– You can now decouple the probe because the measurement value will remain.

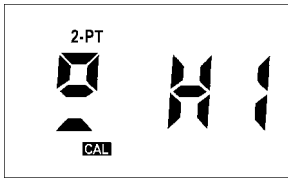
– Correct the displayed measurement value using ▼ ▲ so that it corresponds with the actual thickness of the calibration block.

– Press CAL ON.

After this, calibrate the 2nd point (larger thickness).

– Press CAL ON again.

The following display appears:



Now calibrate the instrument to the larger thickness of the calibration block. Proceed as described above.

– After this, press CAL ON in order to exit the **2-PT** function.

– Check the calibration and, if required, carry out the calibration one more time.

– To do this, press MODE again first.

Attention:

Check that only the status indicator symbol **2-PT** is displayed, no other status indicator symbol must appear on the display.

– After this, press CAL ON to restart the calibration process.

With the modes **THK** and **MIN** the **2-PT** indication remains at the top of the display giving an indication about the current 2-point calibration of the instrument. Automatic probe zero adjustment and 1-point calibration are now deactivated. Therefore, after a 2-point calibration the P 0 indication for the automatic probe zero adjustment no longer appears after the instrument has been switched on.

Switching off 2-point calibration

Of course you can switch the 2-point calibration off again in order to activate the automatic zero point compensation and the 1-point calibration.

– Press MODE until the **2-PT** function is displayed.

– Press CAL ON.

– Set the function **OFF** with ▼ or ▲.

– Press CAL ON once again.

The 2-point calibration is now deactivated, the **2-PT** indication does not appear any more.

☞ Note:

When deactivating the 2-point-calibration, you have to repeat the calibration process according to your application because any previous calibrations (1-point calibration or sound velocity) are not accepted.

5.3 Thickness measurement

Standard measurement: THK mode

The following description of the thickness measurement applies to test objects whose surface temperature corresponds to the ambient temperature. If you require to carry out measurements on hot surfaces refer to Chapter 11.1 *Application information*.

If you want to carry out measurements through coatings, use the operating mode **DUAL MULTI** (please refer to page 5-16).

Operation:

Make certain that the instrument is switched on and is calibrated to the selected probe and the material to be measured (refer to Chapter 5.2 *Calibrating the instrument*).

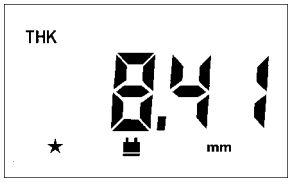
If you require to work with alarm limits (only DM4 and DM4 DL) read the procedure in Chapter 5.4, Page 5-13.

Make certain that the surface of the material is free of dirt, remains of paint etc. and then apply a thin layer of couplant onto the surface of the material.

– Select the **THK** mode (if necessary press MODE).

– Place the probe carefully but firmly onto the surface of the material. Apply a constant pressure in order to obtain a stable measurement value.

The coupling symbol appears when there is sufficient coupling. At the same time the thickness reading is displayed, e.g.:



– You can now couple the probe.

The coupling symbol blanks. The displayed measurement value is retained.

Minimum capture measurement - MIN mode

The **MIN** mode is suitable for determining the smallest measurement value within a series of measurements or within a rapid measurement sequence. The thickness measurement is made in this mode with an increased pulse repetition frequency in order to guarantee the reliable capture of the smallest measurement values during movement of the probe over the surface of the material.

When the probe is coupled, the smallest thickness value of the measurement sequence is displayed. The measurement sequence finishes after a certain “time-out” (adjustable). The measurement sequence continues when you position the probe again within the time-out. You determine the possible “breaks” in your measurement sequence by adjustment of the time-out.

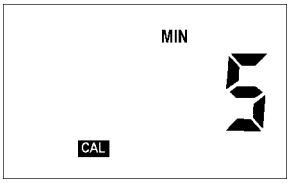
Setting the MIN time-out

You are able to set a time-out from 1 to 5 seconds.

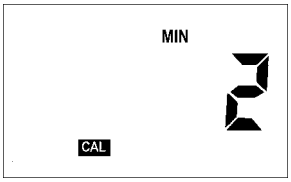
– Press MODE until **MIN** is displayed.

– Press CAL ON.

The current time-out setting in seconds is displayed, e.g.:



– Set the new time-out with ▼ ▲, e.g.:



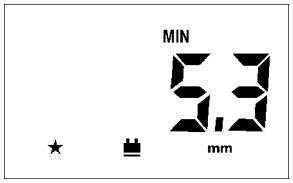
– Press CAL ON again in order to acknowledge the setting.

Carrying out the measurement

– Make certain that the instrument is in the **MIN** mode (if necessary press MODE).

– Couple the probe onto the test object.

The coupling symbol appears at the same time as the measured thickness value, e.g.:



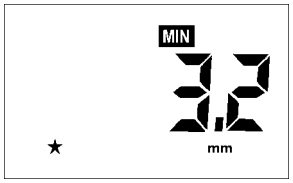
– Move the probe slowly over the range you wish to measure.

The display refresh rate is 4 times per second; you see the current measurment value.

– Decouple the probe.

The smallest value in the measurement sequence is displayed. The **MIN** indication on the display flashes during the time-out.

For example:



If you couple the probe during the time-out the measurement sequence will then be continued; the measured minimum thickness is retained.

When the time-out has finished the **MIN** indication stops flashing. You can then start a new measurement sequence.

5.4 Additional functions in the DM4 and DM4 DL

The DM4 and the DM4 DL have further functions for wall thickness measurement in the **SPEC** menu:

- Sensitivity setting (SA in)
- Lower alarm limit setting (LO-L)
- Upper alarm limit setting (HI-L)
- Selection of Difference mode (d IF)
- Bandpass filter setting (FLtr)
- In addition to these, the DM4 DL also has functions for data transfer (refer to Chapter 7).

Setting the sensitivity SA in

You can change the sensitivity of the DM4 and the DM4 DL. The selection of the sensitivity is dependent on the characteristics of the material (structure, graininess, paint layer etc.).

