



# HEIDENHAIN



## ND 2100G Gage-Chek

Operating Instructions

English (en)  
2/2017

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# 1 About these instructions

These instructions provide all the information and safety precautions needed for the safe operation of the product.

## 1.1 Information on the model

Product designation	ID number
ND 2100G GAGE-CHEK	665 408-xx

*ID label*

The ID label is provided on the back of the ND.

Example:



- 1 Product designation
- 2 Index
- 3 ID number


*Validity of the documentation*

**i** A document number is provided at the bottom left on the last page of the documentation. The documentation is valid if the document number matches the document number given under [www.heidenhain.de](http://www.heidenhain.de).

For this purpose, you need to compare the product designation, the ID number and the index given on the ID label with the corresponding details provided under [www.heidenhain.de](http://www.heidenhain.de).

## 1.2 Notes on reading the documentation

The table below lists the components of the documentation in the order of priority for reading.

 <b>WARNING</b>	
<p>Failure to comply with the documentation may result in fatal accidents, personal injury or damage to equipment.</p> <p>▶ Please read the documentation carefully from beginning to end and keep it for future reference.</p>	
Documentation	Description
Addendum	An addendum supplements or supersedes the corresponding contents of the Operating Instructions and, if applicable, of the Installation Instructions. If this document is included in the shipment, read it first before you proceed. All other contents of the documentation retain their validity.
Installation Instructions	The Installation Instructions contain all the information and safety precautions needed for the proper mounting and installation of the product. They are an excerpt from the Operating Instructions and are included in every shipment. This document has the second highest priority for reading.
Operating Instructions	The Operating Instructions contain all the information and safety precautions needed for the proper operation of the product according to its intended use. It is not included in the shipment and has the third highest priority for reading. It must be downloaded from the following address and printed prior to commissioning the product: <a href="http://www.heidenhain.de">www.heidenhain.de</a>
Documentation of connected measuring devices and other peripherals	These documents are not included in the shipment. They are shipped with the respective measuring devices and peripherals

## 1.3 Storage and distribution of the documentation

These instructions must be kept in the immediate vicinity of the workplace and must be available to all personnel at all times. The operating company must inform the personnel where these instructions are kept. If the instructions have become illegible, the operating company must obtain a new copy from the manufacturer.

If the product is handed over or sold to a third party, the following documents must be given to the new owner:

- Addendum, if supplied
- Installation Instructions
- Operating Instructions

### 1.4 Target group for the instructions

The Operating Instructions must be read and observed by every person who performs any of the following tasks:

- Mounting
- Installation
- Commissioning
- Setup, programming and operation
- Cleaning and maintenance
- Troubleshooting
- Removal
- Disposal

### 1.5 Explanation of symbols

Specific text elements in this manual are identified by special formatting:

Text element	Format
Sequence of steps	▶ Switch on the unit.
Input of text or numbers	Entry of password <b>007</b> ...
Keys (arrow keys, command keys, soft keys, etc.) and menus	Press the «right» arrow key ..., In the «Setup» menu ...
Key sequences (i.e. sequence of keys or soft keys to be pressed one after the other)	Soft keys «Menu/Datum/Master» ...
Names of screens and views, formulas and functions, field names	In the <b>DRO</b> view ..., The <b>OnEvent</b> function is used for ..., In the <b>Temp Disp Res</b> field ...

## 2 Safety

General accepted safety precautions, in particular the applicable precautions relating to the handling of live electrical equipment, must be followed when operating the system. Failure to observe these safety precautions may result in personal injury or damage to the equipment.

It is understood that safety rules within individual companies vary. If a conflict exists between the material contained in these instructions and the rules of a company using this system, the more stringent rules take precedence.

### 2.1 Bestimmungsgemäße Verwendung

The device must be used orderly. Es ist ausschließlich für die folgende Verwendung bestimmt:

- Mehrstellenmessungen von Gut-/Schlecht-Erkennungen und SPC-Auswertungen
- Messungen in Verbindung mit einem Mehrstellenmessplatz

Eine andere oder darüber hinausgehende Benutzung des Geräts gilt als nicht bestimmungsgemäß und kann zu Gefahren und Schäden führen.



Das Gerät unterstützt die Verwendung einer Vielzahl von Peripheriegeräten verschiedener Hersteller. HEIDENHAIN kann keine Aussagen zur bestimmungsgemäßen Verwendung dieser Geräte treffen. Die Informationen zur bestimmungsgemäßen Verwendung aus den entsprechenden Dokumentationen müssen beachtet werden. Falls diese nicht vorliegen, müssen sie von den Herstellern angefordert werden.

### 2.2 Improper use

Any use that has not been specified in "Bestimmungsgemäße Verwendung", page 10 is considered improper use. The company operating the device is solely liable for any damage resulting from improper use.

In addition, the following uses are not permitted:

- Use with parts, cables or connectors that are defective or that do not comply with applicable standards
- Use in potentially explosive environments or fire risk areas
- Use outside the operating conditions specified in "Specifications", page 261
- Any alterations of the product or peripherals that have not been authorized by the manufacturers

### 2.3 Personnel qualification

The personnel for mounting, installation, operation, service and maintenance must be appropriately qualified for this work and must have obtained sufficient information from the documentation supplied with the product and with the connected peripherals.

The personnel required for the individual activities to be performed on the product are indicated in the respective sections of these instructions.

The personnel groups that are responsible for mounting, installation, operation, service and maintenance have different qualifications and tasks, which are specified as follows.

## Safety

### General safety precautions

---

<i>User</i>	The user uses and operates the product within the framework specified for the intended use. The user is informed by the operating company about the special tasks and about the potential risks involved with improper handling.
<i>Qualified personnel</i>	The qualified personnel are trained by the operating company to perform advanced operation and parameterization. The qualified personnel have the required technical training, knowledge and experience and know the applicable regulations, and are thus capable of performing the assigned work regarding the application concerned and of proactively identifying and avoiding potential risks.
<i>Electrical specialist</i>	<p>The electrical specialist has the required technical training, knowledge and experience and knows the applicable standards and regulations, and is thus capable of performing work on electrical systems and of proactively identifying and avoiding potential risks. Electrical specialists have been specially trained for the environment they work in.</p> <p>Electrical specialists must comply with the provisions of the applicable legal regulations on accident prevention.</p>

## 2.4 Obligations of the operating company

The operating company owns or leases the product and the peripherals. It is responsible that the intended use is complied with at all times.

The operating company must:

- Assign the different tasks to be performed on the product to appropriate, qualified and authorized personnel
- Train the personnel in the authorizations and tasks specified in "Personnel qualification", page 10 and furnish documented proof of such training.
- Ensure that the product is operated only when in perfect technical condition
- Ensure that the product is protected from unauthorized use after the end of a shift

## 2.5 General safety precautions



The product supports the use of a wide variety of peripheral devices from different manufacturers. HEIDENHAIN cannot make any statements on the specific safety precautions to be taken for these devices. The safety precautions provided in the respective documentations must be observed. If no such information has been supplied, it must be obtained from the manufacturers concerned.

The specific safety precautions required for the individual activities to be performed on the product are indicated in the respective sections of these instructions.

### 2.5.1 Classification of hazard warnings

Hazard warnings warn of hazards in handling the product and provide information on their prevention. They are classified by hazard severity and divided into the following groups:

*Warning types*



#### **DANGER**

Warns of **imminent danger**.

Failure to avoid the danger may result in **severe injury** or **death**.

#### **WARNING**

Warns of **potential danger**.  
Failure to avoid the danger may result in **severe injury** or **death**.

#### **CAUTION**

Warns of **potential danger**.  
Failure to avoid the danger may result in **slight** or **minor injury**.

#### **NOTICE**

Warns of a **potentially harmful situation**.  
Failure to avoid the situation may cause **damage to the product** or to **equipment in its surroundings**.



An information box provides **important additional or supplementary information** about an activity or concept.

It also draws attention to situations or conditions that may lead to measurement errors or equipment malfunctions.



## 2.5.2 Electrical safety precautions

 **DANGER**

When opening the product, there is a possibility of coming into contact with live electrical components.

This may result in electric shock, burns or death. In addition, opening the product will invalidate the guarantee, warranty and liability of the manufacturer for any resulting accidents, personal injury or equipment damage.

- ▶ Never open the housing.
- ▶ Only the manufacturer is permitted to access the inside of the product.

 **DANGER**

Direct or indirect contact with live electrical components will lead to a dangerous amount of electricity passing through the human body.

This may result in electric shock, burns or death.

- ▶ Work on the electrical system and live electrical components is only to be performed by trained electrical specialists.
- ▶ For power connection and all interface connections, use only cables and connectors that comply with applicable standards.
- ▶ Use only fuses with the prescribed classification. For more information see "Specifications", page 261.
- ▶ Have the manufacturer exchange defective electrical components immediately.
- ▶ Regularly inspect all connected cables and all connectors provided on the product. Defects, such as loose connections or scorched cables, must be removed immediately.

**NOTICE**

This product contains components that can be destroyed by electrostatic discharge (ESD).

- ▶ It is essential to observe the safety precautions for handling ESD-sensitive components.
- ▶ Never touch connector pins without ensuring proper grounding.

## 3 Mounting

### Personnel requirement



The following steps are only to be performed by qualified personnel!

For more information see "Personnel qualification", page 10.

### 3.1 Items supplied

#### *Unpacking*

- ▶ Open the top lid of the box.
- ▶ Remove the packaging materials.
- ▶ Unpack the contents.
- ▶ Check the delivery for completeness.
- ▶ Check the delivery for damage.



If any components were damaged in transit, keep the packaging materials for inspection and contact your HEIDENHAIN distributor or OEM. This applies also if you need replacement parts.

#### *In case of damage in transit*

- ▶ Have the shipping agent confirm the damage.
- ▶ Keep the packaging materials for inspection.
- ▶ Notify the sender of the damage.
- ▶ If necessary, contact your distributor for mediation.
- ▶ Contact your HEIDENHAIN distributor or OEM for replacement parts.

