Operating Instructions

3723047

Millimar C 1208 /C 1216 / C 1240

Mahr

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Dear valued customer,

Congratulations on choosing a product by Mahr GmbH. We kindly request that you follow the instructions below in order to ensure the long-term precision of your measuring instrument.

We operate a policy of continuous improvement and are constantly developing our products, especially with regard to renaming of type designations. It is possible therefore that there may be slight differences between the text and illustrations in this document and the measuring instrument in your possession. We reserve the right to make changes to the design and scope of supply, the right to undertake further technical developments, and all rights relating to translation of this documentation.

Permitted Uses

The Millimar C 1208/C 1216/C 1240 is an electronic length measuring and evaluating instrument for use in a production environment. Permitted use is subject to compliance with all published information relating to this product. Any other use is not in accordance with the permitted use. The manufacturer accepts no liability for damages resulting from improper use. All statutory and other regulations and guidelines applicable to the area of use must be observed.

There are 3 different versions available:

C 1208/C 1216 M, T, F:
One or two inductive probes can be connected.

C 1208 PE:
a pneumatic sensor (air plug gage, air ring gage) can be connected.

C 1240 M:
One or two Mahr compatible inductive probes (including the probe type 1340, which up to now could only be used in conjunction with the evaluation unit Millimar 1240) can be connected.

The operating, maintenance and repair information specified in these operating instructions and the operating instructions for the measuring station components must be observed.

These Operating Instructions contain the following symbols:

General information.

Important information. Non-observance of this information can result in incorrect measurements or even damage to the instruments!

Disposal

Electronic devices, including accessories and used batteries (rechargeable and disposable), must not be disposed of as regular garbage, since they contain high-value materials that can be recycled and reused. European Directive 2012/19/EU (WEEE) requires that electrical and electronic devices must be collected separately to unsorted municipal waste so that they may be subsequently reprocessed. The crossed-out garbage can symbol indicates that separate collection is necessary.
Mahr GmbH carries out the redemption and disposal of its electrical and electronic products in accordance with legal requirements. Please contact your local service representative.

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Mahr GmbH is registered in Germany with the Elektro-Altgeräte-Register (EAR, 'national register for used electrical appliances') under WEEE Reg. No. DE 56624193.

Voided warranty

Service that is due to viruses that were introduced via a network connection or other data carrier, are generally excluded from the warranty services.

Storage temperatures below –10 °C or above +50 °C and relative humidity levels above 85 % will invalidate the warranty for the instrument.

Safety Instructions

This instrument complies with the relevant safety regulations. It was dispatched from our production facility in good condition and perfect working order. However, failure to follow the instructions given below can cause personal injury or death.

1. Before you connect up and use the equipment for the first time, read the accompanying documentation. Follow the safety precautions detailed in the operating instructions.
2. Keep the documentation close to the equipment ready for quick reference.
3. Follow safety precautions, accident prevention regulations and internal company instructions. You should request further information from your company safety officer.
4. Before you connect up the equipment, check the local supply voltage to make sure that it is within the working range of the AC adapter (100 V - 240 V, 50 Hz - 60 Hz). If they do not match, the instrument may not be connected under any circumstances!
5. The instrument may only be connected to a grounded power socket which complies with the regulations of the local power supply company. This also applies to any extension cables used.
6. Only use original, intact AC adapters.
7. When connecting inductive probes make sure that the plugs are firmly screwed onto the connection sockets.
8. When connecting pneumatic probes make sure that the compressed air is connected properly.
9. Do not drop the instrument and make sure it is positioned securely.
10. Do not operate the instrument in areas where there is a risk of explosion and do not expose it to direct sunlight!
11. Do not clean the membrane keypad with cleaners that contain solvents.
12. Before opening the housing, disconnect the power supply.
13. The gages with which the Millimar is used are subject to gage monitoring. For this reason, gage monitoring performed by the user or Mahr Service must ensure adherence to the specified error limits.

Confirmation of traceability

We declare under our sole responsibility that this product is in conformity with standards and technical data as specified in our sales documents (operating instructions, leaflet, catalogue).
We certify that the measuring equipment used to check this product, and guaranteed by our Quality Assurance, is traceable to national standards.
Thank you very much for your confidence in purchasing this product.

CE

EU Declaration of Conformity

This measuring instrument conforms to the applicable EU directives.

A copy of the Declaration of Conformity can be requested from the following address:
Mahr GmbH, Standort Esslingen, Reutlinger Str. 48, 73728 Esslingen, Germany, or can be downloaded from:
www.mahr.de/de/Leistungen/Fertigungsmesstechnik/Produkte

Order No.	Last Modification	Version
3723047	November 08, 2016	Valid from program version V3.86 onward

Table of Contents

0 Initial commissioning

1. Carefully unpack the Millimar, probes, and power supply unit.

Do not dispose of the original packaging. In the case of a complaint or repair, the appropriate components will need to be returned to the manufacturer in the original packaging. Damage caused during transit when components are not suitably packaged is not covered by the Mahr GmbH warranty!

2. Connect the Millimar to the power supply using the power supply unit supplied.

No other power supply unit should be used. Damage caused by using any other power supply unit is not covered by the Mahr GmbH warranty!

3. Connect the probes to the C1 and/or C2 inputs.

C 1208 PE units have only one probe input for pneumatic probes C 1208/C 1216/C 1240 M, T, F units have two probe inputs. One inductive probe can be connected to each input. If only one probe is being used, this should always be connected to the C1 input.

4. Turn on the unit using the on/off switch.
   The unit will automatically carry out a self-test. Once the self-test is completed the word "DEUTSCH" flashes".

5. Use **DATA** and **MASTER** to select the appropriate display language (Deutsch, English, Français, Español, Italiano, Português, Svensk).
   The selected setting can be changed at any time.

6. Press **START** when the desired language is displayed.
   The letters "MM" flash on the display.

7. Use **DATA** and **MASTER** to select the measuring unit (mm, µm or inch) that should be used to display measured values.
   The selected setting can be changed at any time.

8. Press **START** when the desired measuring unit is displayed.
   The standard display elements appear (analog scale, display range, current measured value, the selected measuring unit, and the probe connection formula).

9. The default connection formula for units with an inductive module is "+C1 +C2" and for units with a PE module "+C1". These settings can be changed at any time in the catalog of functions and parameters (see point 12).

10. Set the display range of the scale.
    To do this –
    - Press the **RANGE** key.
      The current display range for the selected measuring unit is displayed flashing (e.g. ± 1 mm).
    - Use the **DATA** and **MASTER** keys to set the required display range.
    - Press **START** to adopt the set display range.

11. Set the indicated value of the probe(s) to zero. To do this, press first the **MASTER** then the **START** keys.

12. Change the instrument settings as required. To do this, press the **MENU** key to open the Millimar catalog of functions and parameters. The following appears on the digital display: FEATURE
    1.
    The designation that appears in the top line (in this case "FEATURE") indicates the current function, the numerical value in the bottom line (in this case "1") indicates the internal numbering of the relevant function or setting in the catalog. The number of digits in the bottom line therefore indicates where in the catalog of functions and parameters the operator is currently located.

Navigating the catalog of functions and parameters

The red arrows on the keys indicate the direction in which the operator will move in the catalog of functions and parameters by pressing the respective keys.

Use the **DATA** and **MASTER** keys to display further functions/settings located on the same level of the catalog.

Press the **MENU** key to access the subfunctions/ settings of a function/subfunction that is currently displayed.

Press the **ESC** key to return to the higher function level.

Press **START** to accept parameter settings. This automatically returns you to the higher function level.

Changing numerical values for parameter settings

– To do this, select the appropriate parameter for the numerical value as described above and press the **MENU** key. An algebraic sign now begins to flash in front of the numerical value.
– Use the **DATA** and **MASTER** keys to set the algebraic sign ("+" or "–").
– Use **MENU** to move to the first digit of the numerical value (which then begins to flash) and set the required value using the **DATA** and **MASTER** keys.
– Use **MENU** to move to the next digit of the numerical value and set the value here too.

If a digit in the numerical value is not to be changed, simply continue to press **MENU** until the next digit that requires changing begins to flash. If a digit is unintentionally skipped, return to it by pressing **ESC** and change the digit as described above. If **ESC** is pressed when the algebraic sign is flashing, the final digit of the numerical value begins to flash.

– Set the remaining digits of the numerical value as described above.
– Once the numerical value has been set as required, press the **START** key. This terminates the process and the set numerical value flashes. The flashing values are then accepted with **START**. Accepting the value returns you to the higher function level. Pressing any of the other keys brings you back to the numerical value entry.

Further information on the keypad keys can be found in the Chapter entitled "Control elements".

1 General points

The Millimar C 1208/1216/1240 is an electronic length measuring and evaluating instrument for use in a production environment. It is available in three versions:
C 1208/C 1216 M, T, F: one or two inductive probes can be connected.
C 1208 PE: a pneumatic sensor (air plug gage, air ring gage) can be connected.
C 1240 M:
One or two Mahr compatible inductive probes (including the probe type 1340, which up to now could only be used in conjunction with the evaluation unit Millimar 1240) can be connected.
All 3 versions are suitable for dynamic and static measurement.
The current measured value is shown on the display in both analog format (as a value on a scale) and digital format (as a numerical value below the scale). If required, numerical values from two probes can also be displayed simultaneously. However, this is only possible when performing static measurements.

Resolution can be set in several stages as required. The lowest possible resolution with a C 1208 unit is 0.1 µm and 0.01 µm with a C 1216/ C 1240 unit.
As well as displaying the current measured value, it is also possible to display the aggregate of, or the difference between, measured values from two probes. The required connection formula between the two channels is indicated on the display.

Internal measured value memories also enable the acquisition of maximum, minimum and mean values over a certain period of time (measurement period). At the end of the measurement period, these values are used to calculate the features, which are then indicated on the display.
The measurement period can be set using the Millimar keypad, an external control signal or an internal timer.

Depending on the interface protocol that is selected, the RS 232 interface enables measurement results to be transferred to/queried by an external computer and instrument parameters to be queried or set by a computer. It is also possible to connect a printer.
Other instruments such as other instruments from the Millimar range, or a programmable controller can be connected to the interface for auxiliary appliances (I/O).

The Millimar C 1208/C 1216/ C 1240 offers:

- Static or dynamic measurement
- Analog results display
- Digital results display
- Easy-to-adjust functions using 8 function keys
- Fast access to popular functions by assigning up to 6 functions to the freely programmable **SELECT** key
- Convenient programming with a connected Windows-based computer using MarTalk.
- RS 232 interface for sequence control or for integration into a quality assurance system
- (C 1216/ C 1240 units only!) Parallel interface for auxiliary appliances with three optocoupler digital inputs and three optocoupler digital outputs and one analog output.
- Saving the last 400 measured values in Millimar and reading these out over the RS 232 interface.
- Customer calibration
- Connection to the inductive probe Millimar 1340 (only C 1216/C 1240 !)

2 Control elements

Fig. 1
Front of Millimar C 1208/C 1216/C 1240

1 Display
2 Keypad
3 Status lamps

Display (1)

All important measurement information is depicted on the display – measured value (analog and digital), connection formula, display range (not when 2 features are displayed simultaneously), measuring unit, indication of whether the displayed value is a maximum, minimum, aggregate or differential value, and indication (letter "T") that the measured value memory is active (if applicable).
It also displays the catalog of functions and parameters.

Keypad (2)

The keypad comprises 8 keys. Four keys are used to navigate Millimar's catalog of functions and parameters (**DATA**, **MENU**, **MASTER** and **ESC**).

MENU

Displays Millimar's catalog of functions and parameters.
In the catalog of functions and parameters itself, this key is used to switch between subfunctions and enter numerical values.
When entering numerical values, this key is used to move from one digit to the next (to the right). The selected digit flashes to show that it can be changed.

DATA

Used to navigate the catalog of functions and parameters and to begin data transfer.
Within a function level of this catalog, this key is used to scroll up in order to show further functions/settings.

When setting numerical values, this key is used to increase the value of the flashing (and therefore selected) digit by 1. If the number 9 is displayed when the **DATA** key is pressed, this will change to 0.

Press the **START** key to stop entry of numerical values. The numerical value that has been entered flashes. Press the **START** key again to adopt the numerical value.

If the **DATA** key is pressed at the end of a measurement and the interface has been set appropriately, data is transferred to a connected PC, see Chapter 14.

MASTER

In measuring mode, this key is used to start a master measurement.
In the catalog of functions and parameters, this key is used within the selected function level to scroll down in order to show further functions/settings.

When setting numerical values in the catalog of functions and parameters, this key is used to decrease the value of the flashing (and therefore selected) digit by 1. If 0 is displayed when the **MASTER** key is pressed, this will change to the number 9.

Press the **START** key to stop entry of numerical values. The numerical value that has been entered flashes. Press the **START** key again to adopt the numerical value.

ESC

This key is used in the catalog of functions and parameters to move from function sublevels to the higher level.

When entering numerical values, this key is used to move from one digit to the next (to the left). The selected digit flashes to show that it can be changed.

Pressing **ESC** when in setup mode exits this mode.

Restoring factory settings

Pressing the **ESC** key immediately after switching on the unit initializes the instrument, restoring all the original factory settings. This is indicated by "INITALL" appearing on the display.

– Hold down the **ESC** key when switching on Millimar. The unit boots up and "INITALL" is displayed. Once the boot-up process has been completed "DEUTSCH (4.3.1)" flashes.

– Use the **DATA** and **MASTER** keys to set the display language and press **START** (twice) to adopt the selected language. "MM (4.4.1)" flashes.

– Use the **DATA** and **MASTER** keys to set the measuring unit and press **START** (twice) to adopt the selected unit. "MAHR" appears on the display, followed by the standard display elements.

RANGE

Opens the selection list in which the size of the display range can be selected. The increments of the analog scale and the number format of the numerical display are changed accordingly. The following increments are available for the different measuring units:

mm	µm	inch
10	10 000	0.3
3	3 000	0.1
1	1 000	0.03
0.3	300	0.01
0.1	100	0.003
0.03	30	0.001
0.01	10	0.0003
0.003	3	0.0001
0.001*	1*	0.00003*
0.0003*	0.3*	0.00001*
I – – – – – I	I – – – – – I	I – – – – – I

"I – – – – – I" stands for "tolerance limited". This means that the display range depicts the range between the lower and upper tolerance limit. This can be used with the analog display to quickly identify where the current measured value lies in the tolerance range. This enables trends (e.g. ever larger dimensions) to be rapidly identified, enabling appropriate countermeasures to be implemented.

As tolerance ranges vary, the lettering of the analog scale (the numerical values) is removed.

The unit of measurement of the display (mm, µm or inch) cannot be changed with this key. If an alternate unit of measurement is required for the display, this has to be selected via the catalog of functions and parameters under "SETTING" --> "UNIT". The current measuring unit is indicated in the bottom line of the display.

* additional settings for C 1216 / C 1240 instruments

SELECT

This key is freely programmable. Up to six frequently used functions or subfunctions can be assigned to this key.
To assign a function to the key, simply select the required function in the catalog of functions and parameters and press the **SELECT** key. The message "SELECT x" appears, whereby the "x" stands for one of the key's six memory locations .

It is not possible to save different parameter values (e.g. the factor "0.3") or settings (e.g. the measuring unit "MM") to the **SELECT** key.

If **SELECT** is pressed in measuring mode, the function assigned to memory location 1 is displayed. Continually pressing **SELECT** scrolls through the other functions saved to the key.

Press **MENU** to make parameter settings or enter numerical values for the selected function. Settings and values are selected, changed, set, and accepted as indicated in the catalog of functions and parameters.

If all the assignments of the key are to be deleted, select "SETTING" --> "CLR-SEL (4.8)" in the catalog of functions and parameters then press the **MENU** key. Answer the Safety inquiry by pressing **START**.

Press **ESC** to exit deletion of **SELECT** key assignments. The **DATA** and **MASTER** keys have no effect here.

TEST (indication of raw values)

This function is required for moving and correctly positioning (i.e. setting up) the probe in the measuring device as the current position of the probe(s) is indicated directly i.e. without being multiplied by a factor or corrected by the master correction value.
The measured value of channel C1 is indicated on the analog scale and in the upper line of the numerical display. The measured value of C2 is indicated in the lower line of the numerical display.

On pressing either the **DATA** or **MASTER** key, the word CALIBRA. and the currently set display range are indicated. If one of the two keys is pressed again, the display range is enlarged or reduced according to the programmed increments and the scaling of the analog scale and the number format of the numerical display are changed accordingly.