The basic setting **Automatic** changes the sensitivity depending on the sound velocity.

Operation:

– Press MODE until **SPEC** appears.

– Press ▼ or ▲ until SA in is displayed.

– Press CAL ON.

The active sensitivity set is displayed.

– Select the required sensitivity with ▼ or ▲:
  AUtO automatically sets the sensitivity on
  LO low sensitivity
  MEd medium sensitivity
  HI high sensitivity

– Acknowledge with CAL ON.

Setting the alarm limits

Attention:

When a Data Logger is active whilst changing the alarm limits, the previously stored settings are overwritten.

You can set an upper and a lower alarm limit. If a measurement value goes above or falls below the limit, a red LED lights on the front panel of the instrument.

In addition to this, the + symbol appears before the value of an over-limit condition and a - before a value with an under-limit condition.

Operation:

– Press MODE until **SPEC** appears in the display.

– Press ▼ or ▲ until H I-L or LO-L is displayed.

– Press CAL ON.

The active setting is displayed (basic setting: OFF).

– Press ▼ or ▲ in order to switch on the corresponding alarm limit.

– Press CAL ON again.

The active limit value set is displayed.

Basic setting:
H I-L : 500 mm
LO-L : 0.5 mm

– Set the required limit value with ▼ or ▲.
There is an adjustment range available from 0.5 to 500 mm. In doing this, the lower limit must not be the same or larger than the upper limit value.

– Press CAL ON.

The set alarm limit is stored.

– Press MODE in order to return to thickness measurement.

Switching the alarm off again

– Press MODE until **SPEC** is displayed.

– Press ▲ or ▼ until H I-L or LO-L is displayed.

– Press CAL ON.

– Switch the corresponding function to OFF using ▲ or ▼.

– Acknowledge with CAL ON.

The corresponding alarm limit is switched off.

Difference mode: d IF

In the Difference mode the measured thickness is compared with an adjustable nominal value.
The difference is displayed.

Operation:

– Press MODE until **SPEC** is displayed.

– Press ▼ or ▲ until DIF appears.

– Press CAL ON.

The active setting appears (basic setting: OFF).

– Press ▼ or ▲ in order to switch on the Difference mode.

– Press CAL ON.

You will see the active nominal value which is set.

– Set the required nominal value with ▼ or ▲.

– Press CAL ON again.

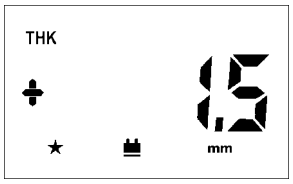
– Press MODE until you are in the Standard mode again.

You can now carry out your measurements. The difference between the entered nominal value and the corresponding thickness value is immediately displayed.

Example:

Entered value: 4.0 mm
Measured value: 5.5 mm

Displayed value:



The measured value is 1.5 mm larger than the nominal value.

With a smaller value, a minus sign is displayed before the measurement value.

Setting the bandpass filter: FLtr

You can optimize the amplifier for the probe frequency with the FLtr function. You suppress parasitic oscillations with it.

The basic setting is HI and is suitable for probes with a frequency from 2 MHz to 10 MHz.

Operation.

– Press [MODE] until **SPEC** is displayed.

– Press [▼] or [▲] until FLtr appears.

– Press [CAL ON].

The active setting appears:

- HI (High)
  for probe frequencies from 2 - 10 MHz
  or
- LO (Low)
  for probe frequencies from 300 kHz - 2 MHz.

– Select the required setting with [▼] or [▲] and press [CAL ON] in order to exit the function.

Measuring through coatings: operating mode DUAL MULTI

With their operating mode **DUAL MULTI**, DM4 and DM4 DL offer you the possibility of acurately measuring the metal wall thickness under adherent coatings (paint coatings, plastic coatings, fiber-reinforced plastic sheathings, etc.).

If such a coating is not taken into account in the wall thickness measurement, the result may be considerable measurement errors depending on the coating thickness.

The operating mode **DUAL MULTI** avoids these measurement errors without removing the coating by allowing the measurement between two adjacent backwall echoes.

☞ **Note:**

It is irrelevant for the operating mode **DUAL MULTI** wether you choose the **DA3** or the **AUTO** mode.

The following standard probes are suitable for the operating mode **DUAL MULTI**:

- DA 301 DA 401
- DA 311 DA 411
- DA 312 DA 412
- DA 312 B16
- DA 317
- DA 319

The measuring range of the probes depends on the type and thickness of the coating, thickness of the metal, and the quality of the bonding between metal and coating.

Operation:

– Make sure that the instrument is switched on and calibrated to the selected probe and material to be measured (please refer to chapter 5.2 *Calibrating the instrument*).

☞ **Note:**

You can carry out a 1-point calibration in **DUAL MULTI** mode as well if two backwall echoes are measured on the calibration block. To do this, switch the instrument

to **DUAL MULTI** mode (please see below) and then proceed as described in *1-point calibration*, page 5-6.

If you want to use alarm limits, please read the description of the mode proceeding in chapter 5.4, page 5-13.

– Activate the operating mode **DUAL MULTI** by pressing the DUAL MULTI key.

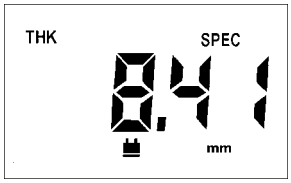
– The display then shows the annunciators **THK** and **SPEC**.

Note:

If you have connected a probe which is not suitable for the operating mode **DUAL MULTI** no is displayed. The display **SPEC** does not appear in this case.

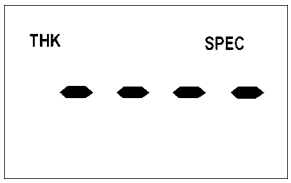
Place the probe gently but firmly on the material surface. Apply uniform pressure to obtain a stable reading.

The coupling symbol is lit as soon as 2 backwall echoes are measured. The wall thickness reading is displayed, e.g.:



If there aren't two backwall echoes and if no measurement can be carried out,

- the coupling symbol is not lit,
- the red LED is lit,
- the following display appears:



In this case, try to polish the surface and carry out another measurement in the **DUAL MULTI** mode at first. It might also be advantageous to change the filter setting in some cases.