#### *Items supplied*

The following items are included in the shipment:

- Unit with pre-installed mounting adapter  
or  
Unit with separate mounting stand for assembly on site
- Protective cover for the unit
- Power cord
- Connector for relay contacts
- Installation Instructions
- Addendum (optional, for more information see "Notes on reading the documentation", page 8)

*Accessories*

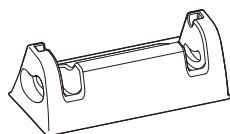
The following items are optionally available and can be ordered from HEIDENHAIN as additional accessories:

Optional accessories	ID number
Mounting adapter	682419-01
Mounting stand	382892-02
Foot switch	681041-01
Remote keypad	681043-01
QUADRA-CHEK Wedge communication software	709141-01
Protective cover	681051-03

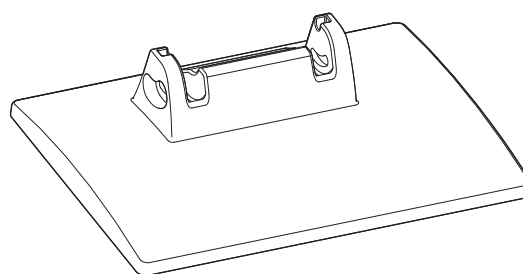
**3.2 Assembly**

- If the unit is supplied with pre-installed mounting adapter, no assembly is required.
- If the unit is supplied with separate mounting stand, the stand needs to be attached. For more information see "Attaching the mounting stand", page 15

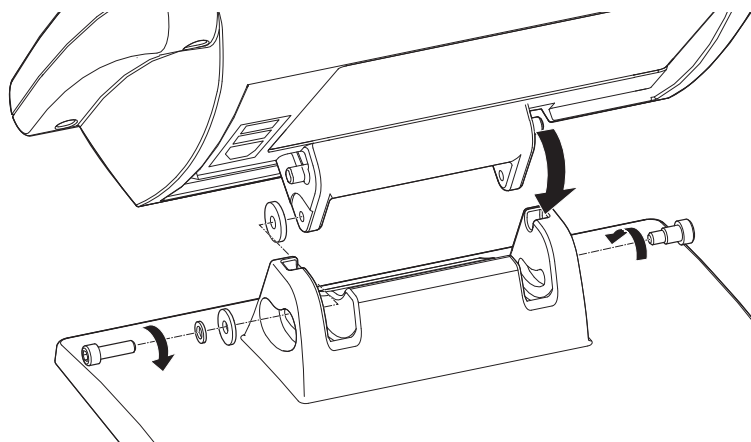
Pre-installed mounting adapter:



Mounting stand:



**Attaching the mounting stand**



## Mounting the unit with mounting stand on a benchtop or machine (optional)

Using the mounting holes provided on the underside of the mounting stand, you can firmly screw the unit to a benchtop.

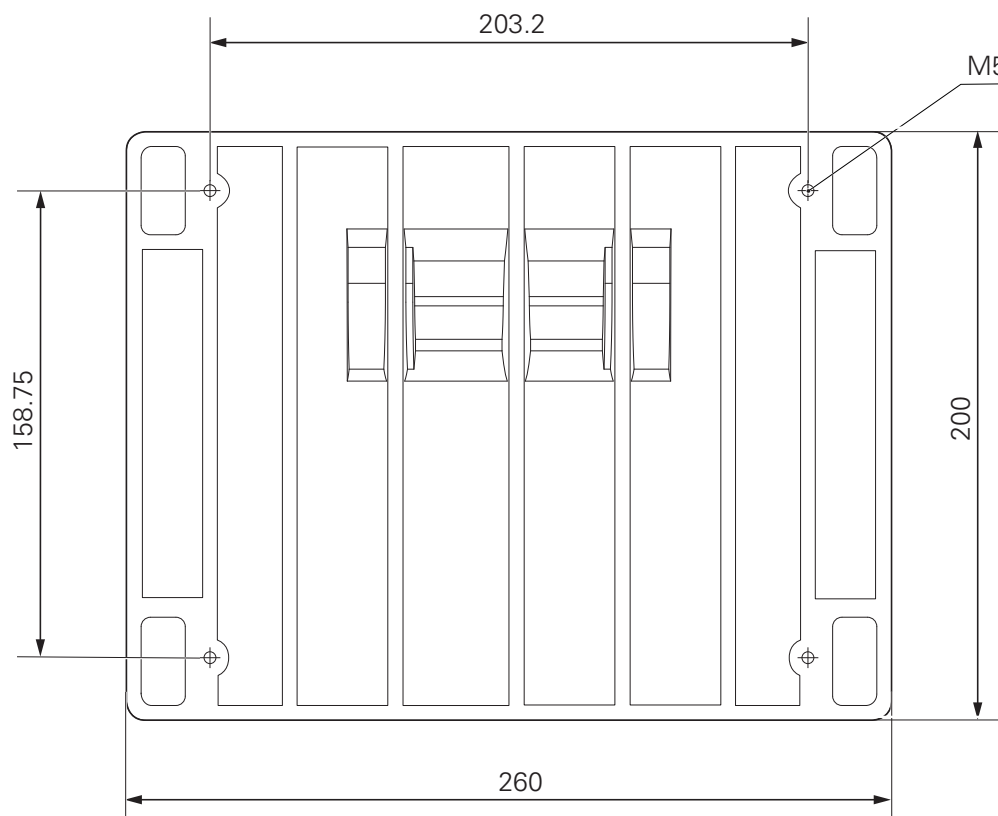
Horizontal tilting of the unit in the tilt guides is still possible after screw-mounting.



If the unit has a pre-installed mounting adapter, you need to remove the mounting adapter first and then attach the mounting stand. For more information see "Attaching the mounting stand", page 15. The mounting stand is available as an optional accessory (ID 382892-02).

The mounting adapter is removed in the reverse order in which the mounting stand is attached.

*Dimensions for screw mounting*



*Requirements for the location*



When mounting the unit on a benchtop or machine, choose a surface that is flat and stable and provides sufficient space for installation and operation.

The surface has to be accessible from the rear to allow screw mounting of the unit.

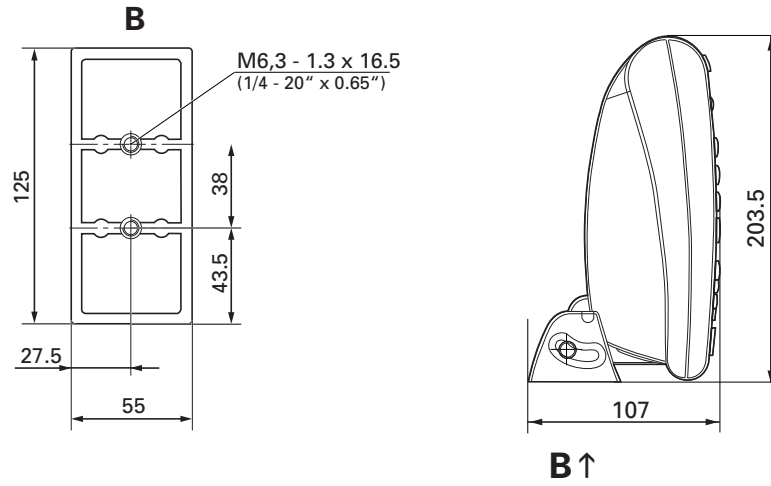
*Mounting the unit with mounting stand on a benchtop or machine*

- ▶ Drill four holes at the desired mounting location.
- ▶ Align the mounting holes of the unit with the holes you drilled.
- ▶ To fasten the mounting stand to the mounting location, insert and tighten the four M5 screws from the rear.

## Mounting the unit with mounting adapter on a support arm or benchtop

Using the mounting holes on the underside of the pre-installed mounting adapter, you can screw the unit to a support arm or benchtop.

*Dimensions of mounting adapter*



## 4 Installation

### NOTICE

Disturbances caused by lack of grounding or improper grounding!

- ▶ Never operate the unit without proper ground connection.
- ▶ Connect the ground connector on the rear panel to the central grounding point of the unit.  
Minimum cross section of the conductor: 6 mm<sup>2</sup>.

### NOTICE

Risk of damage to internal components!

- ▶ Do not engage or disengage any connecting elements while the unit is under power.



Depending on the unit's equipment, the installation may differ from the procedure described in this chapter. If the Addendum shipped with the product contains information on the installation, the information given in the Addendum takes precedence over the information in this chapter.



The responsibility for every system in which this product is used lies with the person installing this system.



The illustrations of pin layouts always show the pin assignments of the connectors and not of the ports on the unit.

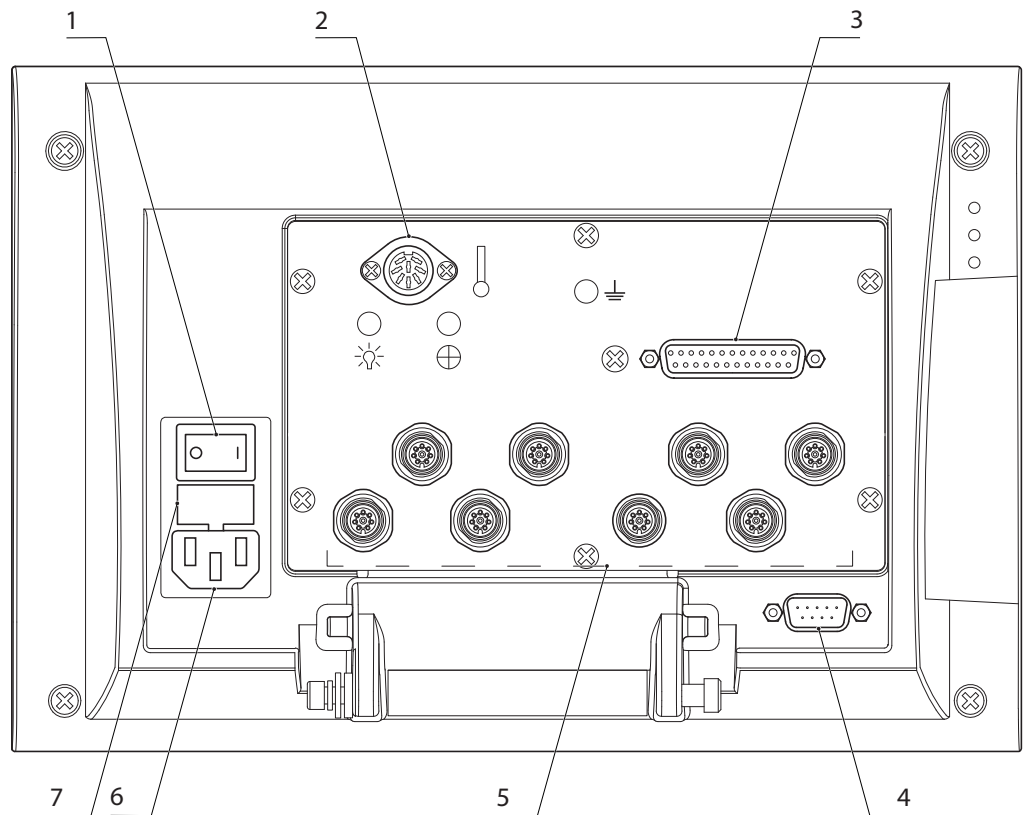
### Personnel requirement



The following steps are only to be performed by qualified personnel!  
For more information see "Personnel qualification", page 10.