Press either the **ESC** or **START** key to exit setup mode.

START

This key is used to select settings or set numerical values in the catalog of functions and parameters. The most recently selected settings and numerical values flash. Press the **START** key again to adopt the flashing settings. The display then moves to the next level up in the catalog of functions and parameters. The changed settings are used for the next measurement.

Press **START** in the first (1., …, 4.) or second (1.1, …, 4.9) function level to exit the catalog of functions and parameters.

Pressing **START** in setup mode (**TEST**) exits setup mode.

Depending on the settings selected under "PROCESS" (of measurement), pressing **START** initiates individual measurements or measuring cycles. If the appropriate settings have been selected, **START** can also be used to end measurements (see Chapter 10.2).

Status lamps (3)

These are used to indicate the positioning of the current measured value or result in relation to the tolerance limits. The colors used to indicate values that are within tolerances, that are borderline, or that breach tolerances can be selected in the catalog of functions and parameters under "FEATURE"--> "TOLERNCE"--> "COLOR".

Serial RS 232 interface (rear side of Millimar)

A printer or computer can be connected to this 9 channel interface. If necessary (e.g. if the measured value memory is full and there is a risk that the first entry will be overwritten by the most recent), data that has already been acquired can be printed out on a connected printer and then deleted.

If a computer is connected, the following processes can be executed depending on the setting of the Millimar interface

– Measured values can be transferred to, or queried from, the computer
– Parameter settings can be changed or queried by the computer
– Measurements can be initiated or terminated by the computer.

Data saved on the computer can be processed using appropriate programs (statistics programs, QA programs) – see Chapter 14 "Using the serial interface (RS 232)".

Parallel interface (rear side of Millimar)

The 25-pin interface marked with "I/O" enables data to be transferred to and from other instruments in the Millimar range (e.g. footswitches) or a programmable controller for e.g. automatic sorting processes (see Chapter 15 "Using the parallel I/O interface").

Connection for power supply unit (rear side of the Millimar)

The power supply unit is plugged into the connection marked with "9 V ⎓". This power supply unit covers a voltage range between 100 V and 240 V and a frequency range of between 47 Hz and 63 Hz.

No other power supply must be used.

On/off switch (rear side of the Millimar)

Millimar is switched on and off using the on/off switch.
Once the unit has been switched on, the software boots and the display indicates in sequence the type of instrument (C 1208 C 1216 or C 1240), the software version number, the compatibility of the probe inputs, and finally the standard display elements.

3 Performing basic settings

3.1 Selecting the display language

The information, functions and settings that appear on the Millimar display are available in the following languages :

German	English	French
Spanish	Italian	Portuguese
Swedish		

The appropriate language can be selected when commissioning the instrument (see Chapter "Initial commissioning"). However, the language selection made at this point can be changed at any time. To do this:

1. Press the **MENU** key when the standard display elements are shown. The catalog of functions and parameters is opened and the setting "FEATURE (1)" is displayed.

2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".

3. Press **MENU** again. The setting "DISPLAY (4.1)" is displayed.

4. Use the **DATA** and **MASTER** keys to select the setting "LANGUAG. (4.3)".

5. Press **MENU** again. The most recently selected language setting flashes.

6. Use the **DATA** and **MASTER** keys to select the new display language (ENGLISH, FRANC., ITAL., ESPANOL, PORTUG., SVENSKA or DEUTSCH).

7. Press **START**. The selected display language flashes.

8. Press **START** again to adopt the flashing display language. The display then returns to the catalog of functions and parameters item "LANGUAG. (4.3)".

   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the language selection list (cf. point 6). An alternative display language can be selected.

9. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
   If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

3.2 Setting the contrast

The contrast can be adjusted to the light conditions of the location. On delivery, contrast is set to medium. However, this can be changed at any time. To do this:

1. Press the **MENU** key when the standard display elements are shown. The catalog of functions and parameters is opened and the setting "FEATURE (1)" is displayed.

2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".

3. Press **MENU** again. The setting "DISPLAY (4.1)" is displayed.

4. Press **MENU** again. The setting "FEATURE (4.1.1)" is displayed.

5. Use the **DATA** and **MASTER** keys to select the setting "CONTR. (4.1.3)".

6. Press **MENU** again. Setting "CONT.+/–" and the numerical value of the current contrast setting are displayed.

7. Use the **DATA** and **MASTER** keys to select the new contrast (16, 13, ….., 1, 0).

   The highest contrast setting is "16" and the lowest "1". When "0" is selected, the display becomes blank. This setting is not recommended!

8. Press **START**. The numerical value of the contrast setting that has been selected flashes.

9. Press **START** again to adopt the flashing contrast setting. The display then returns to the catalog of functions and parameters item "CONTR. (4.1.3)".

   If at this point either the **DATA** or **MASTER** key is pressed instead of **START**, the display returns to the contrast setting selection list (cf. point 7). The contrast can be changed again.

10. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

3.3 Setting the unit of measurement

Tolerances are usually set for workpiece measurements and deviations using a specific unit of measurement. To simplify checking, it is recommended that this specific unit of measurement is also used to display measured values. Workpiece measurements and deviations can be depicted on the Millimar in the following units of measurement: millimeters, micrometers or inches.

The unit of measurement can be selected when commissioning the instrument (see Chapter "Initial commissioning"). However, the unit selected during this procedure can by changed at any point. To do this:

1. Press the **MENU** key when the standard display elements are shown. The catalog of functions and parameters is opened and the setting "FEATURE (1)" is displayed.

2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".

3. Press **MENU** again. The setting "DISPLAY (4.1)" is displayed.

4. Use the **DATA** and **MASTER** keys to select the setting "UNIT (4.4)".

5. Press **MENU** again. The current unit of measurement flashes.

6. Use the **DATA** and **MASTER** keys to select the new unit of measurement (MM, INCH or MICRON)

7. Press **START**. The selected unit of measurement flashes.

8. Press **START** again to adopt the flashing unit of measurement. The display then returns to the catalog of functions and parameters item "UNIT (4.4)".

   

   If at this point either the **DATA** or **MASTER** key is pressed instead of **START**, the display returns to the unit of measurement selection list (cf. point 6). The unit of measurement can be changed again.

9. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear. The selected measuring unit is indicated in the bottom line of the display as mm, µm or inch.
   If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

3.4 Setting the resolution/display format of the measured value

The resolution of the numerical display can be adjusted to match the type and size of the expected indicated value. To do this:

1. Press the **MENU** key when the standard display elements are shown. The catalog of functions and parameters is opened and the setting "FEATURE (1)" is displayed.

2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".

3. Press **MENU** again. The setting "DISPLAY (4.1)" is displayed.

4. Press **MENU** again. The setting "FEATURE (4.1.1)" is displayed.

5. Use the **DATA** and **MASTER** keys to select the setting "RESOL. (4.1.2)".

6. Press **MENU** again. The (schematized) number of places before and after the decimal point of the numerical display are indicated.

7. Use the **DATA** and **MASTER** keys to select the new display format. The options are:

mm	**µm**	**inch**
000.00	00000	0.0000
000.000	00000.0	0.00000
000.0000	00000.00*	0.000005
0.00000*		0.000000*

8. Press **START**. The selected display format flashes.

9. Press **START** again to adopt the flashing display format. The display then returns to the catalog of functions and parameters item "RESOL. (4.1.2)".

   If at this point either the **DATA** or **MASTER** is pressed instead of **START**, the display returns to the display format selection list (cf. point 7). The display format can be changed again.

10. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

* This format is only available for the Millimar C 1216/C 1240.

3.5 Selecting the number of features/ test results to be displayed

Up to two features can be displayed simultaneously on Millimar. However, this is only possible when static measurements are being carried out. The number of features that are to be simultaneously displayed (either 1 or 2) must be specified before measuring starts. To do this:

1. Press the **MENU** key when the standard display elements are shown. The catalog of functions and parameters is opened and the setting "FEATURE (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".
3. Press **MENU** again. The setting "DISPLAY (4.1)" is displayed.
4. Press **MENU** again. The setting "FEATURE (4.1.1)" is displayed.
5. Press **MENU** again. The setting "1 FEAT." is displayed.
6. Use the **DATA** and **MASTER** keys to select the feature display mode. The options are:

   `1 FEAT.` One feature from one static or dynamic measurement is displayed in the bottom line of the numerical display.

   `2 FEAT.` Two features from one static measurement are displayed. One is displayed in the top line of the numerical display, one in the bottom line.

   

   This, however, is only possible up to a certain point. The Millimar switches about four times per second from on probe channel to the other and digitizes the encountered measured value. Only suitable for static measurements!

   `AUTODET` From the two features of a static or dynamic measurement just one at a time is displayed in the bottom line of the numerical display. The display switches from one feature to the other when the set area limits are exceeded or fallen short of.

7. Press **START**. The selected feature display mode flashes.

8. Press the **START** key again to adopt the flashing mode. The display then returns to the catalog of functions and parameters item "FEATURE (4.1.1)".
   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the feature display mode selection list (cf. point 7). The feature display mode can be changed again.

9. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
   If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

If the "2 FEAT." or "AUTODET" mode has been selected, changes will have been applied to the standard display elements and/or the catalog of functions and parameters.

AUTODET
If this mode has been selected, the FEAT.2 function appears in the catalog of functions and parameters in addition to FEAT. 1 or FEATURE. The DET LIM function is also available under FEAT.1 (1) and FEAT.2 (2). This function enables limits to be set for automatic feature detection.

2 FEAT.
If this mode has been selected, the FEAT. 2 function appears in the catalog of functions and parameters in addition to FEAT. 1. The value of the second feature is indicated in the top line of the numerical display instead of the current display range and the value of the first feature is displayed in the bottom line.

4 Positioning the probe in the measuring device (setup)

To use a probe to take measurements across the full measuring range available, it has to be correctly positioned in the measuring instrument. If this is not the case, the measuring range can be exceeded or fallen short of.

1. Insert the probe into the measuring instrument.

2. Fit a setting master or a workpiece of known size into the measuring instrument.

3. Press the **TEST** key.
   The measured value transmitted by the probe across channel C1 is depicted on the scale and in the top line of the numerical display. If applicable, the bottom line of the numerical display depicts the measured value transmitted by the probe across C2.

4. If the Millimar display range is too small or large to allow the probe to be correctly positioned, it can be changed using the **DATA** and **MASTER** keys. To do this: Press either the **DATA** or **MASTER** key. The current display range is shown. Press one of the two keys again to resize the display range in line with the programmed increments and to change the analog scale accordingly.

5. Move the probe by hand or using a positioning device if available, so that the measured value is zero.

6. Clamp the probe in this position.

7. Press either the **ESC** or **START** key to exit setup mode.

5 Aligning probe sensitivity

Probe sensitivity is subject to variations caused during production. These variations are usually less than 0.5 %. Deviations such as this can be tolerated for many measuring tasks. In these instances, there is no need to align sensitivity. However, in the case of differential measurements (C1-C2), these deviations can distort measurement results to an unacceptable extent.

The sensitivity of the display is also subject to variations caused during production processes. If only the Millimar display is to be calibrated, a nominal value selector (e.g. the 1283 WN) can be attached to the C 1208/C 1216/C 1240 instead of the probe. However, to enable precise measurements, the entire measuring chain should be calibrated.

The C 1208/C 1216/C 1240 offers two options for correcting these deviations – firstly, the signals of both probes/channels can be multiplied with a common factor, or secondly, the sensitivity of the probe connected to C1 can be determined (calibrated) then the sensitivity of the probe connected to C2 aligned to that of the first probe.

When calibrating the sensitivity of the probe connected to C1, the probe is used to record the measured values at two measuring points that are known to be a certain distance apart. Gage blocks and setting masters of various sizes are particularly suited to this purpose and can be used to calibrate the entire measuring chain. This means that production-related deviations in sensitivity affecting both the display and probe can be measured and corrected. The setting masters and/or gage blocks should differ by at least 500 µm for a Millimar C 1216 with a measuring range of ± 2000 µm. For measurements within a range of ±200 µm, or for the Millimar C 1208 resp. C 1240, the difference should be at least 100 µm.

5.1 Calibrating a measuring channel

Three standards are required: one for the zero point, one for the positive indication value and one for the negative indication value. A nonimal value adjuster (e.g. Millimar 1283 WN) may be used instead of the standards.

1. Press the **MENU** key. The catalog item "FEATURE (1)" is displayed.
2. Press the **DATA** key. The catalog item "SETTING (4)" is displayed.
3. Press the **MENU** key again. The catalog item "DISPLAY (4.1)" is displayed.
4. Press the **DATA** key again. The entry "CALIBR (4.9)" is displayed.
5. Press the **MENU** key. The entry "PASSWRD" is displayed along with seven zeroes below it. The first zero is flashing.
6. Enter the password (1 000 000) and confirm with **START**. "CHAN 1 (4.9.1)" is displayed.
7. Press the **MENU** key. "ZERO LO" is displayed.
8. Adjust the value 0 on the nominal value adjuster and confirm with **START**. „OFFSET" will be displayed for about 2 seconds and then menu item „NEG VAL (4.9.1.1.1) together with a numerical value.
9. Use the **MENU, DATA** and **MASTER** keys to set the numerical value displayed to the negative value of the nominal value adjuster and accept it with **START**.
10. Set the nominal value adjuster to the negative calibration value and confirm with **START**. „POS VAL (4.9.1.1.1.1) is displayed.
11. Adjust the positive calibration value as detailed for the negative one (see points 9 and 10 of this description). „CHAN 1 (4.9.1) is displayed then.
12. A correction factor is calculated from the measuring values and the nominal values entered. In subsequent measurements, all of the measuring values of the probe at C1 will be multiplied by this factor.

    Correction factors may lie in a range between 0.3 and 3.0. If the calculated factor exceeds this range in either direction, the previously set factor remains in effect and the error message "OUT LIM" is displayed.

13. If no other settings are to be made in the catalog of functions and parameters, press **START**. The current measuring value or result is displayed again.

    To make further settings, use the **ESC, MASTER, DATA** and **MENU** keys to navigate to the corresponding item in the catalog of functions and parameters and make the required settings.

5.2 Aligning the sensitivity of the probe connected to C2 to that of the probe connected to C1 (instruments with inductive probes only)

If two probes are being used and if the measured values from both probes are interlinked, the sensitivity of the probe connected to C2 must be aligned to that of the probe connected to C1. However, alignment is only possible as long as the sensitivity differential does not exceed ± 1.3 %.

In addition, the probe connected to C1 must be calibrated before aligning the sensitivities of both probes (see Chapter 5.1). For aligning the sensitivities, two gage blocks of different size are necessary.

1. Fix the probe connected to C2 in a suitable mounting device, e.g. a measuring stand, and allow it to contact the smaller of the two gage blocks.
2. Press **MENU** to open the catalog of functions and parameters.
3. Use the **DATA** and **MASTER** keys to select "SETTING (4)".
4. Press **MENU** again. "DISPLAY (4.1)" is displayed.
5. Press the **DATA** key again. "CALIBR. (4.9)" is displayed.
6. Press the **MENU** key. "PASSWRD" is displayed with seven zeros below it, the first of which flashes.
7. Enter the password (1 000 000) and confirm it with **START.**
8. Press **MASTER** to display "C2 (4.9.2)".
9. Set the display to OFFS LO with **MENU**.
10. Press **START**. The displayed value changes to 0.000. In addition "ABGL LO" is output.
11. Exchange the smaller gage block for the larger one.
12. Use the **DATA** and **MASTER** keys to set the difference in size of the two gage blocks as precisely as possible.
13. Press **START**. The sensitivity of the probe connected to C2 is aligned to that of the probe connected to C1
14. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

6 Inputing settings for calculation and display of a feature

Depending on the device type, either one pneumatic or up to two inductive probes can be connected to the Millimar C 1208/C 1216/ C 1240. One or two features are calculated and displayed based on raw value(s) (see Chapter "Selecting the number of features/test results to be displayed"). A connection formula is required in order to calculate the feature (F). This formula consists of both a freely selectable factor and the raw value(s) from the probe(s).

C 1208 PE, C 1208/C 1216 M, F, T/C 1240 M

F = Factor × (± C1)

C 1208/C 1216 M, F, T, C 1240 M

F = Factor × (± C2)
F = Factor × (± C1 ± C2)

If the extent of a workpiece's deviation from a nominal dimension is to be displayed rather than its absolute value, the value of the nominal dimension must also be established.