If this does not lead to any success, carry out the wall thickness measurement in the standard mode, however, you have to remove the coating from the test object surface to do this.

– Deactivate the operating mode **DUAL MULTI** by pressing the DUAL MULTI key again.

5.5 Activating and deactivating functions

DM4 and DM4 DL offer you the possibility to configure functions: You can compile the function range of the instrument as you require.

You can activate and deactivate the following functions:

- 2-Pt : 2-point calibration
- FLtr : Bandpass filter setting **(SPEC)**
- dIF : Difference mode **(SPEC)**
- HI-L : Upper alarm limit setting **(SPEC)**
- LO-L : Lower alarm limit setting **(SPEC)**
- GAIn : Sensitivity setting **(SPEC**)
- SPEC : Complete **SPEC** menu
- MIn : **MIN** mode
- VEL : Display and adjustment of the sound velocity

Operation:

Selecting the configuration level

The instrument is switched off.

– Switch on the instrument with CAL ON and keep CAL ON pressed.

– As soon as an indication appears additionally press ▼. Keep both keys pressed for about 3 seconds.

After switching on, the normal displays appear.

After this, the instrument switches into the function first activated/deactivated (independent of which function was last selected: basic setting: 2-PE).

Selecting functions

– Press ▲ or ▼ until the required function is displayed.

Function activation/deactivation

When the function is displayed which you wish to activate or deactivate:

– Press CAL ON.

The active setting is displayed:

- On = Function is activated.
- OFF = Function is deactivated.

– Press ▲ or ▼, in order to change the setting as required.

– Acknowledge with CAL ON.

The function which you have activated or deactivated is displayed again.

– Carry out the same steps for all functions whose setting you want to change.

– After this press MODE.

The instrument switches into the Standard mode.

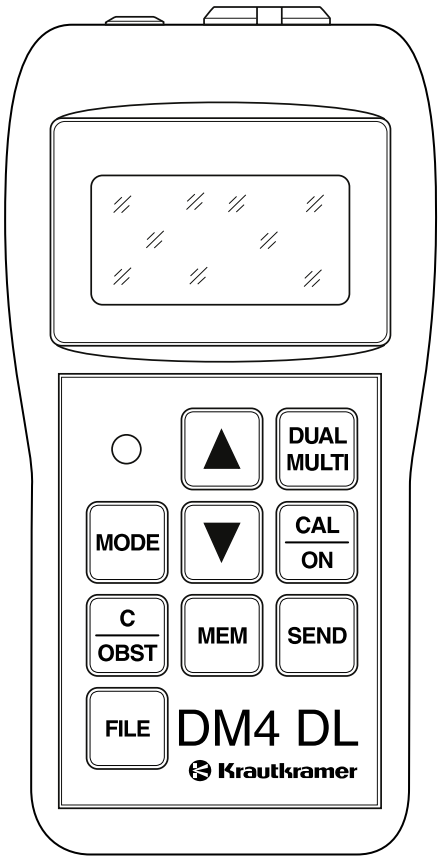
All activated modes are indicated on the display.

Note:

When functions are deactivated they are reset to their basic setting.

Operation of the Data Logger (DM4 DL only) 6

6.1 Data Logger



The DM4 DL is equipped with a Data Logger with which you are able to directly store measurement values.

The stored data can be

- displayed
- deleted
- printed
- transferred to a PC.

As opposed to the DM4E and the DM4, the DM4 DL has four additional keys: SEND, C OBST, MEM, FILE (refer to figure).

Note:

The possibility to print stored data and to transfer this data to a PC is described in Chapter 7 *Documenting measurement values.*

In the menu **SPEC** the DM4 DL has additional possibilities for data configuration when printing.

The measurement values are combined into files when stored. The number of measurement values per file (file size) is automatically determined when you configure the Data Logger, i.e. determining the number of files required (max. 999). The DM4 DL divides the total storage capacity of 5394 measurement values by the determined number of files and applies the maximum number of same sized files permitted by the capacity.

The first measurement value is stored in each file starting with memory location number 1. You can also select another output location. The following measurement values are continually stored until all memory locations are filled or if another file is selected for storage.

☞ Note:

The stored measurement values are retained even when the batteries are taken out of the instrument.

We therefore recommend that you make a backup of important data onto an external data carrier. Refer to Chapter 7.2 *Transferring data to a PC*, Page 7-8.

6.2 Setting the number of files

Before you can store the measurement values with the Data Logger you must determine the number of files.

The number of files depends on the number of memory locations required for each file. One memory location corresponds to one measurement value. Depending on your application, determine the maximum number of measurement values which can be stored in a file. On the basis of the maximum file size, select the possible file number using the table in Chapter 11.3.

You can only configure the Data Logger, i.e. setting the number of files, when the complete memory is empty.

Operation:

You are in a measurement mode (**THK, THK/SPEC**, **MIN** or **DIF**).

– Press FILE.

The following display appears when the Data Logger is empty:

Note:

If the memory is not empty, the file number will be displayed (e.g. F.001). In this case you must firstly clear the memory. Refer to Page 6-12 of this chapter, *Clearing the complete memory*.

When C.ALL appears you can then configure the Data Logger.

– Press ▲ or ▼ in order to enter the required number of files, e.g.:

Example:

With a set number of 64 files you have 80 memory locations available per file (refer to the table in Chapter 11.3)

– Acknowledge with FILE.

The display CONF appears for about 12 seconds.

The Data Logger configures the memory.

After this, the DM4 DL switches back to its selected measurement mode. The Data Logger is now configured. You can store your measurement values.

6.3 Storing the measurement values

In order to store measurement values, you must firstly select a file in which it is to be stored.

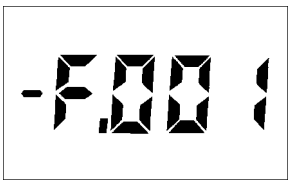
File selection

Operation:

You are in a measurement mode(**THK, MIN** or **DIF**).