## 4.1 Product overview

### Rear panel



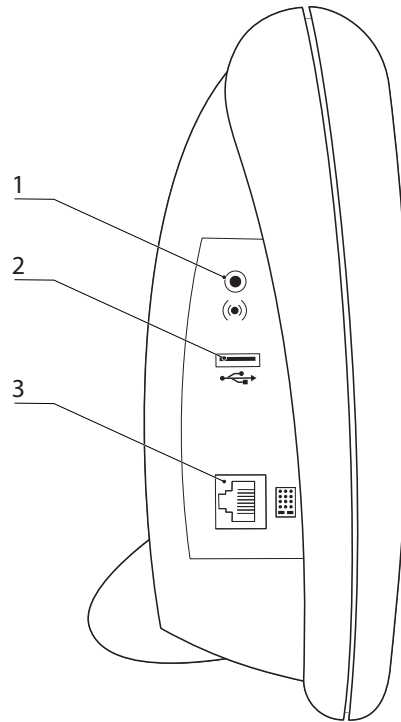
- 1 Power switch
- 2 Relay outputs
- 3 I/O interface
- 4 RS-232-C/V.24 port
- 5 Inputs for measuring devices
- 6 Power connector
- 7 Line fuse



The number and type of measuring device connectors may vary from unit to unit.

### Left side panel

The left side panel (as seen from the front) provides the following connectors:



- 1** Speaker/headphone jack
- 2** USB Type A connector
- 3** RJ-45 jack for foot switch or remote keypad



## 4.2 Connecting power

### **WARNING**

Risk of electric shock!

Improper grounding of electrical devices involves a risk of serious injury or death by electric shock.

- ▶ Always use 3-wire power cables.
- ▶ Make sure the ground wire is correctly connected to the ground of the building's electrical installations.

### **WARNING**

Fire hazard from the use of power cables that do not meet the minimum requirements!

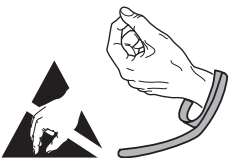
- ▶ Use only power cables that fulfill or exceed the specified minimum requirements.

### **NOTICE**

Surge suppressors limit the amplitude of potentially damaging power line transients caused by electrical machinery or lightning, and protect the product from most power line transients that can corrupt system memory or damage circuits.

- ▶ Always connect the unit to power through a high-quality surge suppressor.
- ▶ Use the supplied power cable to connect the power connector to a 3-wire grounded power outlet. For information about the location of the power connector on the rear panel, see "Rear panel", page 19.

## 4.3 Electrostatic discharge



### **NOTICE**

This product contains components that can be destroyed by electrostatic discharge (ESD).

- ▶ It is essential to observe the safety precautions for handling ESD-sensitive components.
- ▶ Never touch connector pins without ensuring proper grounding.

## Installation

Connecting measuring devices

### 4.4 Connecting measuring devices

*Connection possibilities*

Measuring devices are connected to the channel inputs provided on the rear panel. For information about their location on the rear panel, see "Rear panel", page 19.

The number and type of connectors available for the measuring devices may vary from unit to unit.

*Connecting the measuring device cables*

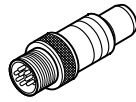
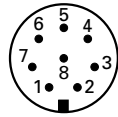
- ▶ Connect the cables of the measuring devices tightly to the respective connectors on the rear panel.
- ▶ If the connectors include mounting screws, do not overtighten them.



Vacant pins or wires must not be used.

*8-pin EnDat coupling: Pin assignment*

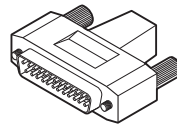
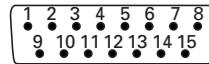
For EnDat pin layouts



1	2	3	4	5	6	7	8
Sensor 0 V	Sensor U <sub>P</sub>	Data	Data	0 V	Clock	Clock	U <sub>P</sub>

*15-pin D-sub connector: Pin layout*

For 1 V<sub>PP</sub> pin layouts



1	2	3	4	7	9
A+	0 V	B+	U <sub>P</sub>	R-	A-
10	11	12	14	5/6/8/13/15	
Sensor 0 V	B-	Sensor U <sub>P</sub>	R+	/	

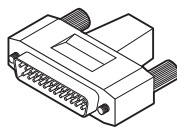
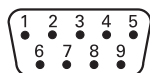
## Installation

Connecting a computer

---

9-pin D-sub connector: For TTL pin layouts

Pin layout



1	2	3	4	5	6	7	8	9
/	$U_{a1}$	$\overline{U_{a1}}$	$U_{a2}$	$\overline{U_{a2}}$	0 V	$U_P$	$\overline{U_{a0}}$	$U_{a0}$

## 4.5 Connecting a computer

- ▶ Connect a computer COM port to the unit's RS-232/V.24 serial port using a standard serial cable. For information about the port's location on the rear panel, see "Product overview", page 19.



Make sure the cable is securely attached. Do not overtighten the connector screws.



For information on the configuration of the RS-232 port, e.g. for products with a second RS-232/V.24 serial port for the connection of RS-232/V.24 measuring devices, see "Setting the RS-232 interface: RS232", page 123.

## 4.6 Connecting headphones and USB printer

### Connecting headphones

Audio alerts can be sent to headphones in areas that are noisy and make it difficult to hear, or are quiet where audio alerts might create a disturbance.

For more information about the audio output, see "Specifications", page 261.

- ▶ Plug the headphones into the audio jack on the side of the unit. Make sure the headphone plug is fully inserted. For information on the location of the headphone jack, see "Rear panel", page 19.

### Headphone plug: Pin layout



<b>1</b>	<b>2</b>
Out	Signal GND

### Connecting a USB printer

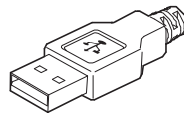
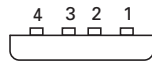
The unit supports certain USB printers.



A list of supported printers is available as a document from [www.heidenhain.de](http://www.heidenhain.de).

- ▶ Connect the USB printer to the USB Type A port on the side of the housing. Make sure the USB cable plug is fully inserted. For information on the location of the USB port, see "Rear panel", page 19.

### USB type A: Pin layout

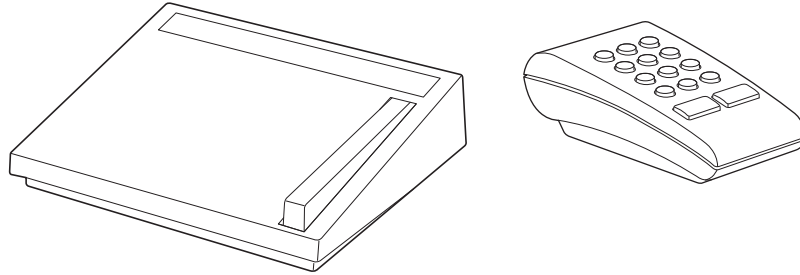


<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>
5 V DC	Data (-)	Data (+)	GND

## Installation

Connecting a foot switch and remote keypad (optional accessories)

### 4.7 Connecting a foot switch and remote keypad (optional accessories)



**i** The foot switch and the remote keypad are available as optional accessories. For more information see "Items supplied", page 14.

*Connecting the foot switch*

The connecting cable fixed to the foot switch has an RJ-45 plug for connection to the RJ-45 jack on the left side of the unit.

- ▶ Connect the RJ-45 plug of the foot switch to the RJ-45 jack provided on the unit.

*Connect the remote keypad*

The remote keypad is connected to the RJ-45 jack on the left side of the unit by using a cable with RJ-45 plugs on both ends.

- ▶ Plug a cable with RJ-45 plugs into the RJ-45 jacks on the unit and on the remote keypad.

*Connecting foot switch and remote keypad simultaneously*

**i** The foot switch and the remote keypad can be used individually or in combination.

**i** The foot switch and the remote keypad can be connected simultaneously using an RJ-45 splitter that is plugged into the RJ-45 jack on the left side of the unit. RJ-45 splitters are available from most retail electronics stores.

**i** When the foot switch and the remote keypad are connected using an RJ-45 splitter, all operating functions of each device are retained.

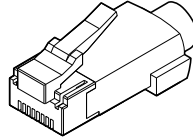
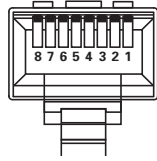
*Hot key mapping with keys 7 and 8 of the remote keypad*

**i** The foot switch shares hot key mapping with the number keys 7 and 8 of the remote keypad. As a result, all functions assigned to the two switch contacts will also be mapped to remote keypad numbers 7 and 8. For more information see "Configuring hot keys: Hot Keys", page 127.