6.1 Setting the factor for correcting the indicated value of a feature

Certain measuring tasks can require a factor other than 1 to be input for the connection formula. Such tasks include measuring the eccentricity of a rotating workpiece or indirect measurement of a workpiece by contacting via a lever that exhibits a lever ratio other than 1:1.
The (MAX-MIN) function has to be used to evaluate **eccentricity**. The differential between the largest and smallest measured values is formed. As measurement is carried out through 360°, the result for factor 1 is equal to double the eccentricity value. Inputting a value of 0.5 enables the user to directly view the actual eccentricity without having to perform further calculations based on the indicated values. Inputting a value of 0.5 halves the resultant value, thus correctly indicating eccentricity.

If indirect contact is made with the workpiece via a **lever** with a lever ratio other than 1:1, the indicated value is distorted in proportion to the lever ratio. If there is a lever ratio of 1:5 (point of contact on the workpiece – lever pivot point – contact point on the lever), the indicated value is 5 times larger than the actual deviation. A factor of (1 : 5 =) 0.2 must be input in order that the deviation can be read directly for a lever ratio of 1:5.

In addition, the algebraic sign of the indicated value can be changed by the factor's algebraic sign. **Example:**
A feature is calculated using the factor -0.5 and the formula -C1. The direct measured value (the raw value) is 1000 µm.
Feature = Factor × Formula
= -0.5 × (-(1000 µm))
= +500 µm

Setting the factor for correcting the indicated value

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Press the **MENU** key again. "FACTOR (1.1)" is displayed.
3. Press the **MENU** key for the third time. The current numerical value of the factor is displayed under "Factor" with a flashing algebraic sign.
4. Change the algebraic sign and numerical value as required (see section "Changing numerical values for parameter settings" in Chapter 0).
5. Once the algebraic sign and numerical value have been set as required, press the **START** key. This terminates the process and the set value flashes.
6. Press the **START** key again to adopt the flashing value as the current setting. The display then returns to the catalog of functions and parameters item "FACTOR (1.1)".
   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical value setting stage (cf. point 4). The indicated numerical value can be changed again.
7. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
   If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

If the factor of the connection formula has to be changed frequently, this function from the catalog of functions and parameters can be assigned to the **SELECT** key to enable rapid access.

6.2 Selecting a channel or channel connection (formula)

A connection formula is needed in order to calculate a feature. This consists of a factor that determines the size of the indicated value (cf. Chapter 6.1) and a channel connection, the "formula".

Setting the connection formula

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Press the **MENU** key again. "FACTOR (1.1)" is displayed.
3. Use the **DATA** and **MASTER** keys to select the setting "FORMULA (1.3)".
4. Press the **MENU** key. The current connection flashes.
5. Use the **MASTER** and **DATA** keys to set the connection that is to be used. The options are:
   - `+C1` Raw value from the probe at jack C1
   - `–C1` Inverted raw value from the probe at jack C1
   - `+C2` Raw value from the probe at jack C2
   - `–C2` Inverted raw value from the probe at jack C2
   - `C1 + C2` Aggregate of the raw values from the probes at jacks C1 and C2
   - `C1 – C2` Difference between the raw values. If C2 < C1, the difference is positive, if C2 > C1, it is negative
   - `C2 – C1` Difference between the raw values. If C2 > C1, the difference is positive, if C2 < C1, it is negative
   - `–C1–C2` The difference between both inverted raw values from the probes at jacks C1 and C2
6. Press **START** once the desired formula is displayed. The formula flashes.
7. Press the **START** key again to adopt the flashing formula as the current setting. The display then returns to the catalog of functions and parameters item "FORMULA (1.3)". If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the connection selection list (cf. point 5). If required, another formula can be selected in place of the one currently indicated.
8. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
   If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

If the formula has to be changed frequently, this function from the catalog of functions and parameters can be assigned to the **SELECT** key to enable rapid access.

7 Selecting a feature

One or two features can be simultaneously calculated and displayed using Millimar.
Set whether one or two features are to be displayed by going to "SETTING" -> "DISPLAY" -> "FEATURE (4.1.1)" in the catalog of functions and parameters (see Chapter "Selecting the number of features/test results to be displayed").

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" (if only one feature is being displayed) or "FEAT. 1 (1)" (if two features are being displayed) appears.
2. Press the **MENU** key again. "FACTOR (1.1)" is displayed.
3. Use the **DATA** and **MASTER** keys to select "FNCTION (1.2)".
4. Press the **MENU** key. The current feature flashes.
5. Use the **DATA** and **MASTER** keys to select the function for the feature to be calculated. The options are:

NORMAL	The current measured value calculated using the selected connection formula is continuously displayed throughout the measurement period.
MAXIMUM	The largest measured value (maximum value) is continuously displayed throughout the measurement period. The indicated value only changes when the so far maximum value is exceeded.
MINIMUM	The smallest measured value (minimum value) is continuously displayed throughout the measurement period. The indicated value only changes when a measured value falls below the so far minimum value.
MAX – MIN	The difference between the smallest measured value so far (minimum value) and the largest measured value so far (maximum value) is continuously displayed throughout the measurement period. The indicated value only changes when a measured value falls below the minimum value or exceeds the maximum value.
MAX + MIN	The aggregate of the smallest measured value so far (minimum value) and the largest measured value so far (maximum value) is continuously displayed throughout the measurement period. The indicated value only changes when a measured value falls below the minimum value or exceeds the maximum value.

MEANVAL — The mean value of all the individual measured values is continuously displayed throughout the measurement period. The mean value is calculated according to the following formula:
(Measured value 1 + Measured value 2 + ... + Measured value x) ÷ Number x of individual measured values.

6. Press **START** once the desired function (the desired feature) is displayed. The function now flashes.
7. Press **START** again to adopt the flashing setting (feature). The display then returns to the catalog of functions and parameters item "FNCTION (1.2)".
   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the feature selection list (cf. point 5 of this section). A different function (a different feature) can then be selected.
8. If only one feature is indicated on the display, press **START** to exit the catalog of functions and parameters. If, however, two features are displayed, follow the instructions in points 9 to 17 of this section.
9. Press the **ESC** key. The setting "FEAT. 1" is displayed.
10. Press the **MASTER** key. The setting "FEAT. 2" is displayed ("2 FEAT." must have been set under "SETTING --> DISPLAY --> FEATURE (4.1.1)").
11. Press the **MENU** key again. "FACTOR (2.1)" is displayed.
12. Use the **DATA** and **MASTER** keys to select "FNCTION (2.2)".
13. Press the **MENU** key. The current feature flashes.
14. Use the **DATA** and **MASTER** keys to select the feature to be calculated. The choice of settings listed in point 5 are available to choose from.
15. Press **START** once the desired function (the desired feature) is displayed. The function now flashes.
16. Press **START** again to adopt the flashing setting (feature). The display then returns to the catalog of functions and parameters item "FNCTION (2.2)".
17. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear. The selected feature's designation is displayed in front of the measuring result: MAX, MIN, MAX+MIN, MAX–MIN, M. The "M" here stands for mean value.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

If the function/feature has to be changed frequently, this function from the catalog of functions and parameters can be assigned to the **SELECT** key to enable rapid access.

8 Master measurement

Measurements that use only one probe are usually comparative measurements, in other words, deviations from a nominal value are measured and displayed. These nominal values are obtained by using measurements on gage blocks, setting plug gages, or special workpieces with known dimensions – known as master workpieces ("masters" for short). These master measurements are carried out prior to the start of the actual test measurement.

A distinction should be made between one-point and two-point master measurements.
In the case of a **one-point master measurement**, contact is made with only one master (gage block) and the indicated value compared with the nominal value noted on the master. This establishes whether the measured actual value deviates from the nominal value and, if so, to what extent. It is assumed here that the deviation established in this fashion is constant over the entire measuring range and the raw values of the subsequent workpiece measurements can then be corrected by the value thus established before measurement results are displayed. For example, if the indicated actual value is + 10 µm larger than the nominal value of the master, the raw values of all subsequent workpiece measurements are reduced by 10 µm before the measurement result is displayed. In contrast, if the master measurement returns an actual value of only 495 µm when the nominal value is 500 µm, 5 µm are automatically added to the raw value of each workpiece measurement before the measurement result is displayed.
The probe's characteristic curve therefore undergoes a parallel shift in the display range (cf. Fig. 3).

In the case of a **two-point master measurement**, contact is made with two masters (gage blocks) of different sizes, one after the other, and the indicated actual values are compared with the nominal values noted on the masters.
Initially, as in the one-point master measurement, measurement on the first (smaller) gage block is used to establish the deviation from the nominal value which is then corrected. The probe's characteristic curve again undergoes a parallel shift in the display range (see Fig. 4A). All raw values from subsequent workpiece measurements are corrected by the value thus established (i.e. reduced if the measuring chain is too sensitive, or increased if the measuring chain is too insensitive). In the first stage therefore, the probe's characteristic curve again undergoes a parallel shift in the display range.
In addition, however, a correction factor is calculated from the deviation between the two nominal values in the first measurement (on the smaller gage block) and the deviation between actual and nominal values MSTR.MAX – MSTR. MIN). This factor is then used to correct the slope of the probe's characteristic curve.

It is therefore important to decide whether a one-point or two-point master measurement is required before initiating a measuring series. The corresponding methodology then has to be set in the catalog of functions and parameters (cf. Chapter 8.1).

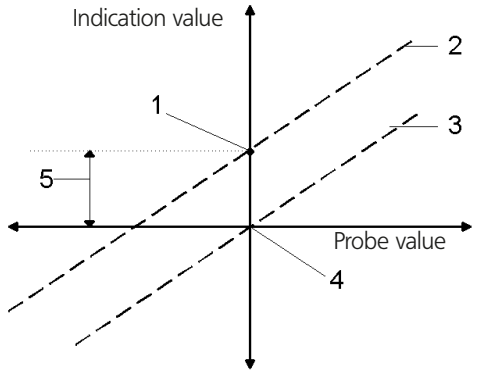

Fig. 3
Shifting the probe's characteristic curve in the display range

1 *Assessed master actual value*
2 *Computed situation of the probe's characteristic curve*
3 *Corrected situation of the probe's characteristic curve based the master measurement*
4 *Master nominal value*
5 *Deviation between the master actual and nominal values*

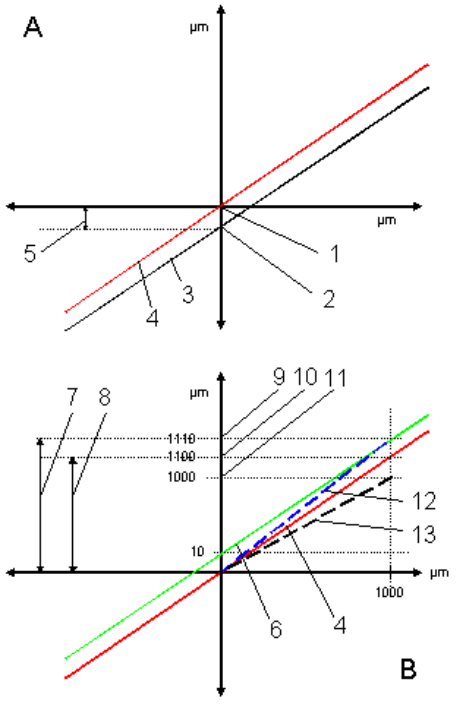

Fig. 4
Shifting the probe's characteristic curve (A) and (B) correcting its slope

1 *Nominal value of MSTR.MIN*
2 *Actual value of MSTR.MIN*
3 *Computed situation of the curve*
4 *Corrected situation of the curve after the MSTR.MIN measurement*
5 *Deviation between the nominal and actual value of the MSTR.MIN measurement*
6 *Parallel shift of the curve such that it runs through the MSTR.MAX actual value*
7 *MSTR.MAX – MSTR.MIN (absolute value)*
8 *MSTR.MAX – MSTR.MIN as a relative value (i.e. when considering the linear error)*
9 *Actual value of MSTR.MAX*
10 *Actual value of MSTR.MAX when considering the linear error*
11 *Nominal value of MSTR.MAX*
12 *Actual slope of the curve*
13 *Slope of the probe's characteristic curve required for obtaining correct values*

8.1 How to select the type of master measurement

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Repeatedly press the **MASTER** key until "PROCESS (3)" appears.
3. Press the **MENU** key again. "MEASURE (3.1)" is displayed.
4. Press the **MASTER** key. "MASTER (3.2)" is displayed.
5. Press the **MENU** key and use the **DATA** and **MASTER** keys to select either MAST 1P (3.2.1, one-point master measurement) or MAST 2P (3.2.2, two-point master measurement).

   The setting "MAST 2P" can only be selected, if the channel connection (formula) "C1" or "–C1" was set before.

6. Press **START** to terminate the measuring method selection process and press **START** again to adopt the selected method.
7. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
   If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

8.2 Entering the nominal master value for a one-point master measurement

The dimensions of master workpieces usually deviate only fractionally from the required nominal size. The actual size of the master workpiece, known as the master actual value, must be entered in the catalog of functions and parameters prior to starting master measurement.

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Press the **MENU** key again to get to the submenus.
3. Use the **DATA** and **MASTER** keys to select "MASTER " and press the **MENU** key again. "MASTER" is displayed along with a numerical value that will vary depending on the measuring unit that has been selected for the display: 0.3 mm or 300 µm or 0.011811 inch.
4. Change the indicated numerical value to match the nominal value of the master (see section "Changing numerical values for parameter settings" in Chapter 0).
5. Once the nominal value has been set as required, press the **START** key. This terminates the process and the set nominal value flashes.

6. Press the **START** key again to adopt the flashing nominal value as the current setting. The display then returns to the catalog of functions and parameters item "MASTER".
   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical input stage (cf. point 4). The indicated nominal value can be changed again if required.
7. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
   If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

8.3 Entering the nominal master value for a two-point master measurement

The dimensions of master workpieces usually deviate only fractionally from the required nominal size. The actual size of the master workpiece must be entered in the catalog of functions and parameters prior to starting master measurement.

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Press the **MENU** key again.
3. Use the **DATA** and **MASTER** keys to select "MSTR.MAX".
4. Press the **MENU** key again. "MSTR.MAX" is displayed along with a numerical value that will vary depending on the measuring unit that has been selected for the display: 0.3 mm or 300 µm or 0.011811 inch.
5. Change the indicated numerical value to match the nominal value of the larger of the two masters (see section "Changing numerical values for parameter settings" in Chapter 0).
6. Once the nominal value has been set as required, press the **START** key. This terminates the process and the set nominal value flashes.

7. Press the **START** key again to adopt the flashing nominal value of the larger master as the current setting. The display then returns to the catalog of functions and parameters item "MSTR.MAX".
   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical input stage (cf. point 4). The indicated nominal value can be changed again if required.

8. Once the nominal value of the larger master has been correctly entered and "MSTR.MAX" is displayed, press **MASTER** in the catalog of functions and parameters. MSTR.MIN" is displayed.

9. Press **MENU** again.

10. Set the nominal value for the smaller master as described in section "Changing numerical values for parameter settings" of Chapter 0.

11. Press the **START** key to adopt the flashing nominal value of the smaller master as the current setting. The display then returns to the catalog of functions and parameters item MSTR.MIN".
    If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical input stage (cf. point 10). The indicated nominal value can be changed again if required.

12. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

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8.4 Carrying out a one-point master measurement

1. If necessary, return to the standard display elements.
2. Insert the master into the measuring instrument.
3. Press the **MASTER** key. The master nominal value is displayed.
4. Press **START**. The master measurement is started.
5. Remove the master and insert the workpiece that is to be measured.
6. The deviation of the workpiece from the specified nominal value is displayed.

8.5 Carrying out a two-point master measurement

1. If necessary, return to the standard display elements.
2. Insert the smaller master into the measuring instrument.
3. Press the **MASTER** key. The master nominal value of the smaller master is displayed.
4. Press **START**. The actual value of the smaller master is displayed.
5. Remove the smaller master and insert the larger master.
6. Press **START** again. The nominal value of the larger master is displayed.
7. Press **START** again. The actual value of the larger master is displayed.
8. Remove the master and insert the workpiece that is to be measured.
9. Press **START** again. The deviation of the workpiece from the specified nominal value is displayed.

9 Setting tolerances and limit values

The relation of the measured value to warning and tolerance limits is indicated on the scale and by the status lamps. The limits can be set according to requirements, as can the color produced by the status lamps when a limit is reached.