– Press [FILE].

The active file is displayed when the Data Logger is first used:



You will see the following information in addition to the file number:

-F.nnn Empty file, contains no measurement value
F.nnn File which already contains measurement values but is not full
+F.nnn File full, cannot store further measurement values.

(nnn = File number)

Note:

– The Data Logger is not configurated when F.ALL appears. Refer to Chater 6.2 *Setting the number of* files*.*

Press [▲] or [▼], if you wish to select another file. You must select a file which has at least one free memory location.

Note:

You can scroll through the existing files with [▼] [▲]. After selecting the highest file number with [▲] the display F.ALL will appear (all files). You will need this setting for clearing the files (refer to Page 6-12). After

this the display will jump back to file number 1. The display F.ALL will appear after selection of the smallest file number (1); after this, the display will jump to the highest file number.

– When the required file is displayed, acknowledge with FILE.

The active memory location number is briefly displayed, i.e. the first free memory location (L.nnn) of the selected file, e.g. when the file is empty:

That means the first measurement value on memory location number 1 is allocated.

After this, the DM4 DL switches back into the ready-for-measurement state.

Storing measurement values in the selected file

When you have selected a file in which there are free storage locations, measurement values can be stored in the Data Logger.

You are able to store measurement values in all measurement modes. The following settings are stored:

- Diffence values in the dIF mode
- Upper and lower alarm limits
- Probe data with dialog probes

Operation:

– Carry out your thickness measurement.

– When the measurement value which you wish to store is displayed, press SEND.

The measurement value is stored in the selected file in the Data Logger. The active memory location number is briefly displayed, e.g. L.001.

You can store the measurement values by pressing SEND until all memory locations are allocated.

After a value has been stored in the Data Logger the SEND key remains inhibited until a new valid measurement. Zero values are not stored.

⚠ Attention:

Make certain that all measurement values are stored with the same resolution so that no errors occur with statistical data in the report printout.

If you store the measurement values after each other L.FUL will appear after the last memory location has been allocated. When this happens, select a new file or delete the stored measurement values (refer to Chapter 6.5, Page 6-11).

☞ Note:

L.FUL appears every time an attempt is made to store a measurement value onto a memory location which is already allocated. For selecting individual memory locations, e.g. to see if empty locations are available in the file, refer to Page 6-8.

Inhibiting a memory location

You can inhibit a memory location and proceed to the next location, for example when you are not able to measure a particular point within a measurement series.

If needed, you can select the inhibited memory location later in order to store a measurement value there. The inhibited memory location is simply overwritten.

Operation:

You are in the mode **THK, THK/SPEC** or **MIN** and have activated a file in which you wish to store your values.

– Uncouple the probe.

– Press C OBST.

As usual the memory location number will be briefly displayed, e.g. L.003. Finally Ob St (obstruct) will appear.

The memory location is inhibited.

– Simply carry out your next measurement.

The DM4 DL automatically stores the next measurement value into the next memory location.

Selecting a memory location

You can individually select memory locations at which the next measurement value is to be stored if, for example, you overwrite an inhibited measurement value.

Operation:

You are in the mode **THK, THK/SPEC** or **MIN**:

– Press MEM.

The active memory location number is displayed, e.g. +L.003.

Whereby:

+L.nnn = memory location allocated

-L.nnn = memory location empty

– With ▼ or ▲ you can select the memory location at which the next measurement value is to be stored.

– Press MEM twice.

The instrument again switches to the ready-for-measurement state. The selected memory location is active.

☞ **Note:**

The following chapter describes how you display individual measurement values contained in the memory locations.

6.4 Viewing stored measurement values

You can have your measurement values in the Data Logger displayed.

Operation:

– If necessary, select the file whose measurement values you wish to see (refer to Page 6-5).

You are in the **THK, THK/SPEC** or **MIN** mode.

– Press MEM.

The active memory location number is displayed, e.g. +L.001.

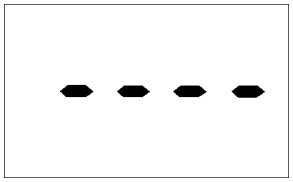
– Press ▲ or ▼ until the required memory location appears.

– Press MEM again in order to display the stored measurement value.

The measurement value is displayed in the selected unit of measure.

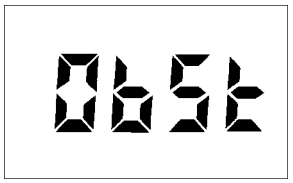
– Press ▲ or ▼ in order to view other memory locations.

In doing this, the following indications can appear:



No measurement value is stored in this memory position (is already indicated by the minus sign at the memory location number).

The flashing minus sign indicates an under lower alarm limit condition. A plus sign would therefore indicate an over upper alarm limit condition.



Memory location is inhibited (refer to Page 6-8).

– Press MODE again in order to exit the measurement value display.

The instrument is again ready for measurement.

6.5 Deleting stored measurement values

You can either delete individual measurement values, complete files or the total memory. Free memory locations can be reallocated with new measurement values after deleting individual measurement values.

Deleting and replacing individual measurement values

Operation:

– With [FILE] and [▼] [▲] select the required file and press [FILE] again.

– Press [MEM] and [▼] [▲] in order to select the required memory locations.

– Press [MEM] and then [▼] [▲] until the measurement value you wish to delete is displayed.

– Press [C OBST].

A message appears briefly indicating deletion of the measurement value (e.g. C.0.02) and then the indication for an empty memory location:

– Press [MEM] again in order to return to the measurement mode.

The measurement value is deleted. The new measurement value can now be filed into the empty memory location.

Deleting a file

⚠ **Attention:**

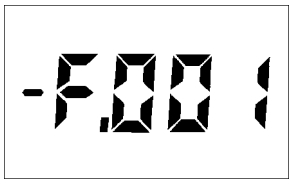
When you delete a file, the data is irretrievably lost. Save your data beforehand on an external data carrier (refer to Chapter 7.2 *Transferring data to a PC*).