## Installation

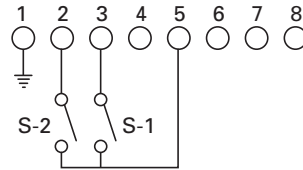
### Wiring of switching inputs and outputs

RJ-45 plug:  
Pin layout



1	2	3	4	5	6	7	8
Case GND	S-2	S-1	/	S-1, S-2 COM	/	/	/

COM: Common



## 4.8 Wiring of switching inputs and outputs



The functions are based on the formulas and values stored by qualified personnel.

The wiring of the switching inputs and outputs depends on the customer's peripherals (see manufacturer's documentation).

### Personnel requirement



Depending on the peripherals to be connected, the connection work may need to be carried out by an electrical specialist.

Example: SELV exceeded.

*Relay connection*

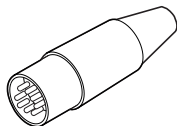
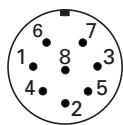
The contacts of a single-pole, double-throw dry-contact relay are accessible on the product's rear panel for special applications requiring low-power electrical switching. The normally open and normally closed contacts of the relay are available for use in low-current, low-voltage applications.

For more information on the relay connection, see "Specifications", page 261.

## Installation

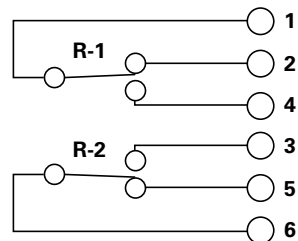
### Wiring of switching inputs and outputs

Relay connector:  
Pin layout



1	2	3	4	5	6	7	8
R-1 COM	R-1 NC	R-2 NO	R-1 NO	R-2 NC	R-2 COM	/	/

- COM: Common
- NC: Normally closed
- NO: Normally open

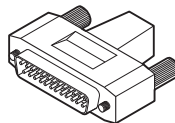
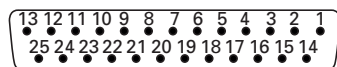


Data I/O connection

The I/O interface enables the digital readout unit to communicate with the peripherals through TTL inputs and outputs. Signals from peripherals can be evaluated and connected peripheral devices can be controlled.

For more information about the I/O connection, see "Specifications", page 261.

Data I/O connector:  
Pin layout



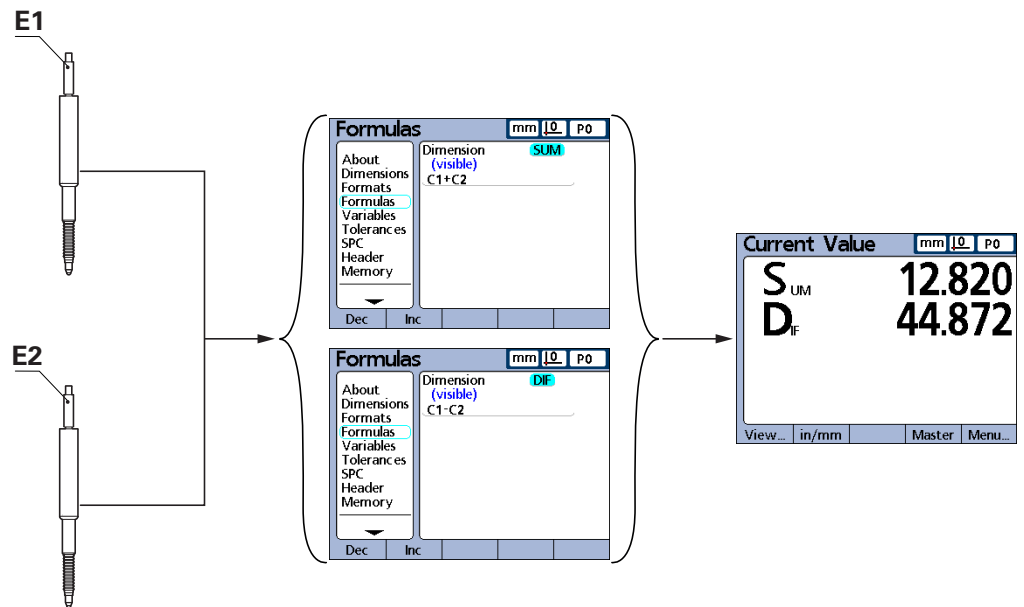
1	2	3	4	5	6	7	8	9
Data Out 9	Data Out 1	Data Out 2	Data Out 3	Data Out 4	Data Out 5	Data Out 6	Data Out 7	Data Out 8
10	11	12	13	14	15	16	17	18
Data In 5	Data In 4	Data In 3	Data In 2	Data Out 10	Data In 1	Data Out 11	Data Out 12	Signal GND
19	20	21	22	23	24	25		
Signal GND	Signal GND	Signal GND	Signal GND	Signal GND	Signal GND	Signal GND		

## 5 Basic Operation

Operation of the unit is performed using various keys when conducting measurements. The LCD screen displays different menus for creating formulas and making additional settings. The measurement results can be displayed in different views on the screen.

Measurements are conducted under user control, or are semi-automated and conducted in conjunction with a multipoint inspection system.

Channel input data can be algebraically combined or processed by mathematical and control formulas to display dimensions such as flatness, volume and runout. The required formulas are created as part of the setup procedure using menus and mathematical functions.



C1=28.846 mm  
C2=-16.026 mm

Sum=C1+C2  
Dif=C1-C2

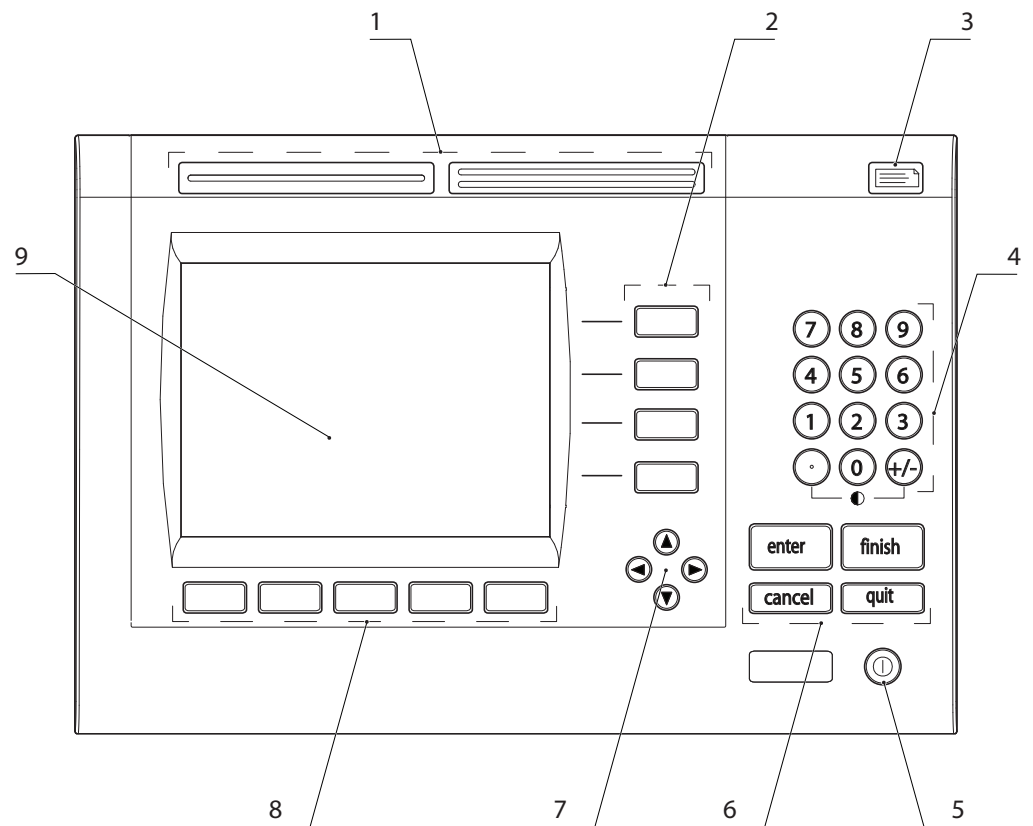
Sum=12.820  
Dif=44.872

Dimensional inspections of components are performed using encoders or transducers as part of in-line production activities or final quality inspection.



## 5.1 Product overview

### Front panel

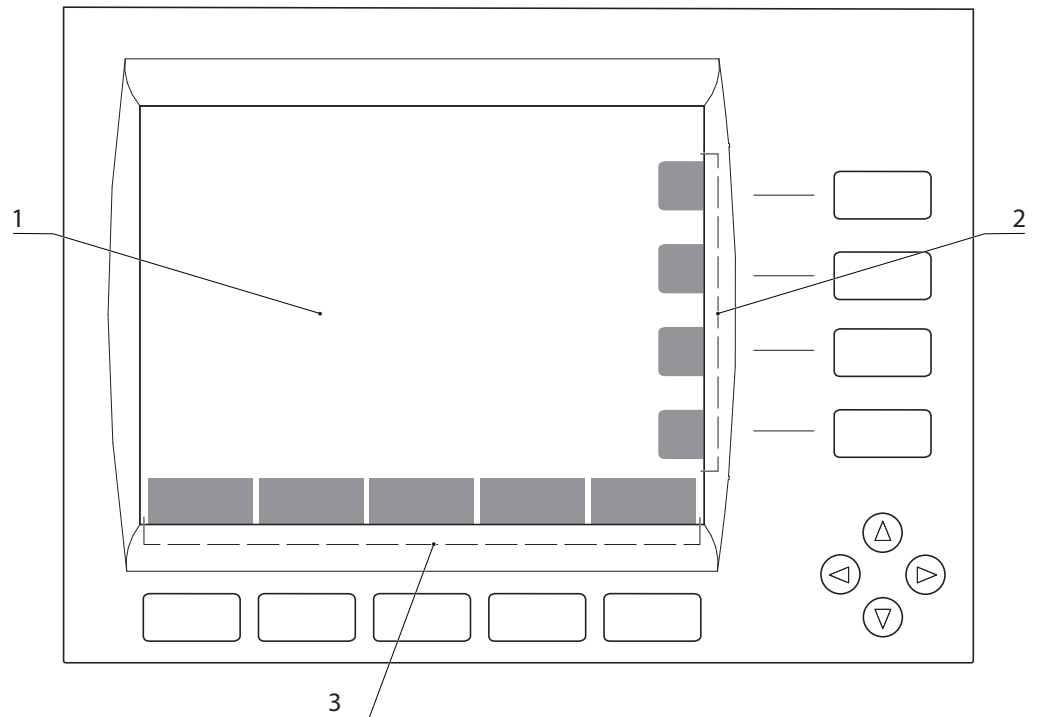


- 1 Fast track keys
- 2 Dimension keys
- 3 «Send» key
- 4 Numerical keys
- 5 «LCD on/off» key
- 6 Command keys
- 7 Arrow keys
- 8 Soft keys
- 9 LCD screen

The front panel provides the LCD screen and the operating keys, see "LCD screen", page 30 and "Keys", page 32.