9.1 Setting tolerance limits

Tolerance limits describe the maximum and minimum dimensions of a workpiece that will enable the item to function correctly. If these limits are breached, the workpiece must either be scrapped or reworked.
The tolerance limits to be set on Millimar should be taken from manufacturing or testing documentation. They are not freely selectable.

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Press the **MENU** key again. "FACTOR (1.1)" is displayed.
3. Use the **DATA** and **MASTER** keys to select "TOLERNCE (1.4)".
4. Press the **MENU** key. "COLOR (1.4.1)" is displayed.
5. Press the **MASTER** key. "TOLER. + (1.4.2)" is displayed.
6. Press the **MENU** key. The current value of the upper tolerance limit is displayed under "TOLER. +" with a flashing algebraic sign.
7. Change the algebraic sign and numerical value of the upper tolerance limit as required (see section "Changing numerical values for parameter settings" in Chapter 0).

   A negative value can also be set for the upper tolerance limit. However, care should be taken when setting the lower tolerance limit that the lower tolerance value is still lower than the upper tolerance value.

8. Once the algebraic sign and numerical value have been set as required, press the **START** key. This terminates the process and the set value flashes.
9. Press the **START** key again to adopt the flashing value as the current setting. The display then returns to the catalog of functions and parameters item "TOLER. + (1.4.2)".
   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical value setting stage (cf. point 7). The indicated numerical value can be changed again.

10. Press the **MASTER** key. "TOLER. – (1.4.3)" is displayed.

11. Press the **MENU** key. The current value of the lower tolerance limit is displayed under "TOLER. –" with a flashing algebraic sign.

12. Change the algebraic sign and numerical value of the lower tolerance limit as required (see section "Changing numerical values for parameter settings" in Chapter 0).

    If a negative value has been set for the upper tolerance limit, care should be taken when setting the lower tolerance limit that the lower tolerance value is still lower than the upper tolerance value!

13. Once the algebraic sign and numerical value have been set as required, press the **START** key. This terminates the process and the set value flashes.

14. Press the **START** key again to adopt the flashing value as the current setting. The display then returns to the catalog of functions and parameters item "TOLER. – (1.4.3)".
    If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical input stage (cf. point 12). The indicated numerical value can be changed again.

15. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear. The tolerance limits that have just been set are indicated below the scale as dashes.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

9.2 Setting warning limits

If tolerance limits are breached, the workpiece in question must either be reworked or, if unusable, scrapped. To avoid this and to quickly identify trends, warning limits can be set prior to the tolerance limits being reached. Although workpieces that breach these warning limits are still usable, the repeated and successive breaching of these limits indicates that the production process must be amended to prevent items produced at a later stage from breaching tolerance limits.

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Press the **MENU** key again. "FACTOR (1.1)" is displayed.
3. Use the **DATA** and **MASTER** keys to select "TOLERNCE (1.4)".
4. Press the **MENU** key. "COLOR (1.4.1)" is displayed.
5. Use the **MASTER** and **DATA** keys to select "WARN. + (1.4.4)".
6. Press the **MENU** key. The current value of the upper warning limit is displayed under "WARN. +" with a flashing algebraic sign.
7. Change the algebraic sign and numerical value of the upper warning limit as required (see section "Changing numerical values for parameter settings" in Chapter 0).
8. Once the algebraic sign and numerical value have been set as required, press the **START** key. This terminates the process and the set value flashes.
9. Press the **START** key again to adopt the flashing value as the current setting. The display then returns to the catalog of functions and parameters item "WARN. + (1.4.4)".
   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical input stage (cf. point 7). The indicated numerical value can be changed again.
10. Press the **MASTER** key. "WARN. – (1.4.5)" is displayed.
11. Press the **MENU** key. The current value of the lower warning limit is displayed under "WARN. –" with a flashing algebraic sign.

12. Change the algebraic sign and numerical value of the lower warning limit as required (see section "Changing numerical values for parameter settings" in Chapter 0).

13. Once the algebraic sign and numerical value have been set as required, press the **START** key. This terminates the process and the set value flashes.

14. Press the **START** key again to adopt the flashing value as the current setting. The display then returns to the catalog of functions and parameters item "WARN. – (1.4.5)".
    If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical value setting stage (cf. point 11). The indicated numerical value can be changed again.

15. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

In contrast to the tolerance limits, the warning limits are not entered on the scale. The warning limits are monitored using the status lamps. The colors of the status lamps change when the entered numerical values are reached.

9.3 Setting the color of the status lamps for warning and tolerance limits

The relation of a measured value to the tolerance limits is indicated on the scale by the position of the flashing indicator in relation to tolerance markings (lines underneath the scale) and by the color of the status lamps.
The relation of the measured value to the warning limits is indicated solely by the color of the status lamps.
The user can specify the color of the status lamps when limit values are complied with, when warning limits are breached and when tolerance limits are breached:

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Press the **MENU** key again. "FACTOR (1.1)" is displayed.
3. Use the **DATA** and **MASTER** keys to select "TOLERNCE (1.4)".
4. Press the **MENU** key. "COLOR (1.4.1)" is displayed.
5. Press the **MENU** key again. "TOLER.+ (1.4.1.1)" is displayed.
6. Press the **MENU** key again. ">T RED+ (1.4.1.1.1)" flashes.
7. If required, press **MASTER** to select the setting ">T YELLW + (1.4.1.1.2)".
8. Press **START** to adopt the selected setting. "TOLER.+ (1.4.1.1)" is displayed again.
9. Press the **MASTER** key. "TOLER. – (1.4.1.2)" is displayed.
10. Select the color (<T RED or <T YELLW) the status lamps should adopt when a value falls below the lower tolerance limit and adopt the selection by pressing **START**.
11. Press the **MASTER** key. "WARN. – (1.4.1.3)" is displayed.
12. Select the color (W.YELW or W.GREEN) the status lamps should adopt when a value falls below the lower warning limit or exceeds the upper warning limit and adopt the selection by pressing **START**.

    The color selected at this point applies for both upper and lower warning limits. It is not possible to have one color for the upper warning limit and a different color for the lower warning limit.

13. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear. The colors that are selected are immediately applied for the status lamps. If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

9.4 Setting plausibility limits

Plausibility limits reduce the validity range of measured values within the measuring range. On delivery, the plausibility limits are set to + 2.5 mm and – 2.5 mm. In case a probe with a measuring range of just ± 1 mm is used, it is recommended to narrow the plausibility limits to ± 1 mm, as well.

If plausibility limits are fallen short of or exceeded, "OVERFLW" appears on the display. This indicates to the operator that the measurement results are outside the measuring and palusibility range and require closer analysis.

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Press the **MENU** key again. "FACTOR (1.1)" is displayed.
3. Use the **DATA** and **MASTER** keys to select "PLAUS.".
4. Press the **MENU** key. "PLAUS. +" is displayed.
5. Press the **MENU** key again. The current plausibility value is displayed under "PLAUS. +" with a flashing algebraic sign.
6. Change the algebraic sign and numerical value of the upper plausibility limit as required (see section "Changing numerical values for parameter settings" in Chapter 0).
   A negative value can also be set for the upper plausibility limit. However, care should be taken when setting the lower plausibility limit that the lower value is still lower than the upper value.
7. Once the algebraic sign and numerical value have been set as required, press the **START** key. This terminates the process and the set value flashes.
8. Press the **START** key again to adopt the flashing value as the current setting. The display then returns to the catalog of functions and parameters item "PLAUS. +".
   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical input stage (cf. point 6). The indicated numerical value can be changed again.
9. Press the **MASTER** key. "PLAUS. +" is displayed.
10. Press the **MENU** key. The current value of the lower plausibility limit is displayed under "PLAUS. –" with a flashing algebraic sign.
11. Change the algebraic sign and numerical value of the lower plausibility limit as required (see section "Changing numerical values for parameter settings" in Chapter 0).

If a negative value has been set for the upper plausibility limit, care should be taken when setting the lower plausibility limit that the lower value is still lower than the upper value.!

12. Once the algebraic sign and numerical value have been set as required, press the **START** key. This terminates the process and the set value flashes.

13. Press the **START** key again to adopt the flashing value as the current setting. The display then returns to the catalog of functions and parameters item "PLAUS. – (1.6.2)".

    If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical value setting stage (cf. point 11). The indicated numerical value can be changed again.

14. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.

    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

10 Setting parameters for recording measured values

10.1 Setting filter parameters

The signals from the probes can be filtered to avoid interference caused by grooves or soiling on the workpiece. The limit value of the filter can be set in defined increments, whereby the larger the limit value that is set, the lower the filter effect.
During dynamic measurement, signal filtering is dependent on both the limit value and the rotational speed of the workpiece.

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Press **DATA** to display "SETTING (4)".
3. Press the **MENU** key. "DISPLAY (4.1)" is displayed.
4. Press **MASTER** to display "FILTER(4.2)".
5. Press the **MENU** key. "SAMPL/S" appears, with the numerical value flashing underneath. The following limit values can be set for filtering :
   150, 75, 50, 38, 21, 15, 10, 5, 2, 1.
6. Use the **DATA** and **MASTER** keys to set the required limit value.
7. Press **START** once the desired limit value has been set. The selected limit value flashes.

8. Press the **START** key again to adopt the flashing limit value as the current setting. The display then returns to the catalog of functions and parameters item "FILTER (4.2)".
   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the limit value selection list (cf. point 5). An alternative limit value can be selected.

9. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
   If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

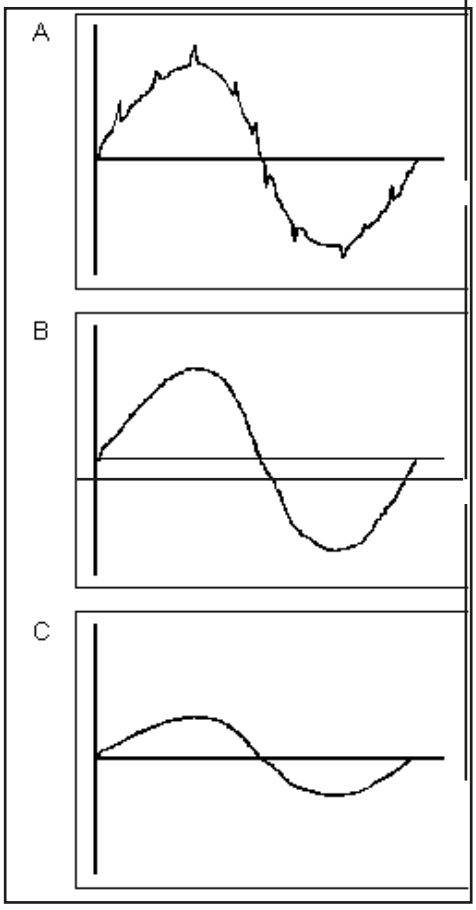


Fig. 5
Filter effect with various limit values

A High limit value
Interference (due to grooves or soiling) on the measuring result

B Low limit value
Interference is largely avoided. The measuring result is not influenced

C Too low a limit value
The measuring signal is corrupted by the erroneous setting

10.2 Specifying the measuring sequence

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "PROCESS (3)".
3. Press the **MENU** key. "MEASURE (3.1)" is displayed.
4. Press the **MENU** key. "MEAS.MOD (3.1.1)" is displayed.
5. Press the **MENU** key again. The current operating mode for workpiece measurement flashes on the display.
6. Use the **DATA** and **MASTER** keys to select the "NORMAL" or "AUTOM." operating mode.
   - NORMAL Measurement begins when **START** is pressed. On pressing **START** again, the MAX, MIN and MEAN value memories are deleted.
   - AUTOM. A measurement is started when **START** is pressed. Pressing **START** again end the measurement and displays the measuring result. In case a time other than zero was set under "TIMER (3.1.2)", measurement automatically ends after the time entered. In case a time T-PAUSE was entered under "CYCLE (3.1.3)", measurement is resumed after the time "T-PAUSE" elapsed. The sequence of measurements and breaks is ended on pressing the **START** key.
     Press the **START** key to end the sequence of single measurements and pauses. The "T" which is indicated in the bottom line of the display during measurement marks the "AUTOM." mode of operation.
7. Press **START** once the desired operating mode has been set. The selected mode now flashes.
8. Press **START** again to adopt the flashing operating mode. The display then returns to the catalog of functions and parameters item "MEAS.MOD (3.1.1)".
   If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the limit value selection list (cf. point 6). The operating mode can be changed.
9. If the operating mode "NORMAL" has been selected, skip to point 20.
   If the operating mode "AUTOM." has been selected, continue with point 10.
10. Press the **MASTER** key. "TIMER (3.1.2)" is displayed.
11. Press the **MENU** key. "T-TIMER" and the numerical value, the first digit of which flashes, appear.
12. Enter the measurement period in seconds as required (see section "Changing numerical values for parameter settings" in Chapter 0).
13. Press **START** once the measurement period has been entered. This terminates the process and the set value flashes.

14. Press **START** again to adopt the flashing measurement period. The display then returns to the catalog of functions and parameters item "TIMER (3.1.2)".
    If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical input stage (cf. point 12). An alternative measurement period can be selected.
15. Press the **MASTER** key. "CYCLE (3.1.3)" is displayed.
16. Press the **MENU** key. "T-PAUSE" and the numerical value, the first digit of which flashes, appear.
17. Enter the duration of the pause period in seconds as required (see section "Changing numerical values for parameter settings" in Chapter 0).
18. Press **START** once the pause period has been entered. This terminates the process and the set pause period flashes.
19. Press **START** again to adopt the flashing pause period. The display then returns to the catalog of functions and parameters item "CYCLE (3.1.3)".
    If at this point either the **MASTER** or **DATA** key is pressed instead of **START**, the display returns to the numerical input stage (cf. point 17). An alternative pause period can be entered.
20. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.

Once the standard display elements appear, a measurement or measuring series can be initiated by pressing **START**. If the operating mode "AUTOM." has been selected, "MEASURE" is displayed during measurement and "PAUSE" during the pause between measurements. If the measuring series is terminated by pressing **START**, "ABORT" appears briefly on the display.
Please also read the notes in the following chapters relating to the operating modes "NORMAL" and "AUTOM.".

If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

10.3 Operating mode “NORMAL“

For instructions on how to activate this mode, see Chapter 10.2.

The feature is continuously calculated based on the connection formula and the function (MAXIMUM, MINIMUM, MAX+MIN, MAX–MIN, MEANVAL or NORMAL) selected. Pressing **START** saves the calculated value. **START** is also used to initiate a new measurement and recalculate the selected feature.

If the setting “NORMAL” has been selected both under “FEATURE --> FNCTION” and “PROCESS --> MEASURE --> MEAS.MOD”, it is always the current measured value that is displayed.

If the setting “MAXIMUM” has been selected under “FEATURE --> FNCTION” and the setting “NORMAL” under “PROCESS --> MEASURE -> MEAS.MOD”, the calculated maximum value is displayed. However, the display only changes when a new maximum value has been calculated, or when the previous maximum value has been saved by pressing **START** and a new measurement initiated.

If the setting “MINIMUM” has been selected under “FEATURE --> FNCTION” and the setting “NORMAL” under “PROCESS --> MEASURE --> MEAS.MOD”, the calculated minimum value is displayed. However, the display only changes when a new minimum value has been calculated, or when the previous minimum value has been saved by pressing **START** and a new measurement initiated.

If one of the settings “MAX+MIN”, “MAX–MIN” or “MEANVAL.” has been selected under “FEATURE --> FNCTION” and the setting “NORMAL” has been selected under “PROCESS --> MEASURE --> MEAS.MOD”, the calculated aggregate, difference, or mean value is continuously updated. Pressing **START** saves the current value. A new measurement is then immediately started.

10.4 Operating mode “AUTOM.“

For instructions on how to activate this mode, see Chapter 10.2.

“MEASURE” is displayed during the set measurement period (T–TIMER) and “PAUSE” during the pause between measurements.

At the end of the measurement period, the selected feature (MAXIMUM, MINIMUM, MAX+MIN, MAX–MIN or MEANVAL) is calculated and displayed for the pause period.
If “NORMAL” has been selected under “FEATURE à FNCTION”, the previously calculated measured value is displayed at the end of the measurement period.

At the end of the pause period, the next measurement starts. The pause/measurement sequence continues until either the **START** key is pressed or the catalog of functions and parameters is opened with the **MENU** key.

10.5 Entering a start delay

If a period of delay is required between pressing the **START** key and actually initiating measurement, a period of time can be entered by which the start of measurement can be put back. A start delay is most useful when performing a dynamic measurement (e.g. of a shaft) and the measurement is to be started automatically via a switching contact in the measuring device. The startup of the shaft causes oscillation in the measuring instrument that can influence the measuring result. During the delay period, which is indicated by "WAIT", the oscillation subsides and ceases to affect the measuring result.