Operation:

– With [FILE] and [▼] [▲] select the required file, e.g. +F.001.

– Press [C OBST] and keep it pressed for about 3 seconds.

A message appears briefly indicating deletion of the file (e.g. [.0.0 1). Then the file number appears.
A minus sign appears indicating that the file is empty, e.g.:



The selected file is deleted.

– With [FILE] return to the measurement mode or, using [▼] [▲], select a new file which you wish to delete.

Clearing the complete memory

You can delete the complete memory, i.e. all files with all measurement values. For example, you must do this when wishing to reconfigure the Data Logger.

⚠ Attention:

When you delete a file, the data is irretrievably lost. Save your data beforehand on an external data carrier (refer to Chapter 7.2 *Transferring data to a PC*).

Operation:

– Press [FILE].

– Press [▲] or [▼] until F.ALL appears. This indication appears at the beginning and at the end of the data series, i.e. with [▲] to the highest available file number and with [▼] to F.001.

– Press [C OBST] and keep pressed for about 3 seconds.

[.ALL is displayed.

– Press [FILE] in order to return to the measurement mode.

The complete memory is cleared. No measurement values are stored until the Data Logger is reconfigured, i.e. the number of files determined.

Documenting measurement values (DM4 DL only) 7

7.1 Printing data

In connection with a printer having a serial interface (e.g. Epson FX), the DM4 DL offers you the possibility to print adjustment and measurement data as well as statistical data.

In the DM4 DLs **SPEC** menu certain adjustments can be carried out for printing the data:

- bAUd Setting the data transfer rate
- LAnG Language selection
- rEP Selection of printer driver
- HEAd Print “File header” with general data
- StAt Print statistical data

For printing your measurement report you need:

- A printer with serial interface RS 232
- A data cable TGDL/PC with adapter GCH1 for connecting the DM4 DL to the printer Epson FX (or GCH3 for a printer Seiko DPU 414).

Preparing the printer

– Using the cable TGDL/PC, connect the printer to the DM4 DL via the serial interface RS 232.

Data transfer for the DM4 DL is made in the following data format:

- Baud rate 9600 (basic setting)
- Data bits 8
- Stop bits 1
- Parity none

The baud rate is adjustable (refer to the following page); all other parameters are fixed.

Make certain that the settings of the printer correspond to whose of the DM4 DL.

Refer to the printer operating manual for information about setting the transfer parameters.

Selecting the baud rate

With regard to data transfer, you will find the selection of settings in the **SPEC** menu.

You can select the data transfer rate (baud rate) with which the data is sent to the printer or PC.

☞ Note:

The baud rate setting must correspond to the setting of the printer or PC.

Operation:

– Press MODE until **SPEC** is displayed.

– Press ▲ or ▼ until bAUd is displayed.

– Press CAL ON.

The active setting is displayed (basic setting 9600).

– Select a setting with ▲ or ▼:

1200 low speed
2400
4800
9600 high speed

– Acknowledge with CAL ON.

You remain in the **SPEC** menu.

Selecting the report language

You can select the language in which your report is printed or transferred to a PC.

Operation:

– Press MODE until **SPEC** is displayed.

– Press ▲ or ▼ until LAnG is displayed.

– Press CAL ON.

The previous setting is displayed.

– Select the required language with ▲ or ▼:

EnG	English
dEU	German
JAPn	Japanese
rUSS	Russian
ItAL	Italian
ESP	Spanish
FrA	French

– Acknowledge with CAL ON.

You remain in the **SPEC** menu.

Note:

For a report printout in Japanese and Russian, the printers used must be equipped with the corresponding character sets.

Selecting the printer driver

For printing or transfer of data, select the appropriate printer driver.
You have the following possibilities for printing data:
EPSON FX 850 with serial interface; Seiko DPU 414.
For data transfer to a PC, select the 24 column format for importing the data into the DATAMATE program or the spreadsheet format for importing the data into spreadsheet programs.

Operation:

– Press MODE until **SPEC** is displayed.

– Press ▲ or ▼ until rEP is displayed.

– Press CAL ON.

The previous format is displayed.

– Select the report format with ▲ or ▼:

EPS	Epson printer
dPU	DPU 411 printer
24-C	24 column format (DATAMATE)
SPrd	Spreadsheet program

– Acknowledge with CAL ON.

You remain in the **SPEC** menu.

Selection of file header printout

You can determine whether a file header with general data be printed or not.

Operation:

– Press MODE until **SPEC** is displayed.

– Press ▲ or ▼ until HEAd is displayed.

– Press CAL ON.

The active setting is displayed.

– Select the required setting with ▲ or ▼:

On	Printout of file header
OFF	No printout of file header

– Acknowledge with CAL ON.

You remain in the **SPEC** menu.

Selection of statistics printout

You can select whether the report printout contains statistical data or not.

Operation:

– Press MODE until **SPEC** is displayed.

– Press ▲ or ▼ until StAt is displayed.

– Press CAL ON.

The active setting is displayed.

– Select the required setting with ▲ or ▼:

On	Printout of statistical data
OFF	No printout of statistical data

– Acknowledge with CAL ON.

You remain in the **SPEC** menu.

Printing the measurement report

You can print individual files or the complete memory containing all files. Even an individual measurement reading can be printed.

The report printouts can be made with or without file header as well as statistical data, depending on the setting in the **SPEC** menu.

Operation:

You are in the **THK** or **DIF** mode.

Printing all files

– Press FILE.

– Press ▲ or ▼ until F.ALL is displayed.

– Press SEND.

5.ALL appears on the display.

All files in the Data Logger are printed. Any empty files or empty memory locations are not printed.

Printing individual files

– Print FILE.

– Press ▲ or ▼ until the required file is displayed, e.g. F.005.

– Press SEND.

5.005 appears on the display.

The selected file is printed. Empty memory locations are not printed.

After printing the stored data press f in order to return to the measurement mode. All printed measurement data remain in the DM4 DL memory.

Printing individual measurement readings

If a printer is connected you are able to directly print a displayed measurement reading by simply pressing SEND.