### 5.1.1 LCD screen

Screen layout



- 1 Views, measured value displays and menus
- 2 Functions of the dimension keys, change depending on situational context
- 3 Functions of the soft keys, change depending on situational context

Depending on the selected function, the current dimension values and measurement results can be represented in different ways. Options for setup and for the configuration of parts can also be displayed.

Home screen

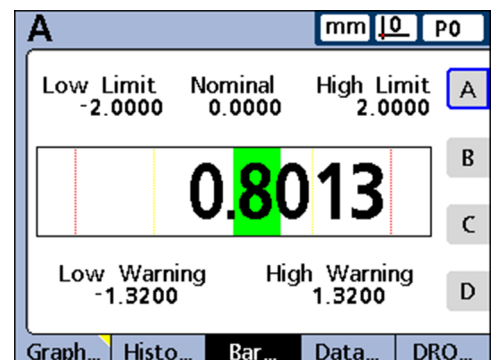
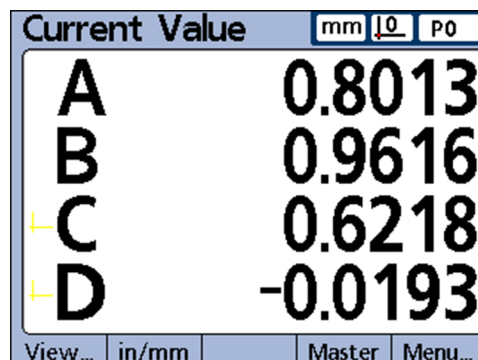
For information on the home screen, see "Switch-on / Switch-off", page 34.

Measured value displays (examples)

The measurement information is displayed on the LCD screen. Different types of representation are available, for example:

- Numerical display of the actual position (digital readout in **DRO** view)
- Bar and dial displays of position values
- Line graphs of values
- Histograms of measurement statistics
- Tables of measurement data and SPC data

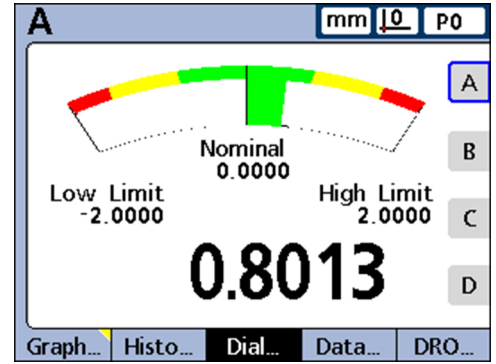
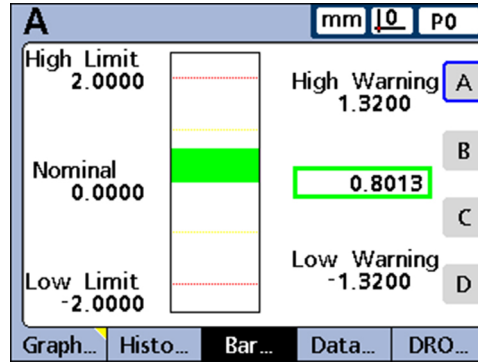
Left:  
Current value display  
(DRO view)  
Right:  
Horizontal bar graph



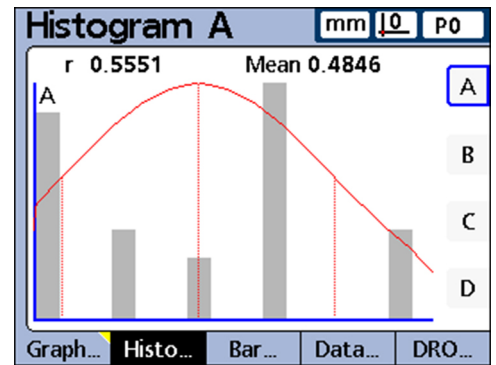
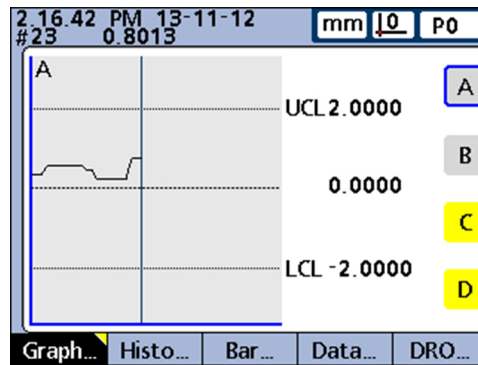
# Basic Operation

Product overview

**Left:**  
Vertical bar graph  
**Right:**  
Dial display



**Left:**  
Line graph  
**Right:**  
Histogram



**Left:**  
Measurement data  
**Right:**  
SPC data



2.16.42 PM 13-11-12 #23 0.8013 mm 10 P0				
A	B	C	D	
0.8013	0.9616	0.6218	-0.0193	A
0.8013	0.9616	0.6218	-0.0193	
0.8013	0.9616	0.6218	-0.0193	B
0.2462	0.9203	0.9227	0.8893	
0.2462	0.9203	0.9227	0.8893	C
0.2462	0.9203	0.9227	0.8893	
0.2462	0.9203	0.9227	0.8893	D
0.2462	0.9203	0.9227	0.8893	





Graph... Histo... Bar... Data... DRO...


2.16.42 PM 13-11-12 #23 0.8013 mm 10 P0				
A				
0.8013				A
0.8013	Mean	0.4846		
0.8013	Max	0.8013		B
0.2462	Min	0.2462		
0.2462	r	0.5551		C
0.2462	$\sigma(p)$	0.1996		
0.2462	6 $\sigma$	1.1974		D
0.2462	Pp	3.3406		
0.2462	Ppk	2.5311		

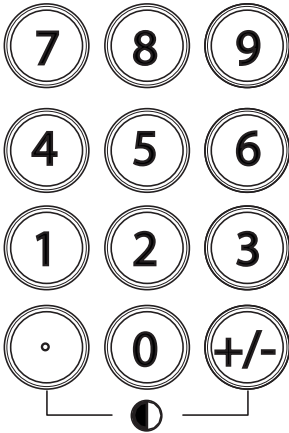
Graph... Histo... Bar... Data... DRO...

## 5.1.2 Keys

Fast track keys	Function
	Function programmed for the left key. Default: «RsetDyn»  For information on the assignment of hot keys, see "Configuring hot keys: Hot Keys", page 127.
	Function programmed for the right key. Default: «enter»





Dimension keys	Function
	<p>Each dimension key can be assigned one of six hot-key functions for use when the <b>DRO</b> view is displayed. When the <b>Graph</b>, <b>Bar</b> and <b>Data</b> views are displayed, the dimension keys are used to display values for single dimensions or a smaller group of dimensions.</p> <p>Pressing a dimension key in the</p> <ul style="list-style-type: none"> <li>■ <b>DRO</b> view: Performs the function assigned in the «Hot Keys» setup screen By default no hot-key function is assigned until the user makes the assignment.</li> <li>■ <b>Graph</b> view: Displays a single line graph for the corresponding dimension</li> <li>■ <b>Bar</b> view: Displays a single bar graph showing current values for the corresponding dimension</li> <li>■ <b>Data</b> view: Displays a single data table of stored values for the corresponding dimension</li> </ul> <p>For information on the assignment of hot keys, see "Configuring hot keys: Hot Keys", page 127.</p>
	
	
	


«Send» key	Function
	Transmit measurement results to a computer, USB printer or USB flash drive

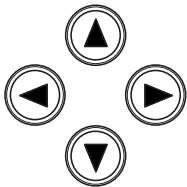
Numerical keys	Function
	<p>Used for numeric data entry</p> <p>The decimal point key and the «+/-» key can also be used to increase or decrease the LCD screen contrast when a decimal point or +/- input are not expected by the unit as part of a data entry process.</p> <p>The screen contrast setting will be saved when the unit is switched off and used as the default contrast setting the next time the unit is switched on.</p>


## Basic Operation

Product overview

Command keys	Function
	<b>Enter data:</b> Enter data for a measurement. The displayed information is stored as measurement or configuration data. This information includes current dimension values or alphanumeric data for a configuration or user prompt data field.
	<b>Exit a screen:</b> Exit the current screen and save any changes that were made. The «finish» key can also be used to return from the display of measurement or SPC data to the current home screen.
	<b>Delete data or dimensions:</b> Erase the last value entered from the numeric keypad or delete data in configuration fields.
	<b>Quit current activity:</b> Abort the current task and return to the home screen, or exit the current menu.

LCD on/off key	Function
	Turn the LCD off or clear data: <ul style="list-style-type: none"><li>■ Switch the LCD screen on or off or</li><li>■ Clear input channel calibrations or</li><li>■ Delete data stored for a single part or for all parts</li></ul>

Arrow keys	Function
	Navigate menus and setup screen data fields. Instead of arrow symbols, the following descriptions are used in this manual: <ul style="list-style-type: none"><li>■ «up» arrow key</li><li>■ «right» arrow key</li><li>■ «down» arrow key</li><li>■ «left» arrow key</li></ul>

Soft keys	Function
	Initiate the functions labeled above the keys at the bottom of the LCD screen  For information on the assignment of hot keys, see "Configuring hot keys: Hot Keys", page 127.

## 5.2 Switch-on / Switch-off

### Switch-on

For information on the location of the power switch, see "Rear panel", page 19.