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "PROCESS (3)".
3. Press the **MENU** key. "MEASURE (3.1)" is displayed.
4. Press **MENU** again "MEAS.MOD (3.1.1)" is displayed.
5. Use the **DATA** and **MASTER** keys to select the setting "DELAY (3.1.4)".
6. Press the **MENU** key. "DELAY" is displayed with a numerical value underneath, the first digit of which flashes.
7. Enter the duration of the start delay period in seconds (see section "Changing numerical values for parameter settings" in Chapter 0).
8. Press **START** once the delay period has been entered. This terminates the process and the set delay period flashes.
9. Press **START** again to adopt the flashing delay period. The display then returns to the catalog of functions and parameters item "DELAY (3.1.4)".
10. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

11 Password protection

The catalog of functions and parameters can be protected by a (seven-digit) password. To activate password protection enter a password, press **START** to confirm it, and exit the catalog of functions and parameters. From this point, the password is requested each time access is sought to subfunctions of the main functions (Feature 1, Feature 2, process or Setting). The password must be entered correctly and confirmed by pressing **START** before the subfunctions can be accessed.

However, depending on the final digit of the password, certain sections of the catalog of functions and parameters can be excluded from password protection.:

Final digit of the password	Accessible main function
1	Feature 1
2	Feature 2
3	Process
4	Setting
5, 6, 7, 8, 0	none
9	Blocks the **MASTER** key on the keypad; master measurements cannot be carried out.

Activating password protection

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".
3. Press the **MENU** key. "DISPLAY (4.1)" is displayed.
4. Use the **DATA** and **MASTER** keys to select the setting "PASSWRD (4.5)".
5. Press the **MENU** key. Seven zeros are displayed under "PASSWRD", the first of which flashes.
6. Enter the password (see section "Changing numerical values for parameter settings" in Chapter 0).

   When selecting the final digit of the password, refer to the table on the left, which indicates the main functions that will not be password protected!

7. Press **START** once the password has been entered. The password is adopted.

   However, password protection is only activated on exiting the catalog of functions and parameters. As long as the catalog of functions and parameters remains open after a password has been entered, changes can still be made on all levels of the catalog.

   In case you forgot the password, restore the Mahr factory settings (cf. Chapter 16).

8. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
   If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

12 Performing measurements

When taking measurements and evaluating results, the polarity direction assignment of the probe must be considered. The polarity of the probe is assigned as follows:
"C1" or "C2" connection formula and retracting measuring bolt ⟹
The numerical value increases, the pointer on the scale moves to the right. In other words, the display moves in the direction of the probe.

The direction of the display can be changed as required

- by selecting a formula with a negative algebraic sign ("-C1" or "–C2")
- by changing the algebraic sign of the factor (-1.0 as opposed to 1.0)

However, if a formula with a negative algebraic sign is selected at the same time as a factor with a negative algebraic sign, the direction of the display is not changed, as both negative algebraic signs cancel each other out.

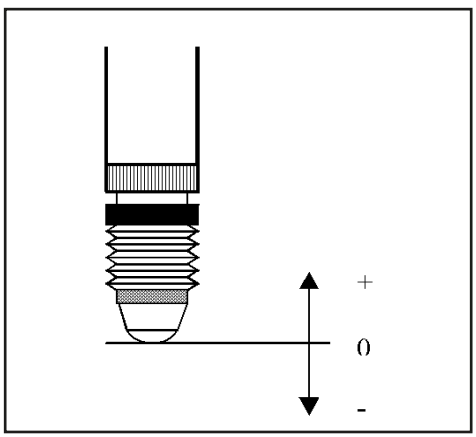
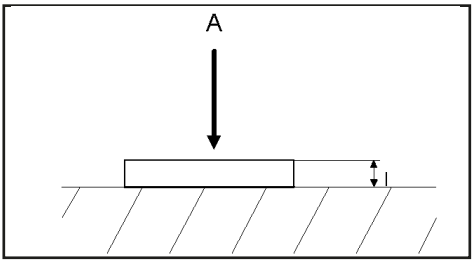


Fig. 6
Signals from the measuring probe and measuring direction assignment

12.1 Performing an aggregate measurement

The thickness of a workpiece is to be measured.



Preset values

Nominal size:	12 mm
Tolerance:	± 0.080 mm
Gage block (Master):	11.998 mm

Millimar settings

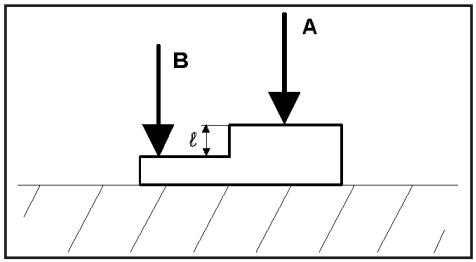
MENU –> FEATURE (1.) – ....
FNCTION (1.2.) = NORMAL (1.2.1)
FORMULA (1.3.) = + C1 (1.3.1)
TOLER.+ (1.4.2.) = +000.080
TOLER.– (1.4.3.) = –000.080
NOMINAL (1.5.) = +012.0000
MASTER (1.8.)/
(MSTR.MAX) = +011.9980

Measuring sequence

1. Adjust the settings as detailed above.
2. Insert the gage block (master) into the measuring device.
3. Press **MASTER** then **START** to calibrate the measuring device with the gage block.
4. Remove the gage block (master) and insert the workpiece into the measuring device.
5. Press **START**.
   The thickness of the workpiece is displayed.

12.2 Performing a differential measurement

The height of a step is to be measured.



Preset values

Nominal size:	16 mm
Tolerance:	+0.012/–0.008 mm
Gage block (Master):	16.002 mm

Millimar settings

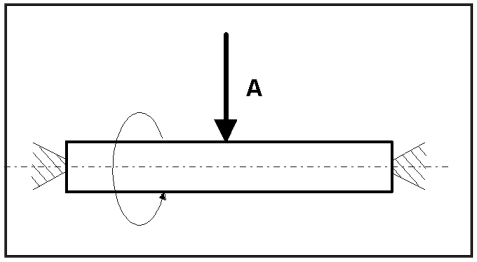
MENU –> FEATURE (1.) – ....
FNCTION (1.2.) = NORMAL (1.2.1)
FORMULA (1.3.) = C1 – C2 (1.3.6)
TOLER.+ (1.4.2.) = +000.0120
TOLER.– (1.4.3.) = –000.0080
NOMINAL (1.5.) = +016.0000
MASTER (1.8.) .)/
(MSTR.MAX) = +016.0020

Measuring sequence

1. Adjust the settings as detailed above.
2. Insert the gage block (master) into the measuring device.
3. Press **MASTER** then **START** to calibrate the measuring device with the gage block.
4. Remove the gage block (master) and insert the workpiece into the measuring device.
5. Press **START**.
   The height of the step is displayed.

12.3 Performing a radial run-out measurement

The radial run-out deviation to the centering tips of a workpiece is to be measured.
Aggregate of unroundness and centricity.



Preset values

Nominal size:	0 mm
Tolerance:	+0.016/–0.0 mm
Gage block (Master):	0.0 mm

Millimar settings

MENU –> FEATURE (1.) – ....
FNCTION (1.2.) = MAX–MIN (1.2.4)
FORMULA (1.3.) = +C1 (1.3.1)
TOLER.+ (1.4.2.) = +000.0160
TOLER.– (1.4.3.) = –000.0000
NOMINAL (1.5.) = +000.0000
MASTER (1.8.))/
(MSTR.MAX) = +000.0000
MENU –> PROCESS (3.) –> MEASURE (3.1.) –>
MEAS.MOD = AUTOM. (3.1.1.2)

Measuring sequence

1. Adjust the settings as detailed above.
2. Insert the gage block (master) into the measuring device.
3. Press the **START** key to initialize measurement. The MAX/MIN memories are wiped! The display shows zero.
4. Turn the workpiece through one rotation.
5. Press **START** again. Measurement is ended. The radial run-out deviation of the workpiece is displayed.

13 Measured value memories

The Millimar C 1208/C 1216/C 1240 has one memory for maximum value, one memory for minimum value, and one memory for mean value. The memory values are calculated over a specific measurement period from the measured values that have been taken. At the end of the measurement period, the memory data is used to precisely calculate one feature. The calculation of exactly one feature based on memory values is also known as dynamic measurement. Dynamic measurements are often performed on axis-symmetrical workpieces.

For example, when measuring a rotating shaft, various features of the workpiece can be derived from the saved values:

`MAX-MIN`	Radial run-out of the shaft
`MAX+MIN)/2`	Mean diameter deviation (can be influenced by individual outliers). Division by "2" must be accomplished by entering a foctor of "0.5" under `FEATURE -> FACTOR`!
`MEAN`	Mean diameter deviation

The catalog of functions and parameters cannot be accessed while measurements are being performed (i.e. throughout the entire measurement period). Measurement must first be ended or canceled by pressing **START**.

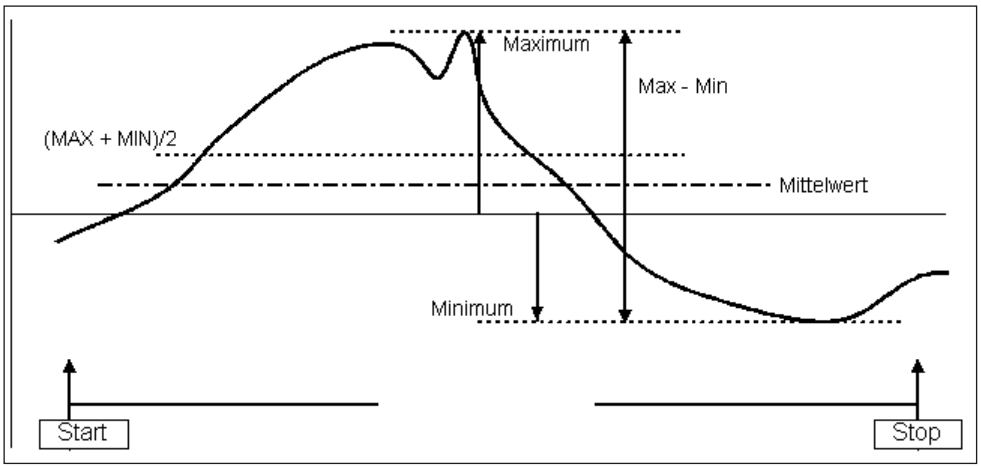


Fig. 7
Depiction of measured value memory data and calculated features

Activating the measured value memory function

Select "AUTOM (3.1.1.2)" under PROCESS --> MEASURE --> MEAS.MOD. The letter "T" appears in the footer of the display, indicating that the measured value memory function is active.

Controlling the measurement period for the measured value memory function

1. With the START key

When the **START** key is pressed for the first time, any data saved in the measured value memories is deleted and the measurement period is started. The data stored in the measured value memories is continuously updated until the **START** key is pressed again. The measurement period ends and the desired feature is calculated from the saved data and displayed.

2. By entering a specified period of time

The measurement period during which data in the measured value memory is updated is specified in seconds. The measurement period can be set under

PROCESS -> MEASURE ->TIMER (3.1.2)

between 0.1 seconds and 999.9 seconds.

Measurement is started either by pressing the **START** key or by an appropriate signal at the control input. At the end of the measurement period, measurement ceases, i.e. the data in the measured value memories is no longer updated.

3. Using a control input

The measured value storage can also be activated and deactivated using control signals. This approach is suitable when e.g. the measured value memory is to be activated and deactivated using contacts that are fitted to the measuring instrument.

14 Using the serial interface (RS 232)

In order to transfer data via the serial interface (RS 232), the interface has to be set (configured) to user requirements and the measuring task in question.

Appropriate settings must be used for the following parameters:

Interface protocol (PROTOCL)

Specify whether data is to be transferred in response to a request or automatically or whether external devices should also be able to change parameter settings.

Data transfer format (FORMAT)

Specify the number of data bits and stop bits with which values should be transferred and whether a parity check should be performed.

Data flow control (HANDSHK)

Specify how data flow control should be executed between asynchronous devices without losing data. This function specifies whether the corresponding control signals are sent via additional lines parallel to the data lines, or whether the signals (embedded in the data stream) are sent over the data lines.

Transfer rate (BAUD)

Specify the rate (in bits per second) at which data is to be transferred.

Frequency of transfer (SEND)

Specify whether data is to be transferred manually by pressing the **DATA** key or automatically at the end of the measurement or continuously.

The data transfer format, the data flow control and the transfer rate must be equal for both devices (partners)!.

14.1 Selecting the interface protocol

"Interface protocol" refers to the way in which different devices exchange data. As the Millimar C 1208/C 1216/C 1240 can be operated with a wide range of devices (printers, computers, control devices, …), there is a broad selection of interface protocols available:

`OFF` If the interface is not required because no data is to be transferred, no interface protocol should be selected.

`ASCII` The acquired measured values or data from the measured value memory are output by either pressing the Millimar **DATA** key or at the end of the measurement or continuously. This interface protocol does not allow data transfer to be initiated by a connected PC.

`OPTORSS` The acquired measured values or data from the measured value memory are output either as set under "`SEND`" or as requested by a connected PC. Here, the unit of measurement is output along with the numerical value. This type of protocoll is especially common with handheld measuring devices.

`OPTORSD` Millimar automatically sends the measured values or data settings requested by a connected PC and ceases data transfer with <CR><LF> (especially common with handheld measuring devices).

M1240 Millimar automatically sends the measured values or data settings requested by a connected PC and ceases data transfer with <CR>.

MARTALK Enables data and settings to be queried by a connected PC and Millimar configuration to be changed using the configuration program D 1000 X or D 1000 S.

As long as the connected Millimar is being configured, the D 1000 S program automatically switches the Millimar's interface protocol to MarTalk by sending a break signal to the Millimar on the reception line. As soon as the configuration is complete, the D 1000 S reinstates the interface protocol selected by the user.

When the connected PC or programmable controller is switched on or off, a break signal can be unintentionally triggered and the interface protocol "MarTalk" activated. However, if Millimar does not receive a valid MarTalk command within the following 2 seconds, the interface protocol set on Millimar by the user will be automatically reinstated.

When using a terminal emulator (e.g. Hyperterm) a break signal can be triggered by pressing the key combination **CTRL** + **PAUSE**/**BREAK**. The "DTR/DSR" line is then deactivated using the pull-down menu "CALL --> SEPARAT."

Setting the interface protocol on Millimar:

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".
3. Press the **MENU** key. "DISPLAY (4.1)" is displayed.
4. Use the **DATA** and **MASTER** keys to select the setting "COM (4.6)".
5. Press the **MENU** key. "PROTOCL (4.6.1)" is displayed.
6. Press the **MENU** key again. The interface protocol that was last selected flashes.
7. Use the **DATA** and **MASTER** keys to select the desired interface protocol (see above). The following interface options are available: OFF, ASCII, M1240, OPTORSS, OPTORSD, MARTALK.
8. Press **START** once the desired interface protocol is displayed. The setting is adopted and "PROTOCL (4.6.1)" is displayed again.
9. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
   If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

14.2 Selecting the data transfer format

The data transfer format determines the number of data bits and stop bits with which values should be transferred and whether or not a parity check should be performed.

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".
3. Press the **MENU** key. "DISPLAY (4.1)" is displayed.
4. Use the **DATA** and **MASTER** keys to select the setting "COM (4.6)".
5. Press the **MENU** key. "PROTOCL (4.6.1)" is displayed.
6. Use the **MASTER** key to select "FORMAT (4.6.2)".
7. Press the **MENU** key. The data transfer format that was last selected flashes.
8. Use the **DATA** and **MASTER** keys to select the desired data transfer format. The following data transfer formats are available:

8-N-1	8 data bits and one stop bit are transferred. No parity check takes place.
7-O-2	7 data bits and two stop bits are transferred. A parity check takes place and must produce an odd value.
7-E-2	7 data bits and two stop bits are transferred. A parity check takes place and must produce an even value.

9. Press **START** once the desired data transfer format is indicated. The setting is adopted and "FORMAT (4.6.2)" is displayed again.

10. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

14.3 Selecting the handshake

Specify whether the control signals for data flow control between asynchronous devices should be sent over additional lines parallel to the data lines (hardware handshake) or whether the signals (embedded in the data stream) should be sent over the data lines (software handshake).