Aborting the print sequence

You can abort printing.

– Press SEND.

Ab Or (abort) appears on the DM4 DL display. Printing is aborted.

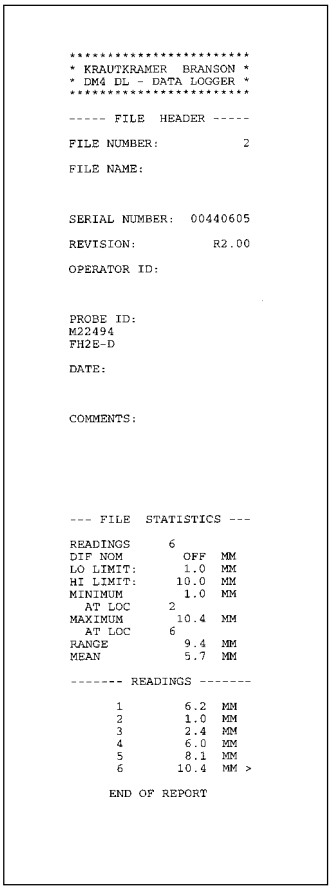
Printing the measurement report

Attention:

The Data Logger only stores measurement readings and not instrument settings.

Please note that header data and statistic information contained in the report pntout relate to the DM4's current instrument settings and not those stored.

Please note as well, that the information in the file header under *PROBE* and *PROBE ID* relating to dialog probes is only printed when the same probe, as used with measurement value recording, is connected during the printout. If the probe is changed during measurement value recording within a file, then the probe is changed then the fields already mentioned remain empty as well.



```
************************
* KRAUTKRAMER  BRANSON *
* DM4 DL - DATA LOGGER *
************************

----- FILE  HEADER -----

FILE NUMBER:            2

FILE NAME:


SERIAL NUMBER:  00440605

REVISION:           R2.00

OPERATOR ID:


PROBE ID:
M22494
FH2E-D

DATE:


COMMENTS:




--- FILE  STATISTICS ---

READINGS      6
DIF NOM         OFF  MM
LO LIMIT:       1.0  MM
HI LIMIT:      10.0  MM
MINIMUM         1.0  MM
  AT LOC        2
MAXIMUM        10.4  MM
  AT LOC        6
RANGE           9.4  MM
MEAN            5.7  MM

------- READINGS -------

       1        6.2  MM
       2        1.0  MM
       3        2.4  MM
       4        6.0  MM
       5        8.1  MM
       6       10.4  MM >

     END OF REPORT
```

Example for measurement report

7.2 Transferring data to a PC

You can transfer the stored measurement readings to a PC.

The data is transferred in ASCII format. For data transfer you will need a normal terminal program, such as contained in Microsoft Windows. The data can then be processed in word processing, database and spreadsheet programs.

☞ Note:

User-friendly data transfer possibilities as well as statistic and analysis functions are offered by special user-programs from Krautkrämer (e.g. **GUS** and **MINIMAX**). Further information can be obtained from Krautkrämer or from your local Krautkrämer representative.

Connnecting a PC

The DM4 DL is switched off.

– Connect the DM4 DL to the PC using the Krautkrämer transfer cable TGDL/PC.

– If necessary check the interface settings (refer to Page 7-2).

Transferring data

Data transfer is made parallel to printer transfer. On your screen you receive the same report format as given for the printer. The adjustment possibilities are also the same (language, file header, statistic).

Operation:

The DM4 DL is either in **THK** or **DIF** mode.

– Press FILE.

– Select the required measurement set with ▲ or ▼.

Note:

If you wish to transfer all measurement sets at once, select F.ALL .

– Press SEND.

The selected data are transferred to the PC.

– Press FILE.

You arrive back into the DM4 DLs active operation mode.

Note:

Empty memory locations and empty measurement sets are not transferred.

The data is now available as ASCII files on your PC and can be further processed.

Transferring individual measurement values

When a PC is connected you are able to directly transfer a displayed measurement value by pressing SEND.

Transferring data for the spreadsheet program

You can transfer the data in a format which is able to be directly imported into a spreadsheet program, e.g. LOTUS or Microsoft EXCEL.

Note:

Refer to the manual for the spreadsheet program regarding information about importing data.

– Select the format SPrd in the function rEP (refer to Page 7-4).

– Then proceed as normal with data transfer.

Note:

The file header is always transferred with this format; the transfer of the statistics can be selected as normal.

Aborting transfer

You can abort the transfer sequence.

– Wait until the information in the file and the statistic is transferred.

– Press SEND.

Ab Or (abort) appears on the DM4 DL display.
Transfer is aborted.

Care and maintenance 8

8.1 Care

Care of the instrument

Clean the instrument and accessories with a damp cloth. Use water or a mild household cleaner.

Attention:

Never use solvents!
The plastic parts could be damaged or become brittle.

Handling AlMn batteries

Due to the fact that wrong treatment of batteries could cause damage to the instrument, please observe the following tips:

– Only use leakproof batteries!

– Remove the batteries from the instrument when not being used over a long period!

Note:

Used or defective batteries are special refuse and must be disposed of in accordance with statutory provisions!

8.2 Maintenance

Basically, DM4 instruments do not require any maintenance.

Attention:

Repair work my only be carried out by authorized Krautkrämer service personnel.