- ▶ Turn the power switch on.

After switching the power on, or after a power failure, the startup screen will be displayed.



- ▶ To advance from the startup screen to the home screen, press the «finish», «enter», «quit» or «cancel» key.

Before the product is used for the first time, the essential commissioning steps must be completed (see "Commissioning", page 51) and the setup parameters for the current measuring task must be configured (see "Software setup", page 60).

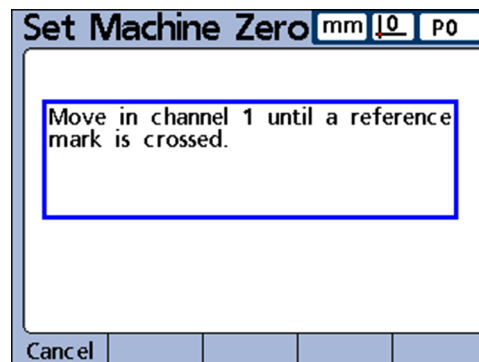
### Home screen

The **DRO** view is the default home screen. For more information on the **DRO** view, see "DRO view", page 35.



Instead of the **DRO** view, you can also select another view as the home screen, see "Home screen", page 113.

If the unit has already been configured and the measuring devices have been set to require crossing the referencing marks, the following screen will appear after switch-on:



In this case, the user first has to move the measuring devices and traverse the reference marks. On completion, the unit will display the home screen described above, except that it does not show zeros, but the defined axis-specific datums or the display defined in the active part/program.

### Switch-off

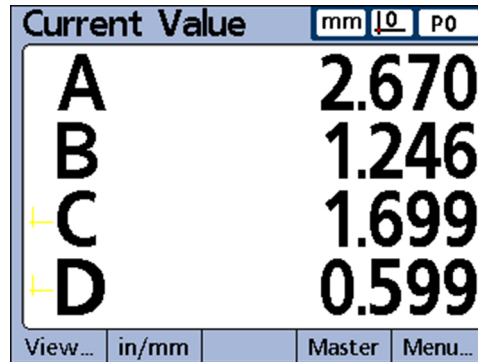
- ▶ Turn the power switch off.

The parts, formulas and dimensions that have been saved during operation will be retained in memory when the unit is switched off.

### 5.3 DRO view

**DRO view**

The **DRO** view is the default home screen. It provides numeric displays of the current values of up to four dimensions.



The symbols in the upper right corner of the screen indicate:

- Unit of measure
- Current datum
- Number or name of the current part

The soft-key row at the bottom of the screen shows the names of the basic functions that can be called from this view:

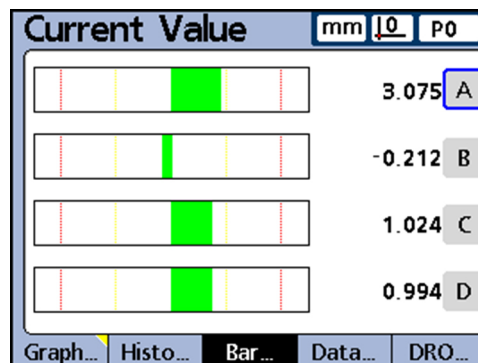
- «View»: Selection of different displays for the measurements (see "View function", page 36)
- «in/mm»: Display of values in mm or inches on the screen (see "in/mm function", page 44)
- «Master»: Calibration of datums (see "Master function", page 44)
- «Menu»: The soft-key row additionally displays the «Datum», «Extra» and «Setup» soft keys (see "Menu screen", page 45).

*Calling a function from the soft-key row*

- ▶ Press the soft key for the desired function.

**Example:** Displaying a bar graph of current values from the **DRO** view

- ▶ Press the «View/Bar...» soft keys.



When there are more than four dimensions, use the arrow keys to scroll the display.

For additional viewing options see "View function", page 36.

Functions in the DRO view

The soft-key row in the **DRO** view provides the following functions:

- «View» function, see "View function", page 36
- «in/mm» function, see "in/mm function", page 44
- «Master» function, see "Master function", page 44
- «Menu» function, see "Menu screen", page 45

### 5.3.1 «View» function

Selecting options for the DRO view

► In the **DRO** view, press the «View» soft key.

The subsequent view will be displayed the way it looked when it was last exited.



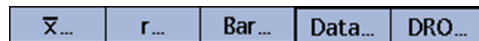
The viewing options vary depending on the selected SPC settings. If SPC is activated, the subgroup size is set to a value >1. For more information on SPC settings, see "Defining statistical parameters: SPC", page 82.

The available viewing options differ in the functions of two leftmost soft keys:

- Soft-key row for subgroups of one:



- Soft-key row for subgroups greater than one:



### Options for subgroups of one

Options

If the subgroup size is set to 1, the soft-key row provides the following viewing options:

- «Graph...»: Displays data in a line graph
- «Histo...»: Displays data in a histogram
- «Bar...»: Displays data in a bar graph
- «Data...»: Displays numerical data in a table
- «DRO...»: Displays current values in the **DRO** view

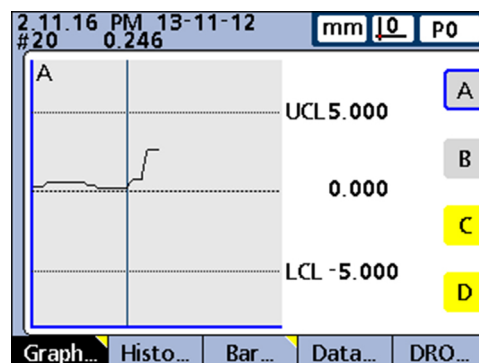
You can toggle the display for the selected dimension between the line graph, histogram, bar, and data table views.

In addition, you can choose whether you want to display one or more channels.

«Graph...»

To display the dimensions in a line graph:

► Press the «Graph...» soft key.



This view displays the line graphs for up to 16 dimensions.



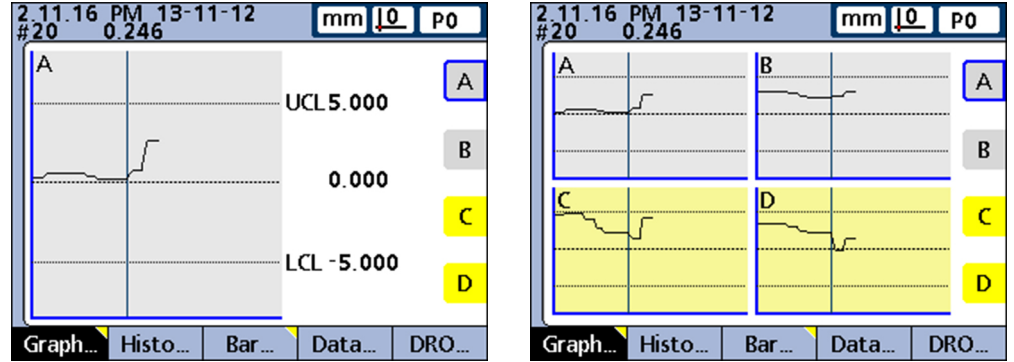
The following information is provided on the upper left of the LCD screen:

- Time and date that the individual value was stored
- Sample ID number for the dimension and the associated data value
- Nominal and limit values (only if a single dimension is displayed)

To toggle between a single and multiple line graphs displayed on the screen:

- ▶ Press the «Graph...» soft key.

The display toggles between a single graph and multiple graphs:



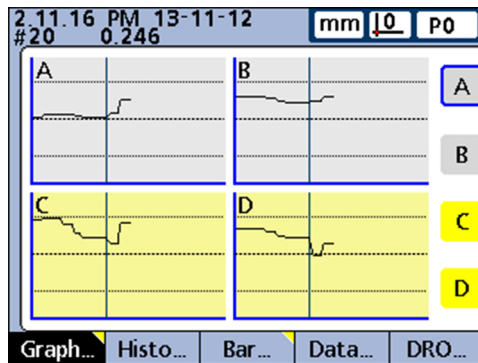
- ▶ When multiple line graphs are displayed, use the arrow keys to scroll the graphs when more data is stored than will fit on the screen.

To display the desired dimension in a single line graph with some additional dimension data:

- ▶ Press the dimension key for the desired graph.

Individual samples can be selected by a vertical line on the graph:

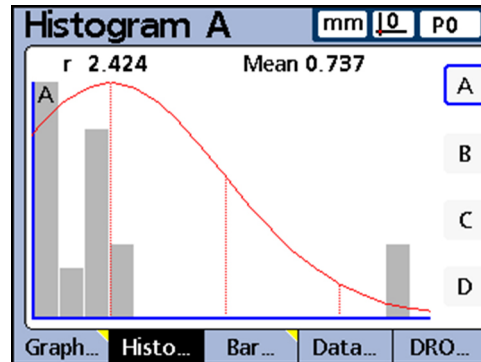
- ▶ Move the vertical line with the «left» and «right» arrow keys.



«Histo...»

To display the dimensions in a histogram:

- ▶ Press the «Histo...» soft key.

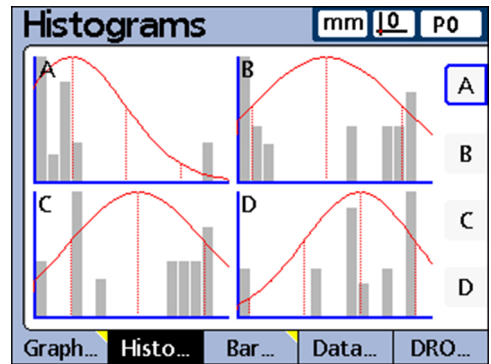
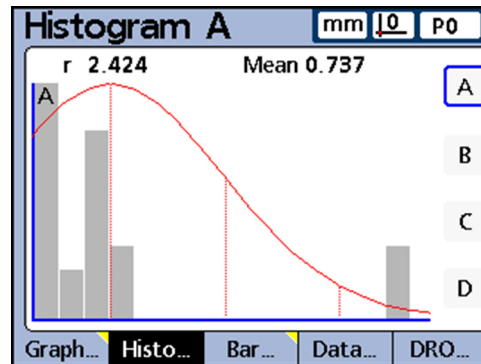


This view displays the values for up to 16 dimensions as histograms.