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".
3. Press the **MENU** key. "DISPLAY (4.1)" is displayed.
4. Use the **DATA** and **MASTER** keys to select the setting "COM (4.6)".
5. Press the **MENU** key. "PROTOCL (4.6.1)" is displayed.
6. Use the **DATA** and **MASTER** keys to select "HANDSHK (4.6.3)".
7. Press the **MENU** key. The setting that was last selected flashes.

8. Use the **DATA** and **MASTER** keys to select the data flow control mode. The following control options are available:

   `NONE` The sending and receiving devices are synchronous (i.e. use the same transfer rate) and therefore the data flow does not need to be interrupted.

   `XON/XOF` The sending and receiving devices are asynchronous. The control signals for interrupting data transfer are embedded in the data stream (software handshake) and transferred via the data line.

   `RTS/CTS` (Request to send/Clear to send) The sending and receiving devices are asynchronous. The control signals for interrupting data transfer are transferred on separate control lines and not on the data line (hardware handshake).

9. Press **START** once the desired setting is indicated. The setting is adopted and "`HANDSHK` (4.6.3)" is displayed again.

10. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

14.4 Selecting the transfer rate

Specify the rate (in bits per second) at which data is to be transferred. The transfer rate (baud rate) of the devices must be identical.

1. Press the **MENU** key. The catalog of functions and parameters item "`FEATURE` (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "`SETTING` (4)".
3. Press the **MENU** key. "`DISPLAY` (4.1)" is displayed.
4. Use the **DATA** and **MASTER** keys to select the setting "`COM` (4.6)".
5. Press the **MENU** key. "`PROTOCL` (4.6.1)" is displayed.
6. Use the **DATA** and **MASTER** keys to select "`BAUD` (4.6.4)".
7. Press the **MENU** key. The transfer rate that was last selected flashes.
8. Use the **DATA** and **MASTER** keys to select the desired transfer rate. The following transfer rates are available: 19,200, 9,600, 4,800, 2,400, 1,200, 600, 38,400.
9. Press **START** once the desired transfer rate is displayed. The setting is adopted and "`BAUD` (4.6.4)" is displayed again.
10. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

14.5 Selecting how to initiate data transfer

Specify whether data is to be transferred either manually by pressing the **DATA** key or automatically at the end of the measurement or continuously.

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".
3. Press the **MENU** key. "DISPLAY (4.1)" is displayed.
4. Use the **DATA** and **MASTER** keys to select the setting "COM (4.6)".
5. Press the **MENU** key. "PROTOCL (4.6.1)" is displayed.
6. Use the **DATA** and **MASTER** keys to select "SEND (4.6.5)".
7. Press the **MENU** key. The setting that was last selected flashes.
8. Use the **DATA** and **MASTER** keys to select the desired setting. The following settings are available:

MANUAL	Measurement results are transferred as required by pressing the **DATA** key.
AUTOM.	Measurement results are transferred immediately following each measurement.
SCANN.	Measurement data is sent during measurement in dependency of the adjusted transfer rate at a rate of about 20 values per second.

   In order to use the AUTOM. and SCANN. settings,
   first one of the following interface protocols must be selected: ASCII, M1240, OPTORSS or OPTORSD
   and second, "AUTOM." must have been adjusted under PROCESS –> MEASURE -> MEAS.MOD.

9. Press **START** once the desired setting is indicated. The setting is adopted and "SEND (4.6.5)" is displayed again.
10. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

14.6 Examples of interface configuration

14.6.1 Interface configuration for data transfer to a printer

MSP2 printer from Mahr

The following settings are recommended when using the Mahr MSP2 printer:

PROTOCL: M1240
FORMAT: 8N1
HANDSHK: NONE
BAUD: 9600
SEND: MANUAL or AUTOM.

If the setting "MANUAL (4.6.5.1)" is selected under "SEND (4.6.5)", data is transferred by pressing the **DATA** key on Millimar or on the printer.

ASCII printer from another manufacturer

The following settings are recommended when using a printer from another manufacturer –

PROTOCL: ASCII
FORMAT: 8N1
HANDSHK: NONE
BAUD: 9600
SEND: MANUAL or AUTOM.

If the setting "MANUAL (4.6.5.1)" is selected under "SEND (4.6.5)", data is transferred by pressing the Millimar **DATA** key.

14.6.2 Interface configuration for data transfer to a computer

Data transfer to a computer usually takes place through dialog, i.e. the computer can use specific commands to request measured values or change settings on the instrument. The following interface protocols are suitable for this activity: MARTALK, M1240, OPTORSD, OPTORSS.
On principle, the ASCII interface protocol is also suitable, however using this setting means that data transfer can only be initiated from the Millimar (by pressing the **DATA** key) and not from the computer.

PROTOCL: MARTALK,M1240,OPTORSD
OPTORSS, ASCII)
FORMAT: 8N1
HANDSHK: XON/XOF
BAUD: 9600
SEND: AUTOM.

M1240 interface protocol

Data can be queried, settings changed, measurements started and stopped, the interface activated or deactivated, or a reset executed.

No data is sent when the catalog of functions and parameters is open or during master measurement.

A command can be acknowledged with <CR>. The following commands can be used:

Requesting the instrument version
PC : I<CR>
Mil :I,MAHRGMBH,C1208,Vn.nn <CR>
where Vn.nn = version number

Starting measurement with a set measurement period (T-TIMER)
PC : F1<CR>
Mil : F1<CR>

Starting measurement
PC : F2<CR>
Mil : F2<CR>

Ending measurement
PC : F3<CR>
Mil : F3<CR>

Switching to basic status (RESET)
PC : R<CR>
Mil : R<CR>

Starting master measurement
PC : Z<CR>
Mil : Z<CR>

The two-point master measurement is just started. It must be ended by pressing any key on the keyboard .

Specifying the unit
PC :P86,1<CR>, setzt Einheit auf mm
PC :P86,2<CR>, setzt Einheit auf inch
PC :P86,3<CR>, setzt Einheit auf µm

Requesting the current measured value(s)
PC : M<CR>
Mil : M1, xxx.xxx<CR>

The data format corresponds to that of the numerical measured value display.

Requesting saved measured values
PC : M70<CR>
Mil : nnnnn, -xxxx.xxx<CR>

A maximum of 400 values are saved. Delete values either by reading them out with M70 or by switching the unit off. Millimar transfers the feature number and then the measured value in the data format of the numerical measured value display.

Requesting the connection formula
PC :P50<CR>
Mil :P50,1+2<CR>, for connection formula C1+C2

Specifying the connection formula
PC :P50,1-2<CR>
Mil :P50,1-2<CR>, sets connection formula to C1-C2

	Poss. connection formulae	Syntax
i	+C1	P50,1 <CR>
	-C1	P50,-1 <CR>
	+C2	P50,2 <CR>
	-C2	P50,-2 <CR>
	C1+C2	P50,1+2 <CR>
	C1-C2	P50,1-2 <CR>
	-C1+C2	P50,2-1 <CR>
	-C1-C2	P50,-1-2 <CR>
i	When working with two features, please observe that the connection formula can only be changed for FEAT. 1 !	

Requesting the nominal size
PC :P91,Mn<CR>
Mil :P91,Mn,-xxx.xxx<CR>

Specifying the nominal size
PC :P91,Mn, xxx.xxx<CR>
Mil :P91,Mn,xxx.xxx<CR>

Requesting the master value
PC :P8,Mn<CR>
Mil :P8,Mn,-xxx.xxx<CR>

Specifying the master value
PC :P8,Mn, -xxx.xxx<CR>
Mil :P8,Mn,-xxx.xxx<CR>

Requesting the tolerance limits
PC :P21,Mn<CR>
Mil :P21,Mn,-xxx.xxx,xxx.xxx<CR>

Specifying the tolerance limits
PC :P21,Mn,-xxx.xxx,xxx.xxx<CR>
Mil :P21,Mn,-xxx.xxx,xxx.xxx<CR>

i Here, the sequence of data segments is the following:
P21 --> Mn --> LTol --> UTol

Please not that the tolerance limits are always entered with regard to the nominal size!

Activating password protection
PC :P99,2<CR>
Mil :P99,2<CR>

Deactivating password protection
PC :P99,0<CR>
Mil :P99,0<CR>

i The password (the seven digit number) itself can only be entered on the Millimar (refer to chapeter 11).
It is not possible to enter or change the password via the PC.

OPTORSD interface protocol

Various types of data can be queried and numerous settings changed –
Execution of a command will be acknowledged.
The following commands can be used:

Requesting the current measured value
PC : ?<CR>
Mil : xxx.xxx<Einheit><CR><LF>

The data format matches that of the numerical measured value display.
No data is sent when the catalog of functions and parameters is open or during master measurement.

Requesting the manufacturer and device name
PC : ID?<CR>
Mil : MAHR GMBH,C1208 <CR><LF>

Requesting the software version number
PC : VER?<CR>
Mil : n.nn_<CR><LF>

Requesting the measuring unit
PC : UNI?<CR>
Mil : mm <CR><LF>

Requesting the serial number
PC : SER?<CR>
Mil : xxxx/xx<CR><LF>

Requesting the connection
PC : CHA?<CR>
Mil : -C1-C2<CR><LF>

Setting the measuring unit to millimeters
PC : mm<CR>

Setting the measuring unit to inches
PC : in<CR>

Setting the measuring unit to microns
PC : um<CR>

Setting the connection formula
PC: CHA+1<CR> or
CHA-1<CR> or
CHA+2<CR> or
CHA-2<CR> or
CHA+1+2<CR> or
CHA+1-2<CR> or
CHA+2-1<CR> or
CHA-1-2<CR>

When working with two features, please observe that the connection formula can only be changed for FEAT. 1 !

Entering a text of 7 characters in line 1 of the Millimar C 1208
PC : DIS <Text><CR>

OPTORSS interface protocol

Only the current measured values can be queried.

Requesting the current measured value
PC : ?<CR>
Mil : xxx.xxx<Einheit><CR><LF>,

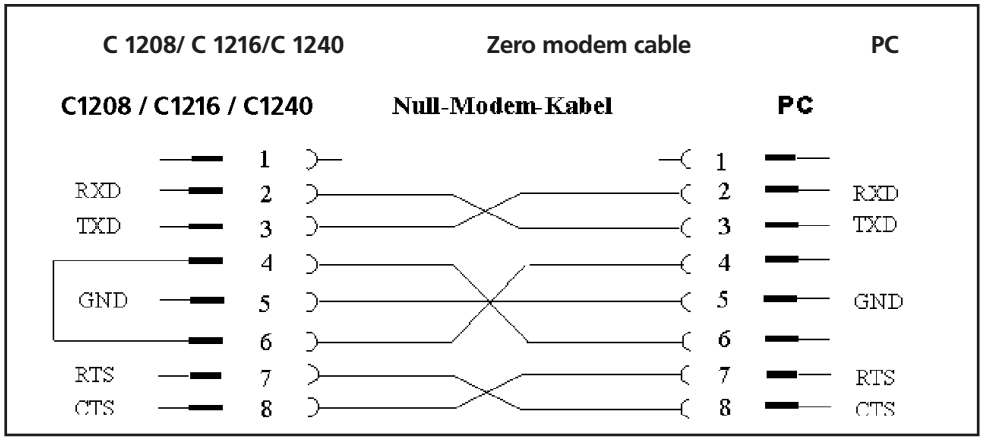
The data format matches that of the numerical measured value display.
No data is sent when the catalog of functions and parameters is open or during master measurement.

MARTALK interface protocol

This protocol type is used by the D 1000 S configuration program.

Further details can be found in the online help for the D 1000 S program.

14.7 Connecting to a PC using a zero-modem cable (circuit diagram)



15 Using the parallel (I/O) interface

A wide range of devices can be connected to the 25-pin interface – programmable controllers, displays, footswitches, recording instruments, ... Connectable devices can either control Millimar functions or be controlled by Millimar. The Millimar can also be used purely for data storage or output. Millimar has three digital control inputs, three digital control outputs, and (Millimar C 1216/C 1240 only!) one analog output to allow the instrument to be connected to such devices.

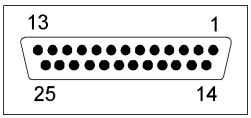
The 3 Millimar digital control outputs can be used to output signals (e.g. when tolerance limits are exceeded) to control units or external displays. The function/significance of the 3 output signals can be adapted to suit the measuring task using several modes (0, 1, 2, 3, 4, 5).

The 3 digital control inputs enable various Millimar functions to be activated. The allocation of the 3 inputs to specific functions can be adapted to suit to the measuring task using several modes (0, 1, 2, 3, 4).

If the digital control inputs and outputs are not needed, MODE 0 should be selected in each case.

Recording instruments, devices with analog/digital converters or control units with analog input can be connected via the analog output (C 1216/ C 1240 only!).

Pin assignment of the interface



Pin	Desig.	Function
1	—	do not assign
2	—	do not assign
3	—	do not assign
4	GND	Ground connection
5	IN-3	opt. input E3 (+)
6	IN-3	opt. input E3 (-)
7	V_{out}	Internal power supply +9 V, max. 100 mA
8	IN-2	opt. input E2 (+)
9	IN-2	opt. input E2 (-)
10	—	not assigned
11	IN-1	opt. input E1 (+)
12	IN-1	opt. input E1 (-)
13	Analog out	analog output*
14	AGND	anlalog ground
15	—	not assigned
16	—	not assigned
17	—	not assigned
18	—	not assigned
19	—	not assigned
20	OUT-3	opt. output A3 (+)
21	OUT-3	opt. output A3 (-)
22	OUT-2	opt. output A2 (+)
23	OUT-2	opt. output A2 (-)
24	OUT-1	opt. output A1 (+)
25	OUT-1	opt. output A1 (-)

* only C 1216/C 1240 instruments=

15.1 Digital control output

Circuit diagram of an output:

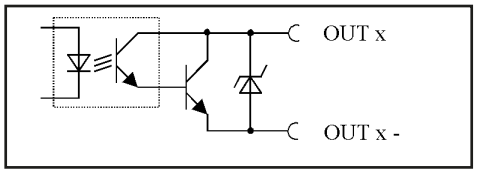


Fig. 8
Circuit diagram of an output from the parallel (I/O) interface

The preset functions (modes) can be assigned to the digital control outputs either via the Millimar or via the Windows based configuration program D1000S.

Digital control output modes:

MODE 0

No signals are sent to the outputs. Always select this setting when the digital control outputs are not to be used.

MODE 1

A1 = Signal „Measurement in progress"
A2 = Signal „Measurement complete"
A3 = Signal „Measurement OK"

MODE 2

A1 = Signal „Measurement OK"
A2 = Signal „Measurement outside warning limit"
A3 = Signal „Measurement outside tolerance"

MODE 3

A1 = Signal „OK"
A2 = Signal „Rework"
A3 = Signal „Reject"

MODE 4*

Enables the Millitron 1840/SG control unit to be connected.
A1 = Signal „OK"
A2 = Signal „Rework"
A3 = Signal „Reject"

MODE 5

A1 = Signal "Measurement OK"
A2 = Signal "Measured value < lower warning limit"
A2 = Signal "Measured value > upper warning limit"

* If MODE 4 is selected for the input signals, MODE 4 is also set for the output signals and vice-versa.

15.2 Digital control input

Circuit diagram of an input

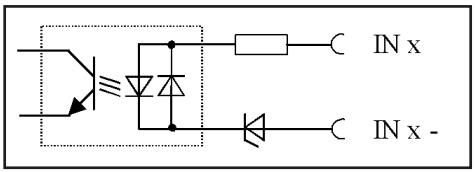


Fig. 9
Circuit diagram of an input from the parallel (I/O) interface

The functions can be assigned to the digital control inputs either via the Millimar or via the Windows based configuration program D1000S.

While it is possible to assign specific functions to a specific control input via the Millimar, only preset function packages (modes) can be assigned via the D1000S. Here, the mode assigned via the D1000S overrides the function assignmets of the Millimar.

In case the Millimar function assignment differs from the standard modes, the Millimar transmits the "Mode 5" signal while uploading data to the D1000S. This means for the D1000S „Do not override the Millimar function assignment".

The D1000S acknowlegdes this by returning "Mode 5" to the Millimar thus leaving the Millimar function assignment unchanged. If, however, the D1000S sends a different mode, the preset functions of this mode override the Millimar function assignment.

Digital control input modes:

MODE 0

Signals at the inputs are ignored.