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Specifications

Principle of operation	Ultrasonic pulse echo method with T/R probes
Gain	Automatic or manual; HI, MED or LOW (adjustable)
Zero adjustment	Automatic; manual with 2-point calibration
Calibration	1-point calibration with set sound velocity, 2-point calibration, manually using the calibration block (with 2 thicknesses) from the same material and with the same sound velocity as the material to be tested
V-path correction	Automatic
Measurement range	standard operation: 0.6 mm - 500 mm / 0.025 inch - 20.0 inch (in steel), depending on the probe, material and surface DUAL MULTI operation: 2 mm - 25 mm (in steel), depending on the probe, material and surface
Display resolution	selectable for thicknesses up to 99.99 mm (9.999 inch): 0.01 mm or 0.1 mm (0.001 inch or 0.01 inch) > 100.0 mm (10 inch): 0.1 mm (0.01 inch)
Units of measure	Selectable: mm or inch
Sound velocity range	1000 - 9999 m/s (resolution 1 m/sec) / 39,000 - 393,700 inch/sec
Display	4 digit LCD with switchable backlight; digit height: 12.7 mm / 5 inch
Display frequency	> 4 Hz
Measurement frequency	25 Hz in the MIN mode; 4 Hz in the THK mode

Power supply	2 batteries (1.5 V AA)
Operating duration	Up to 200 hours with dry cell batteries (without backlight) may be reduced depending on the operating mode
Automatic cutout	After 3 minutes of non-use
Operating temperature	-10° C to +50 °C / +10 °F to +120 °C
Keypad	Dust and waterproof membrane keypad
Battery compartment	Protected against dust and water spray
Housing	Protected against shock, dust and water spray
Size	150 mm × 77 mm × 33 mm / 5.8 inch × 3.0 inch × 1.4 inch (L × W × D)
Weight	255 g / 9 oz. including batteries
Capacity of data logger	5390 measurement values, optionally divided in up to 999 files
Data interfaces	TTL: serial, asynchronous, 0/+5 V, 8 bit, 1 stop-bit, 1200, 2400, 4800 and 9600 Baud, no parity RS 232 C: bipolar logic with connection of a TGDL/PC cable

Interfaces and peripherals 10

10.1 Interface RS 232

Attention:

Only use the supplied special cable from Krautkrämer for connecting peripheral equipment (printer, PC etc.).

This cable contains a special electronic circuit in the DB25 plug for level conversion.

If you wish to connect the transfer cable to instruments with 9 pin RS 232 interfaces, use the supplied adapter.

Data format

Physical data transfer via the DM4 DL's RS 232 interface is made in the following data format:

- Baud rate, preset at the factory 9600
- Number of start bits 1
- Number of stop bits 1
- Number of data bits 8
- Parity none

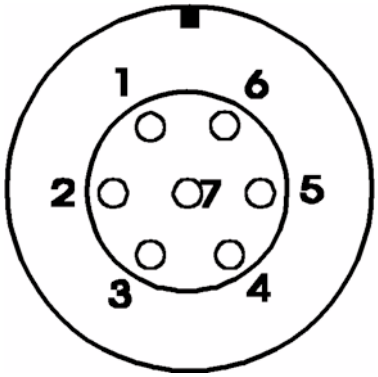
Make certain that the transfer parameters of the connected equipment correspond to these settings.

Note:

The automatic instrument cutout is deactivated during the data transfer sequence.

10.2 Pin layout of the 7 pin Lemo socket (RS 232)

Pin No.	Description	Signal direction	Level
1	ground		
2	+5 V		
3	TXD	output	TTL
4	CTS	input	TTL
5	RXD	input	TTL
6	ground		
7	external request	output	



Layout of 7 pin Lemo socket (RS 232)

Appendix 11

11.1 Application information

General information

The DM4 DL is easy to use and produces reliable and reproducible measurement data when correctly applied and when certain conditions are taken into consideration which influence the measurement accuracy. This chapter describes some of the most common factors of influence.

Foreign inclusions inside the material

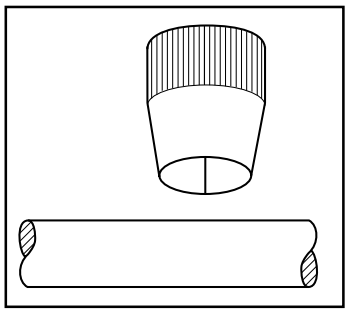
If, during a series of measurements, the DM4 DL suddenly indicates a value which is considerably smaller than the adjacent measuring point close by, then the cause could be a flaw within the material (e.g. foreign inclusion) from which the sound pulse is reflected instead of being reflected from the backwall. If this is the case, this zone should be checked by means of a universal ultrasonic instrument or another suitable NDT method in order to determine the cause of the conspicuous measured value.

Surface quality

Parallel tool marks on the coupling surface can lead to measuring errors with strong surface roughness. If the acoustic separation layer of the probe is oriented vertically toward the marks, this effect does not occur.

In some cases, wrong measured values are obtained from too rough surfaces due to excessive couplant which collects between the probe and the test surface. Very rough surfaces can completely obstruct coupling (no coupling check indication). In such cases, surface machining is required.

Curved surfaces



Couple the probe to the center of the test surface for radial beaming when measuring curved convex surfaces, e.g. tubes or cylindrical containers. The probe's acoustic separation layer must be vertical to the longitudinal axis of the test object (see figure). Probes with smaller contact face diameters generally enable better coupling to curved convex surfaces.

Thickness measurement on hot test objects

The DM4 DL can be used for thickness measurements on materials which have a surface temperature of up to 600°C when equipped with a special high-temperature probe (e.g. DA 305). A couplant especially developed for such applications, ZGM, is also required. It is recommended to proceed as follows:

Calibrate the DM4 DL as described in Chapter 5.

Clean the surface of the test object thoroughly with a wire brush and, if necessary, remove any oxidized layers.

Knead the high-temperature couplant ZGM in the tube before using. Then apply a small drop of ZGM (about 5 mm in diameter) onto the contact surface of the probe, but not to the test object.

Couple the probe carefully onto the surface of the test object. In order to avoid damages to the probe surface, do not turn the probe whilst it is in contact with the surface of the test object. With curved surfaces, it should be ensured that the acoustic separartion layer of the probe is aligned as described in Chapter 4.8 *Handling the probe*. In order to achieve good coupling, let the couplant ZGM melt for 2 or 3 seconds. With tempera-

tures above 550 °C, the couplant can suddenly ignite. However, this does not influence the coupling quality in any way.

Do not couple the probe for more than 5 seconds. If a thickness reading is not displayed within 5 seconds, remove the probe and cool it with water. Good coupling can be achieved on curved surfaces by slightly rocking the probe.