To toggle between a single and multiple histograms displayed on the screen:

- ▶ Press the «Histo...» soft key.

The display toggles between a single histogram and multiple histograms:



To display the desired dimension in a single graph with some additional dimension data:

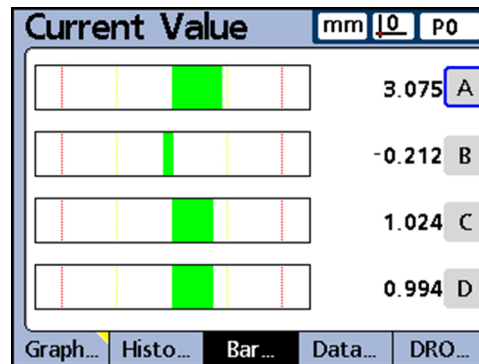
- ▶ Press the dimension key for the desired graph.

The display of a single dimension also shows the total range and mean of the values.

«Bar...»

To display the dimensions in a bar or dial display:

- ▶ Press the «Bar...» soft key.



The bar and dial views provide graphic displays of the current values of up to 16 dimensions.

The default setting for the **Bar** view can be configured to display the bars in horizontal or vertical orientation. This setting is made in the «Display» setup screen. For more information see "Configuring the display: Display", page 110.

- Bar graphs of multiple dimensions show the current values.
- Bar graphs of single dimensions include the current value, nominal value, and high and low warning and limit values.

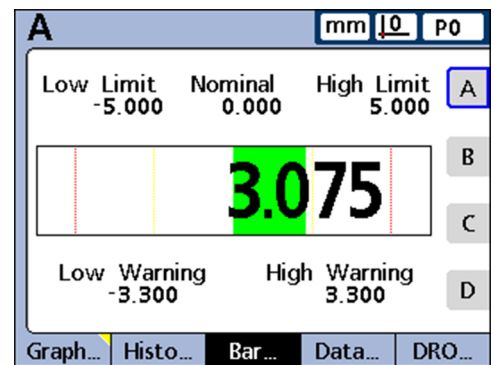
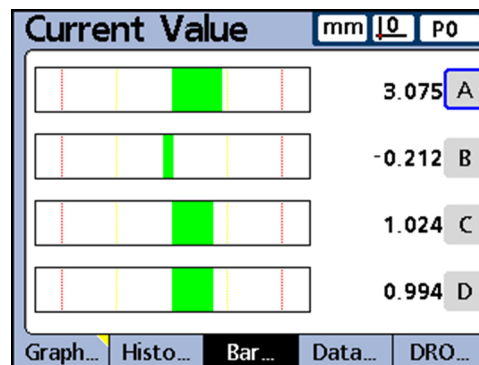
To display a single bar graph of the desired dimension:

- ▶ Press the corresponding dimension key.

To toggle between a single and multiple bar graphs displayed on the screen:

- ▶ Press the «Bar...» soft key.

The display toggles between a single graph and multiple graphs:



The display can be configured in the «Display» setup screen to include a dial in addition to the bars. When a dial display is also available, press the «Bar...» soft key to toggle between the bars and the dials.

The display of a single dimension can be configured to be a bar or a dial, but cannot be toggled between a single bar and a single dial.

«Data...»

To display the dimensions in a data table:

- ▶ Press the «Data...» soft key.

2.11.16 PM 13-11-12				
#20 0.246				
mm 10 P0				
A	B	C	D	
0.246	0.920	0.923	0.889	A
0.246	0.920	0.923	0.889	
0.246	0.920	0.923	0.889	B
0.246	0.920	0.923	0.889	
0.246	0.920	0.923	0.889	C
0.246	0.920	0.923	0.889	
0.493	0.991	1.128	0.995	D
0.493	0.991	1.128	0.995	
0.616	1.133	1.639	1.204	

The **Data** view displays tables containing measurement data stored for up to 4 dimensions.

To toggle between the display of data for all dimensions and data for a single dimension that includes SPC statistics:

- ▶ Press the «Data...» soft key.

More dimension data tables are displayed.

2.11.16 PM 13-11-12				
#20 0.246				
mm 10 P0				
A	B	C	D	
0.246	0.920	0.923	0.889	A
0.246	0.920	0.923	0.889	
0.246	0.920	0.923	0.889	B
0.246	0.920	0.923	0.889	
0.246	0.920	0.923	0.889	C
0.246	0.920	0.923	0.889	
0.493	0.991	1.128	0.995	D
0.493	0.991	1.128	0.995	
0.616	1.133	1.639	1.204	

2.11.16 PM 13-11-12				
#20 0.246				
mm 10 P0				
A				
0.246				A
0.246	Mean	0.737		
0.246	Max	2.670		B
0.246	Min	0.246		
0.246	r	2.424		C
0.246	σ(p)	0.736		
0.246	6 σ	4.417		D
0.493	Pp	2.2638		
0.493	Ppk	1.9302		
0.616				

To display a data table for a single dimension:

- ▶ Press the dimension key for the desired dimension.
- ▶ Use the arrow keys to scroll the tables when more data is stored than will fit on the screen.

## Options for subgroups greater than one

Options

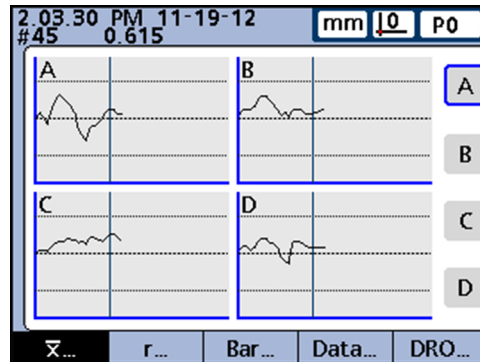
If the subgroup size is set to a value greater than 1, the soft-key row provides the following viewing options:

- « $\bar{x}$ ...»: Displays the mean ( $\bar{x}$ ) of each subgroup for up to 16 dimensions.
- «r...»: Displays the range (r) of each subgroup for up to 16 dimensions
- «Bar...»: Displays data in a bar graph
- «Data...»: Displays numerical data in a table
- «DRO»: Displays current values in the **DRO** view

$\bar{x}$  charts

To display  $\bar{x}$ charts for the dimensions:

- ▶ Press the « $\bar{x}$ » soft key.



This view is displayed for the dimensions in place of the line graph discussed earlier. It graphs the mean ( $\bar{x}$ ) of each subgroup for up to 16 dimensions.

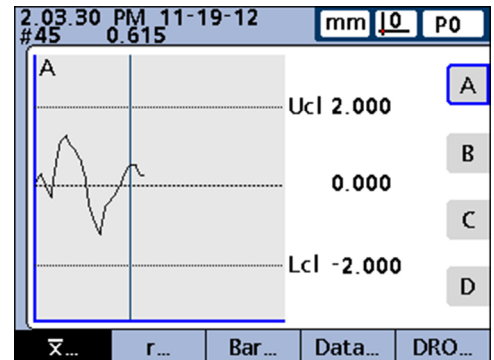
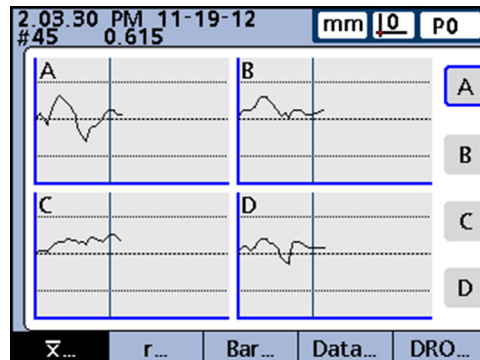
The following information is provided on the upper left of the LCD screen:

- Time and date that the individual value was stored
- Sample ID number for the dimension and the associated data value
- Nominal and limit values (only if a single dimension is displayed)

To toggle between a single and multiple line graphs displayed on the screen:

- ▶ Press the « $\bar{x}$ » soft key.

The display toggles between a single graph and multiple graphs:



To display a single graph of the desired dimension:

- ▶ Press the corresponding dimension key.
- ▶ Use the arrow keys to scroll the graphs when more data is stored than will fit on the screen.

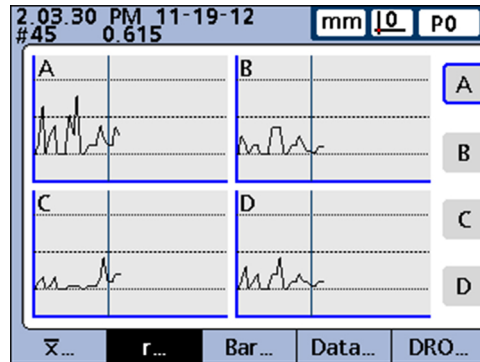
Individual samples can be selected by a vertical line on the graph:

- ▶ Move the vertical line with the «left» and «right» arrow keys.

*r* charts

To display *r* charts for the dimensions:

- ▶ Press the «r...» soft key.



This view graphs the range (*r*) of each subgroup for up to 16 dimensions.

The range is not recalculated for each measurement, but each time a subgroup is completed, see "Defining statistical parameters: SPC", page 82.

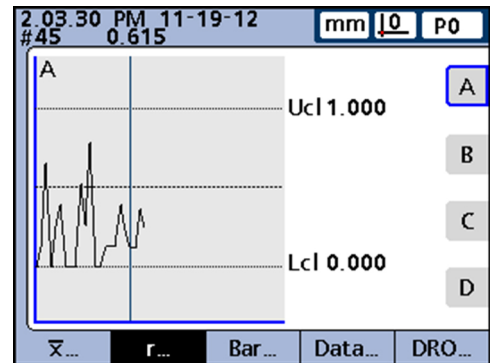
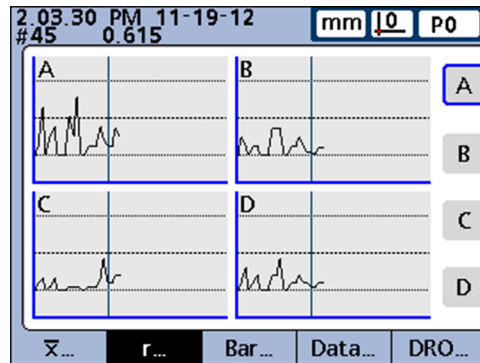
The following information is provided on the upper left of the LCD screen:

- Time and date that the individual value was stored
- Sample ID number for the dimension and the associated data value
- Nominal and limit values (only if a single dimension is displayed)

To toggle between a single and multiple line graphs displayed on the screen:

- ▶ Press the «r...» soft key.