MODE 1

E1 = Measurement period **
E2 = Start signal for master measurement **
E3 = Takeover signal for master measurement**

MODE 2

E1 = Start signal ***
E2 = Stop signal ***
E3 = Reset signal for clearing the MAX/MIN memories**

MODE 3

E1 = Measurement period **
E2 = Signal for sending measured value ***
E3 = Start and takeover signal for master measurement **

MODE 4*

Enables the connection of control unit Millimar S 1840/SG.

E1 = Measurement period **
E2 = Start signal for master measurement***
E3 = Takeover signal for master measurement ***

* If MODE 4 is selected for the input signals, MODE 4 is also set for the output signals and vice-versa.

** Status-controlled

*** Pulse-controlled

Functions which can be assigned to the digital control inputs via the Millimar:

Via the "SETTING" -> "I/O" -> "INPUT (4.7.1)" item of the catalog of functions and parameters, Millimar functions can be assigned to one of the digital inputs.

For each function select the number of the input via which the corresponding function is to be triggered. Entering the input number "0" means that this function will not be triggered via any of the inputs.

Each function can be assigned to just one of the inputs whereas each of the inputs can be assigned several functions. If several functions are assigned to one input, the functions are triggered according to an internally specified sequence.

The following are possible functions:

START	Start signal for measurement-
STOP	Stop signal for measurement-
MEASURE	Measurement period
CLRMXMN	Reset signal for deleting the Max, Min and average memories
TXVALUE	Signal for transmitting the measuring value via the RS-232 interface.
MAST EN	OK signal for the master measurement assigned to a second input.The MASTER function can either be assigned to the same input as the MAST EN function or to a different (2nd) one.
MASTER	Start signal for master measurement
M1SEL	Displays feature 1 (if "Autodetect" is on).
M2SEL	Displays feature 2 (if "Autodetect" is on).
CLRSTO	Deletes all values in the measuring value memories.
SENDSTO	Transmits all values out of the measuring value memories.

15.3 Application examples for the use of digital control inputs and outputs

Example 1: Connection to a programmable controller

When Millimar is connected to a programmable controller, the supply voltage of the programmable controller should provide the necessary current through the optocouplers in order to ensure potential separation.

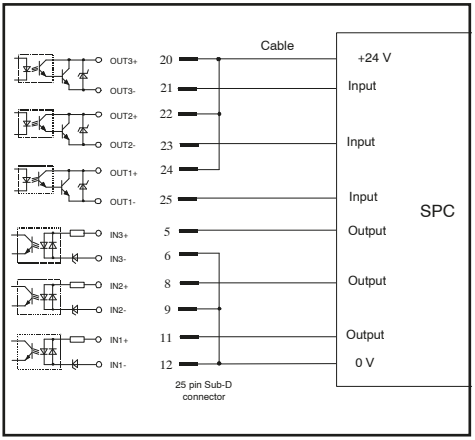


Fig. 10
Connecting a programmable controller

Example 2: Connecting to a device without its own power supply

The internal auxiliary voltage of Millimar can be used when connecting switches or lamps to it. However in such cases, galvanic isolation is only ensured when the connected device ensures this isolation.

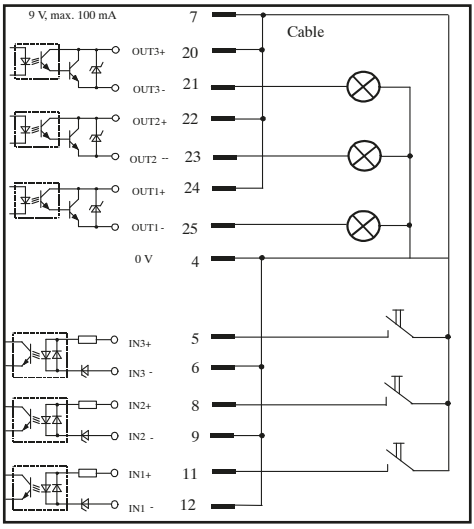


Fig. 11
Connecting lamps for classifying measurement results

15.4 Analog output (C 1216/ C 1240 only !!)

The analog output is intended for use when connecting recording instruments, devices with analog/digital converters or control units with analog input.

The analog output can be used to output the feature that appears in the analog scale and in the first line of the numerical display or the feature that is indicated in the second line of the numerical display.

The sensitivity of the analog output can be set within a broad range. However, the resolution of the analog output can never be better than the resolution of the C1216/ C1240's analog/digital converter.
Digitization of the probe signal, arithmetical signal processing, and output to the D/A converter cause a certain delay between the input signal and the output voltage at the analog output.

15.4.1 Selecting the feature to be indicated

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".
3. Press the **MENU** key. "DISPLAY (4.1)" is displayed.
4. Use the **DATA** and **MASTER** keys to select the setting „I/O (4.7)".
5. Press the **MENU** key. „INPUT. (4.7.1)" is displayed.
6. Use the **DATA** and **MASTER** keys to select the setting „U-OUTP. (4.7.3)".
7. Press the **MENU** key again. „FEATR. (4.7.3.1)" is displayed.
8. Press **MENU** again to display „DAC OFF (4.7.3.1.1)".

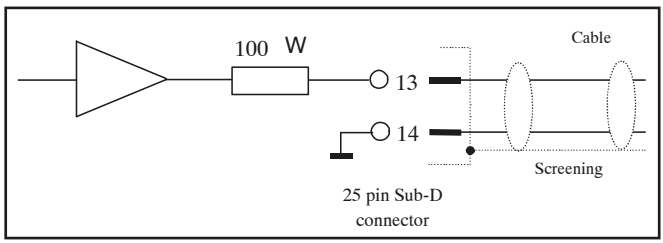


Fig. 12
Circuit diagram of the analog output of the parallel (I/O) interface

9. Use the **DATA** and **MASTER** keys to select the desired setting. The following settings are available:

   `DAC OFF` No features are output via the analog output.

   `LINE 1` The feature indicated on the top line of the numerical measured value display will be output. This, however, is only possible if two features are indicated at the same time (see Chapter 3.5)!

   `LINE 2` The feature indicated on the bottom line of the numerical measured value display will be output.

   `ANALOG` The feature indicated on the analog scale will be output. The output voltage depends on the deflection of the pointer on the scale.

10. Press **START** once the desired setting is indicated. The setting is adopted and „`FEATR.` (4.7.3.1)" is displayed again.

11. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

15.4.2 Setting the sensitivity of the analog output

1. Press the **MENU** key. The catalog of functions and parameters item "FEATURE (1)" is displayed.
2. Use the **DATA** and **MASTER** keys to select the setting "SETTING (4)".
3. Press the **MENU** key. "DISPLAY (4.1)" is displayed.
4. Use the **DATA** and **MASTER** keys to select the setting „I/O (4.7)".
5. Press the **MENU** key. „INPUT. (4.7.1)" is displayed.
6. Use the **DATA** and **MASTER** keys to select the setting „U-OUTP. (4.7.3)".
7. Press the **MENU** key again. „FEATR. (4.7.3.1)" is displayed.
8. Press **MASTER** to select the setting „S FACT.(4.7.3.2)".
9. Press the **MENU** key. "S FACT." Will be displayed together with the value+ 00001.00.
10. Enter the sensitivity of the anlaog output as required (see section "Changing numerical values for parameter settings" in Chapter 0).

The sensitivity value to be entered depends on the feature to be indicated.

DAC OFF
The entered value is of no importance here.

LINE 1, LINE 2
The sensitivity is always specified in V/m – irregardless of the adjusted unit of measurement.
The numerical value to be entered depends on the output voltage required for a certain display value.
Example for computing the numerical value: For a display value of 30 µm a voltage of 5 V is to be output: 5 V:0.03 mm = 166.667 V/mm.

ANALOG
The numerical value to be entered depends on the analog voltage to be output when the pointer is maximally deflected.
Example: A voltage of 3V is to be output when a measured value of 100 µm is indicated in a display range of 100 µm.
Sensitivity value to be entered: 3.000

11. Press **START** twice as soon as the required value was entered. The setting is adopted and „S FACT. (4.7.3.2)" displayed again.

12. If no further settings are to be made in the catalog of functions and parameters, press the **START** key. The standard display elements appear.
    If further settings are necessary, navigate to the appropriate point of the catalog of functions and parameters using the **ESC**, **MASTER**, **DATA** and **MENU** keys and carry out the settings as required.

16 Restoring the factory settings

Pressing the **ESC** key immediately after switching on the unit initializes the instrument, restoring all the original factory settings. This is indicated by "INITALL" appearing on the display during startup.

1. Hold down the **ESC** key when switching on Millimar. The unit boots up and "INITALL" is displayed. Once the boot-up process has been completed "DEUTSCH (4.3.1)" flashes.

2. Use the **DATA** and **MASTER** keys to set the display language and press **START** (twice) to adopt the selected language. MM (4.4.1) flashes.

3. Use the **DATA** and **MASTER** keys to set the measuring unit and press **START** (twice) to adopt the selected unit. "MAHR" appears on the display, followed by the standard display elements.

17 Error messages

Error	Routine	Possible causes	Remedy
OVFLOW	Measurement	The probe value exceeds the measuring or plausibility range.	Select a larger measuring or plausibility range.Correct any probe overmodulation.
OUT LIM	Calibration The calculated correction factor is outside the permissible range.	The specified gage blocks were not used or the dimensions were incorrectly entered.	
		The nominal value selector was incorrectly set.	
		The probe or nominal value selector has been connected to the incorrect input jack.	
ERR RXD	RS232 interface	There is a break signal > 700 ms at the RXD input.	Check the connection between the RS232 interface and external device (e.g. computer, printer, programmable controller).
FRM FEH		A two-point master measurement was selected even though a connection formula including both probe channels is adjusted. Two-point master measurements are only possible if the connection formula set under "FORMULA (1.3)" reads either "C1" or "-C1"!	Adjust either "C1" or "-C1" under "FORMULA (1.3)".
OVF LCD		The number of digits to be displayed exeeds the number of digits the can be indicated on the display.	
The indication does not change even though the bolt of the probe is continuously moving. The raw values indicated after pressing **TEST**, however, are OK.		Under PROCESS-> MEASURE-> MEAS.MOD (3.1.1), the measuring mode "AUTOM: (3.1.1.2)" was adjusted.	Adjust the "NORMAL (3.1.1.1)" measuring mode, as the case may be.

18 Technical data

General

Dimensions (Height x width x depth)	205 x 160 x 165 mm
Weight	2.1 kg
Power supply	9 V DC
through a wide-range power supply unit	100 V up to 240 V, 47 Hz up to 63 Hz
Power consumption	10 W
System of protection	IP54 (IP43 for conductive dust), IEC60529

Carrier frequency

C 1208 M / C 1216M / C 1240M	20 kHz
C 1208 T / C 1216T	13 kHz
C 1208 F / C 1216F	5 kHz

Magnitude of excitation voltage

C 1208 M / C 1216M / C 1240M	5 V
C 1208 T / C 1216T	3 V
C 1208 F / C 1216F	2 V

Measuring range

C 1208	4000 µm (+/- 2000 µm)
C 1216 / C 1240	4000 µm (+/- 2000 µm)
	400 µm (+/- 200 µm)

Sensitivity adjustment range

max. deviation for chan. 2 referred to chan. 1	+/- 1.2 %

Resolution (max.)

C 1208	0.1 µm
C 1216 / C 1240	0.01 µm

Cut-off frequency 60 Hz (-3dB); adjustable via „`FILTER (4.2)`"

Response time

Depends on the value adjusted for „`FILTER (4.2)`".
As a rule, the shortest possible response time is detailed:

Analog scale	100 ms
Numerical display	100 ms
Analog output	20 ms
Digital output	20 ms

Error limits

Scale division of ± 10	2.5 %
Scale division of ± 3	2 %
Numerical display	0.2 µm or 0.3 % of the indicated probe value*
Analog output	5 mV or 0.5 % of the output voltage*
Digital output	0.2 µm or 0.3 % of the indicated probe value*

* As a rule, the larger of the two values in question is valid.

Repetition limit of display 1 digit

Switch repetition limit of digital outputs 0.2 µm

Hysteresis of digital outputs 0.1 µm

Temperature coefficient 0.005 %/°C

Max. number of connectable probes 2

Analog output

Output voltage range	+/- 5V
Output resolution	+/- 2048 increments, corresponding to 2.5 mV
Sensitivity	adjustable (see Chapter 15.4.2)
Minimum load resistance	2 kOhm

Optocoupler outputs

Max. permissible switching voltage	45 V
Maximum current (ohmic load)	100 mA

Optocoupler inputs

Max. input voltage "inactive"	3 V –0-8 V
Max. input voltage „aktive"	7.5 V, -4.75 V
Max. input voltage	35 V
Typical input current	2.7 mA @10 V 7 mA @ 20 V
Delay until a function is triggered	
for 1 Feature	50 ms
2 Features	100 ms

Auxiliary voltage 9 V, max. 100 mA

Input pressure (only C1208 PE)

C 1208 PE/M	2 bar
C 1208 PE F	2.1 bar

Regulated by a fine pressure regulator. Use only pure compressed air that is free of oil!

Compatibility*	**Type of Compact Length Measuring Instrument**		
Type of Probe	C 1208	C 1216	C 1240
1301	x	x	x
1303	x	x	x
1304 K	x	x	x
1318	x	x	x
1340			x
P1300	x	x	x
P2001	x	x	x
P2004	x	x	x
P2010	x	x	x
P2104	x	x	x
Further probe types	on Request		

* *Here it is essential to observe compatibility! The measurement functionality can only then be guaranteed when a measuring probe (for example a Mahr compatible inductive probe: P 1300 MA, Order No. 4400180) is connected to the appropriate length measuring instrument (e.g. C 1208 M, Order No. 5312080).*

19 Mahr contacts

The following contacts are available to assist you:

Mahr GmbH
Standort Esslingen
Reutlinger Straße 48, 73728 Esslingen

E-Mail: mahr.es@mahr.de
Phone: (+49) 0711/9312-600
Fax: (+49) 0711/9312-725

20 Warranty

The unit supplied by us has been built and produced with care. Before being delivered, it also underwent further extensive testing.

We therefore guarantee that the unit complies with the relevant safety conditions and combines sturdy construction with problem-free functionality.
The duration and conditions of the warranty are set out in the general terms and conditions of delivery of Mahr GmbH or in the contract of sale.

Please also note the enclosed service plan with basic information on the maintenance intervals to be observed. Specific service intervals are to be kept to, depending on the range of applications. Proof of regular maintenance can be one of the conditions for accepting any claims under the warranty.

Unless any other arrangements have been made, the following conditions shall apply:
The warranty does not include natural wear and tear or faults arising from incorrect handling, inappropriate use or non-observance of these operating instructions. In particular, the manufacturer can only be held liable for the function and safety features of the unit if any intervention in the unit, other than those mentioned in these operating instructions, is carried out by either the manufacturer himself or a representative expressly appointed by him.

The extreme precision of this instrument is only guaranteed when original Mahr accessories are used.

Loss of warranty:

Storage temperatures below –10 °C or above +50 °C and relative humidity levels above 85 % will invalidate the warranty for the instrument.

21 Index

Symbols

A

B

C

D

E

F

G

H

I

K

L

M

N

O

P

R

S

T

U

V

W

X

Z

Navigating the catalog of functions and parameters

Opening the catalog

The catalog of functions and parameters is opened by pressing the **MENU** key while the standard elements of the display are indicated. In the top line of the numerical measured value display a text (e.g. "FEATR. 1" or "FEATURE") is now output instead of a numerival value. In the bottom line of the numerical display an ordinal numer is displayed (e.g. "1.").

Significance of the elements

The text in the upper line of the numerical display indicates the currently selected function or setting while the ordinal number below the text indicates the position of the indicated function/ setting within the catalog of functions and parameters.

Key functions

When the catalog of functions and parameters is open, only the keys **DATA**, **MASTER**, **MENU**, **ESC** and **START** function .
The red arrows engraved on these keys indicate the direction in which the operator will move in the catalog of functions and parameters by pressing the respective keys.

Navigating the catalog

Use the **DATA** and **MASTER** keys to display further functions/settings located on the same level of the catalog.

Press the **MENU** key to access the subfunctions/ settings of a function/subfunction that is currently displayed (i.e. you access the next lower function level).

Press the **ESC** key to return to the next higher function level.

Press **START** to accept parameter settings. This automatically returns you to the next higher function level.