Cool the probe after thickness measurement by immersing the contact face in water for a few seconds. Do not immerse it any longer than this!

Carefully remove any remaining couplant from the probe before carrying out any further measurement.

In case of hot test objects and temperature variations, always use the DM4 in the DA3 mode (please see page 4-6) as temperature variations are compensated in this mode thanks to the continuous probe zero adjustment even in the coupled state.

There are applications which go beyond the possibilities of the DM4 DL. If high-temperature measurements turn out to be unsatisfactory after several attempts using this method, it is recommended that a high-temperature probe be used in connection with a universal ultrasonic instrument.

11.2 Sound velocity table

Typical sound velocities in different materials (longitudinal waves)

Material	m/s
Aluminium (alloyed)	6380
Aluminium (unalloyed)	6320
Aluminium oxide	9000 - 9850
Brass (CuZn30)	4700
Brass (CuZn40)	4400
Cast iron (globular)	5100 - 5700
Cast iron (laminated)	3800 - 4700
Cast iron (vermicular)	4700 - 5500
Copper	4700 - 5000
Epoxy resin	2600 - 2840
Glass (crown glass)	5800
Glass (safety glass)	6080
Glass (window glass)	5790
Gold	3240
Inconel	5700
Iron (unalloyed)	5960
Lead	2150
Magnesium	5800
Monel	5300 - 6000
Nickel (hard)	5810
Nickel (soft)	5610
Platinum	3960
Plexiglass (PMMA)	2730
Polyamide (6.6 Nylon)	2600
Polyethylene (PE hard)	2530
Polyethylene (PE soft)	2000

Material	m/s
Polypropylene (PP hard)	2600
Polypropylene(PP soft)	2000
Polystyrene (PS)	2350
Polyvinylchoride (PVC hard)	2400
Polyvinylchoride (PVC soft)	2200
Rubber (hard)	2200 - 2540
Rubber (soft)	1460 - 2200
Silicon carbide	10000 - 13000
Silicon carbide	12180
Silicon	8950
Silver	3600
Steel (austenitic)	5650 - 5850
Steel (duplex)	5750 - 5950
Steel (ferritic)	5920
Steel casting (austenitic)	5730

Material	m/s
Teflon (PTFE)	1340 - 1400
Tin	3320
Titanium	6100 - 6230
Tungsten carbide	6660
Tungsten	5200 - 5460
Uranium	3200 - 3380
Uranium carbide	4010 - 4640
Uranium dioxide	4520 - 5160
Zinc	4190
Zircaloy 4	4700
Zircon (unalloyed)	4300
Zircon oxide	7040

The real sound velocities depend on the exact composition, temperature and processing of the material and can deviate within other areas, especially metal alloys and plastics.

11.3 Configuration of the Data Logger

*** Maximum number of readings**

No. of files	No. of locations	Total readings	No. of files	No. of locations	Total readings
1	999	999	18	297	5346
2	999	1998	19	281	5339
3	999	2997	20	266	5320
4	999	3996	21	254	5334
5	999	4995	22	242	5324
6	899	**5394** *	23	231	5313
7	770	5390	24	221	5304
8	673	5384	25	212	5300
9	598	5382	26	204	5304
10	537	5370	27	196	5292
11	488	5368	28	189	5292
12	447	5364	29	182	5278
13	412	5356	30	167	5280
14	383	5362	31	170	5270
15	357	5355	32	165	5280
16	334	5344	33	160	5280
17	314	5338	34	155	5270

No. of files	No. of locations	Total readings	No. of files	No. of locations	Total readings
35	150	5250	52	100	5200
36	146	5256	53	98	5194
37	142	5254	54	96	5184
38	138	5244	55	94	5170
39	134	5226	56	92	5152
40	131	5240	57	91	5187
41	128	5248	58	89	5162
42	125	5250	59	87	5133
43	122	5246	60	86	5160
44	119	5236	61	84	5124
45	116	5220	62	83	5146
46	113	5198	63	82	5166
47	111	5217	64	80	5120
48	108	5184	65	79	5135
49	106	5194	66	78	5148
50	104	5200	67	76	5092
51	102	5202	68	75	5100

No. of files	No. of locations	Total readings
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

No. of files	No. of locations	Total readings
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

No. of files	No. of locations	Total readings
133-135	36	4860
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

No. of files	No. of locations	Total readings
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
493-451	6	3246
452-602	5	3010
603-677	4	2708
678-774	3	2322
775-903	2	
904-999	1	

11.4 EU declaration of conformity

The DM4 instruments meet the requirements of the following EU directives:

- 89/336EEC -Electromagnetic compatibility-

The conformity of the above-mentioned product with the regulations of the directive 89/336EEC is proven by the observance of the standard specifications

- EN 55011 12/1998 Class A, Group 2 and
- EN 50082-2 02/1996.

11.5 Service addresses

The DM4 instruments are manufactured according to state-of-the-art methods using high-quality components. Thorough in-process inspections and a quality management system certified to DIN ISO 9001 ensure an optimum workmanship of the instrument.

Should you nevertheless detect an error or malfunction on your product, please inform the Krautkrämer Service responsible for your products by giving the details (if possible, error number) and a description of the error or malfunction.

If there's anything specific you would like to know about the use, handling, operation and specifications of your instrument, or about our Service Agreement, please contact your local Krautkrämer representative, or one of the following direct addresses:

Krautkrämer GmbH & Co. oHG

Service-Center
Robert-Bosch-Str. 3
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or:

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Changes 12

Changes

Exisiting changes or additions are described in this chapter.

Otherwise this chapter remains empty.

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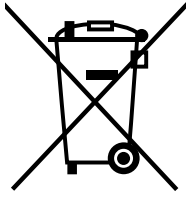
GE Inspection Technologies is an active participant in Europe's Waste Electrical and Electronic Equipment (WEEE) take-back initiative, directive 2002/96/EC.

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

Visit http://www.geinspectiontechnologies.com/en/aboutus/ehs/index.html for take-back instructions and more information about this initiative.

Environmental Compliance



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.

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