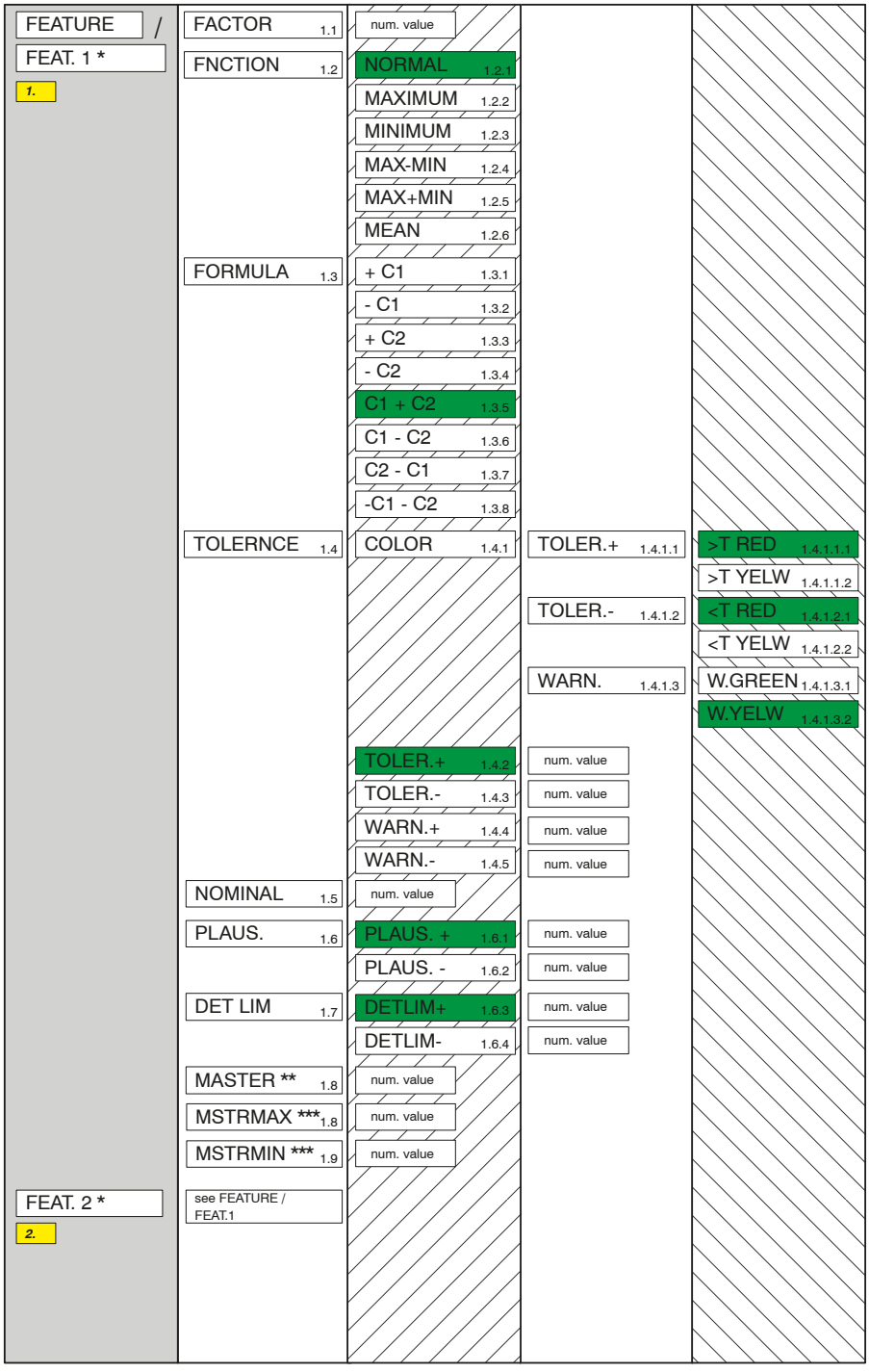
The different function levels of the catalog of functions and parameters are indicated as columns in the following flow charts.

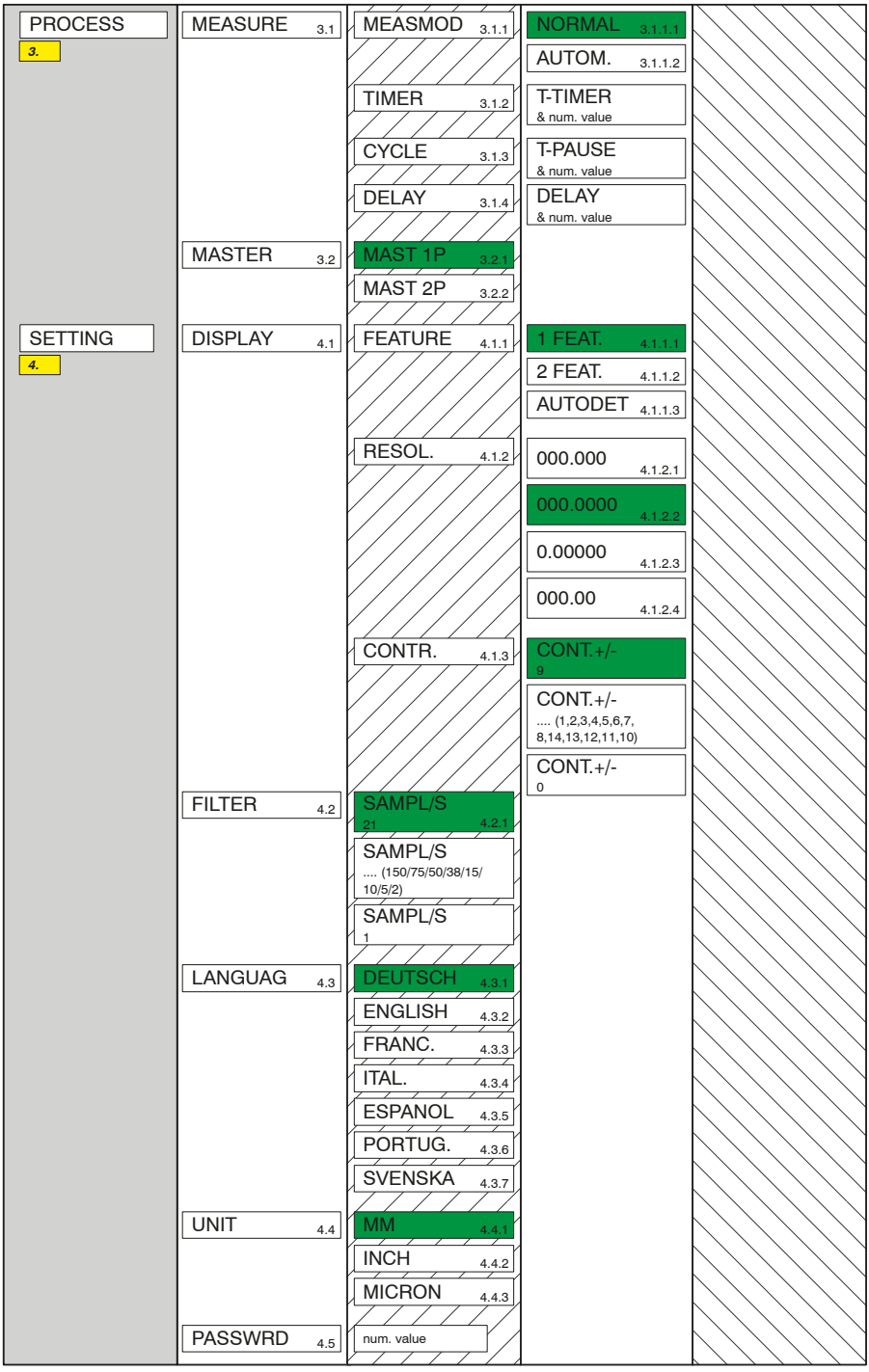
---

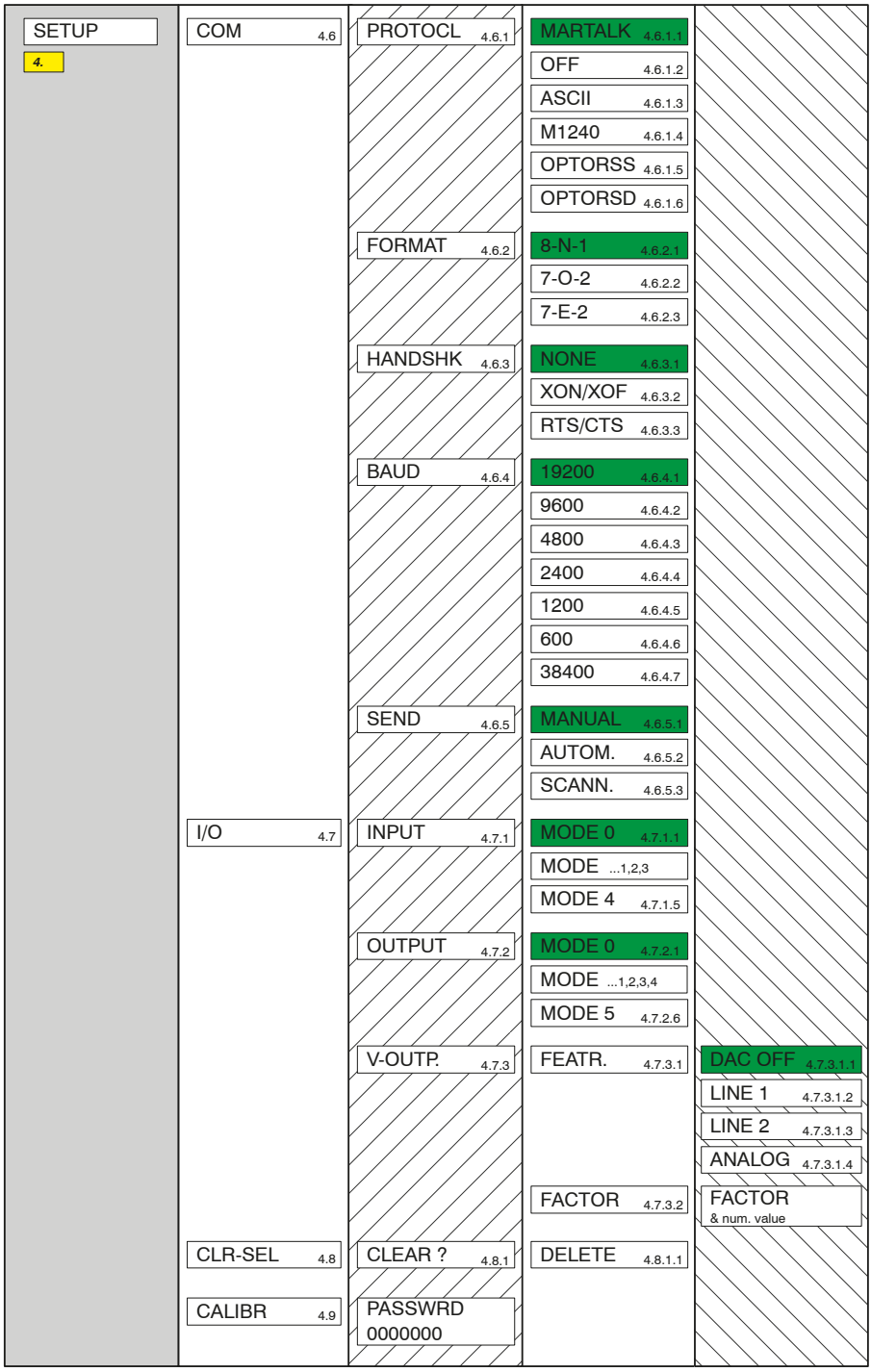
* The functions "FEATR. 2" and "FEATR. 1" (instead of "FEATURE") will only be displayed if "2 FEAT.", was selected under SETTING -> DISPLAY -> FEATURE. The functions and settings offered for FEATURE, FEAT. 1 and FEAT. 2 are identical.

** The "MASTER" function will only be displayed if the setting "MAST 1P" was selected under PROCESS -> MASTER.

*** The functions "MSTR.MAX" und "MSTR.MIN" will only be displayed if the setting "MAST 2P" was selected under PROCESS -> MASTER.


FEATURE / FEAT. 1 *
1.
FACTOR 1.1
num. value
FNCTION 1.2
NORMAL 1.2.1
MAXIMUM 1.2.2
MINIMUM 1.2.3
MAX-MIN 1.2.4
MAX+MIN 1.2.5
MEAN 1.2.6
FORMULA 1.3
+ C1 1.3.1
- C1 1.3.2
+ C2 1.3.3
- C2 1.3.4
C1 + C2 1.3.5
C1 - C2 1.3.6
C2 - C1 1.3.7
-C1 - C2 1.3.8
TOLERNCE 1.4
COLOR 1.4.1
TOLER.+ 1.4.1.1
>T RED 1.4.1.1.1
>T YELW 1.4.1.1.2
TOLER.- 1.4.1.2
<T RED 1.4.1.2.1
<T YELW 1.4.1.2.2
WARN. 1.4.1.3
W.GREEN 1.4.1.3.1
W.YELW 1.4.1.3.2
TOLER.+ 1.4.2
num. value
TOLER.- 1.4.3
num. value
WARN.+ 1.4.4
num. value
WARN.- 1.4.5
num. value
NOMINAL 1.5
num. value
PLAUS. 1.6
PLAUS. + 1.6.1
num. value
PLAUS. - 1.6.2
num. value
DET LIM 1.7
DETLIM+ 1.6.3
num. value
DETLIM- 1.6.4
num. value
MASTER ** 1.8
num. value
MSTRMAX *** 1.8
num. value
MSTRMIN *** 1.9
num. value
FEAT. 2 *
2.
see FEATURE / FEAT.1


PROCESS
3.
MEASURE 3.1
MEASMOD 3.1.1
NORMAL 3.1.1.1
AUTOM. 3.1.1.2
TIMER 3.1.2
T-TIMER & num. value
CYCLE 3.1.3
T-PAUSE & num. value
DELAY 3.1.4
DELAY & num. value
MASTER 3.2
MAST 1P 3.2.1
MAST 2P 3.2.2
SETTING
4.
DISPLAY 4.1
FEATURE 4.1.1
1 FEAT. 4.1.1.1
2 FEAT. 4.1.1.2
AUTODET 4.1.1.3
RESOL. 4.1.2
000.000 4.1.2.1
000.0000 4.1.2.2
0.00000 4.1.2.3
000.00 4.1.2.4
CONTR. 4.1.3
CONT.+/- 9
CONT.+/- .... (1,2,3,4,5,6,7, 8,14,13,12,11,10)
CONT.+/- 0
FILTER 4.2
SAMPL/S 21 4.2.1
SAMPL/S .... (150/75/50/38/15/ 10/5/2)
SAMPL/S 1
LANGUAG 4.3
DEUTSCH 4.3.1
ENGLISH 4.3.2
FRANC. 4.3.3
ITAL. 4.3.4
ESPANOL 4.3.5
PORTUG. 4.3.6
SVENSKA 4.3.7
UNIT 4.4
MM 4.4.1
INCH 4.4.2
MICRON 4.4.3
PASSWRD 4.5
num. value


SETUP
4.
COM 4.6
PROTOCL 4.6.1
MARTALK 4.6.1.1
OFF 4.6.1.2
ASCII 4.6.1.3
M1240 4.6.1.4
OPTORSS 4.6.1.5
OPTORSD 4.6.1.6
FORMAT 4.6.2
8-N-1 4.6.2.1
7-O-2 4.6.2.2
7-E-2 4.6.2.3
HANDSHK 4.6.3
NONE 4.6.3.1
XON/XOF 4.6.3.2
RTS/CTS 4.6.3.3
BAUD 4.6.4
19200 4.6.4.1
9600 4.6.4.2
4800 4.6.4.3
2400 4.6.4.4
1200 4.6.4.5
600 4.6.4.6
38400 4.6.4.7
SEND 4.6.5
MANUAL 4.6.5.1
AUTOM. 4.6.5.2
SCANN. 4.6.5.3
I/O 4.7
INPUT 4.7.1
MODE 0 4.7.1.1
MODE ...1,2,3
MODE 4 4.7.1.5
OUTPUT 4.7.2
MODE 0 4.7.2.1
MODE ...1,2,3,4
MODE 5 4.7.2.6
V-OUTP. 4.7.3
FEATR. 4.7.3.1
DAC OFF 4.7.3.1.1
LINE 1 4.7.3.1.2
LINE 2 4.7.3.1.3
ANALOG 4.7.3.1.4
FACTOR 4.7.3.2
FACTOR
& num. value
CLR-SEL 4.8
CLEAR ? 4.8.1
DELETE 4.8.1.1
CALIBR 4.9
PASSWRD
0000000

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