The display toggles between a single graph and multiple graphs:



To display a single graph of the desired dimension:

- ▶ Press the corresponding dimension key.
- ▶ Use the arrow keys to scroll the graphs when more data is stored than will fit on the screen.

Individual subgroups are selected by a vertical line on the graph.

- ▶ Move the vertical line with the «left» and «right» arrow keys.

## Basic Operation

### DRO view

«Data...»: Dimension data tables

To display the dimensions in a data table:

- ▶ Press the «Data...» soft key.

2.03.30 PM 11-19-12		mm 10 P0	
#45 0.615			
A	B	C	D
0.369	0.566	0.615	0.314
0.369	0.566	0.615	0.314
0.123	0.460	0.820	0.418
0.123	0.460	0.820	0.418
0.492	0.354	1.024	0.314
0.492	0.354	1.024	0.314
0.615	0.319	1.127	0.366
0.615	0.319	1.127	0.366
0.492	0.283	1.024	0.314
0.492	0.283	1.024	0.314

This view displays tables containing measurement data for up to 4 dimensions.

The **Data** view is slightly different from that for SPC subgroups of one. Individual subgroups are indicated by a horizontal line in tables for single dimensions. The data table for multiple dimensions remains unchanged for SPC subgroups greater than one.

The following information is provided on the upper left of the LCD screen:

- Time and date that the individual value was stored
- Sample ID number for the dimension and the associated data value
- Nominal and limit values (only if a single dimension is displayed)

To toggle between the display of data for all dimensions and data for a single dimension that includes SPC statistics:

- ▶ Press the «Data...» soft key.

The view toggles between data for all dimensions and data for a single dimension:

2.03.30 PM 11-19-12		mm 10 P0	
#45 0.615			
A	B	C	D
0.369	0.566	0.615	0.314
0.369	0.566	0.615	0.314
0.123	0.460	0.820	0.418
0.123	0.460	0.820	0.418
0.492	0.354	1.024	0.314
0.492	0.354	1.024	0.314
0.615	0.319	1.127	0.366
0.615	0.319	1.127	0.366
0.492	0.283	1.024	0.314
0.492	0.283	1.024	0.314

2.03.30 PM 11-19-12		mm 10 P0	
#45 0.615			
A			
0.369	$\bar{x}$ 0.213		
0.369	$\bar{x}$ 0.246	Mean	0.203
0.123	r 0.246	Max	1.310
0.123	$\bar{x}$ 0.308	Min	-1.179
0.492	r 0.369	r	2.489
0.492	$\bar{x}$ 0.554	$\sigma(p)$	0.635
0.615	r 0.123	6 $\sigma$	3.808
0.615	$\bar{x}$ 0.554	Pp	1.0503
0.492	r 0.123	Ppk	0.9454
0.492	$\bar{x}$ 0.377		

To display a data table for a single dimension:

- ▶ Press the dimension key for the desired dimension.
- ▶ Use the arrow keys to scroll the tables when more data is stored than will fit on the screen.

### 5.3.2 «in/mm» function

Pressing this soft key toggles the display between inch and millimeter units of measure.



This function for toggling the units of measure has no influence on the measurement configuration of the input channels in the «Channels» setup screen.

The conversion from one unit of measure to another is only performed for the values displayed on screen.

### 5.3.3 «Master» function

The «Master» function is used to calibrate encoder datums and transducer measurement ranges.

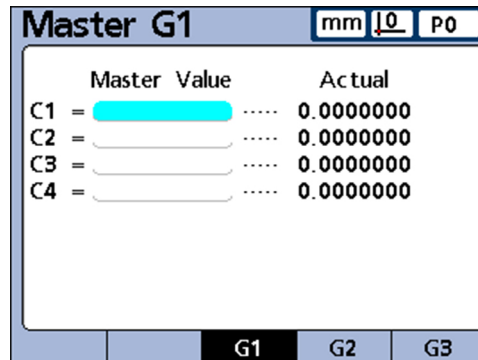


The function is configured in the «Master» setup screen to either calibrate the datum D0 for encoders, or to calibrate the datum D0 and the entire measurement range for transducers.

For more information on calibrating datums for input channels and calibrating value ranges for transducer input channels, see "Calibrating encoders and transducers: Master", page 100.

To open the «Master» screen for calibrating encoder datums:

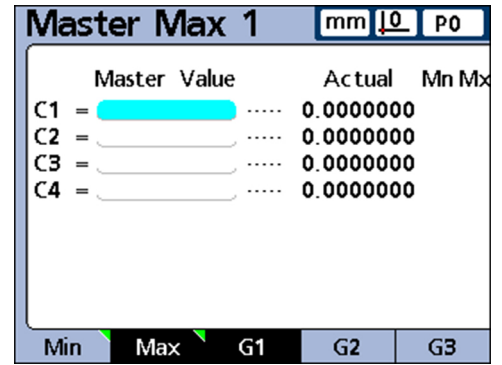
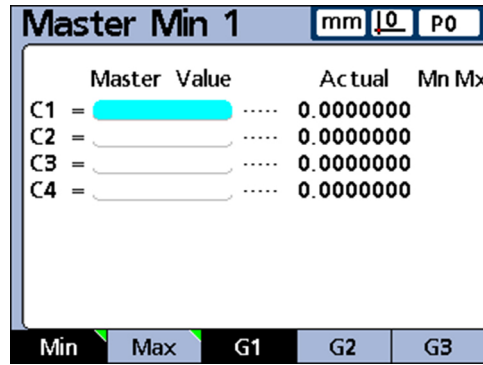
- Press the «Master» soft key.



When the «Master» setup screen is configured to perform full calibrations of transducer input channels (**Master Type** set to **Min-Max**), the full measurement range of any input channel can be calibrated at any time using the «Master Min» and «Master Max» screens.

Prior to using this function, and after clearing a «mastered channel value, the unit's machine zero is applied as the absolute datum. Up to 18 range calibration values can be stored for each transducer input channel. Any of these groups can be quickly recalled and applied later.





## 5.4 Menu screen

*Opening the «Menu» screen*

- ▶ In the **DRO** screen, press the «Menu» soft key.  
The soft-key row changes to allow choosing between different menus.

In the **Menu** screen, the soft-key row provides the following functions:

- «View» function (same as in **DRO** screen), see "View function", page 36
- «in/mm» function (same as in **DRO** screen), see "in/mm function", page 44
- «Datum» function, see "Datum function", page 45
- «Extra» function, see "Extra function", page 46
- «Setup» function, see "Setup function", page 49

### 5.4.1 «Datum» function

*Calling the «Datum» function*

The «Datum» function provides the means to zero, preset, clear and toggle between measurement reference datums.

- ▶ Press the «Menu/Datum» soft keys.

*Options*

The soft-key row provides the following options:

- «D0/D1»: Toggles between the absolute datum (D0) and the incremental datum (D1)
- «Zero...»: Resets a specific or all incremental datums to zero
- «Master»: Calibration of datums (see "Master function", page 44)
- «Preset»: Used for setting incremental datums
- «Clear»: Clears all incremental datums simultaneously. Cleared incremental datums (D1) are made equal to absolute datums (D0).

*Toggling the datum*

To toggle between the absolute datum (D0) and the incremental datum (D1):

- ▶ Press the «D0/D1» soft key.



There are commands and formulas that use a specific datum and toggle the datum automatically, if required. They are described in the respective sections.

Zeroing incremental datums

To zero a specific or all incremental datums:

- ▶ Press the «Zero...» soft key.

Current Value		mm	↓	P0
A		0.000		
B		0.926		
C		-0.162		
D		0.421		
Zero All		Zero A	Zero B	Zero C
Zero D				

- ▶ Press the «Zero» soft key for the datum(s) to be zeroed.

For more information see "Zeroing a dimension reference", page 236.

Setting incremental datums

- ▶ Press the «Preset» soft key.

The **Preset dimension** screen for setting the incremental datums is displayed.

Select dimensions		mm	↓	P0
A				
B				
C				
D				
				w/Norm

For more information see "Presetting a dimension reference to a specific value", page 237.

### 5.4.2 «Extra» function

The «Extra» function provides quick access to a variety of display functions and other functions of the measuring device.

Calling the «Extra» function

- ▶ Press the «Menu/Extra» soft keys.

Current Value		mm	↓	P0
A	Cycle	0.000		
B	DMS/DD	0.000		
C	Fast3	0.000		
D	Hold	0.000		
	Part?	0.000		
	Rad/Dia	0.000		
	Recall	0.000		
	RsetDyn	0.000		
	Send	0.000		
	SendRec	0.000		
View...	in/mm	Datum...	Extra	Setup

#### *Options*

The soft-key row provides the following options:

- **DMS/DD**: Toggles the display of angles between Degrees, Minutes, Seconds (DMS) and Decimal Degrees (DD)
- **Recall**: Applies the last used incremental datum (D1) that was preset by the user
- **Rad/Dia**: Toggles between the radius and diameter measurement types on the **DRO** screen, if radius or diameter was specified in the «Formats» setup screen
- **RsetDyn**: Resets the minimum and maximum values acquired during dynamic measurements. This function must be initiated prior to new dynamic measurements
- **Send**: Sends the specified current dimension values, or all current dimension values to the RS-232/V.24 serial port for transmission to a computer. The user is prompted to send one or all values
- **SendRec**: Sends stored records to the RS-232/V.24 serial port for transmission to a computer see "Setting the print format and report contents: Report", page 114
- **Hold**: Toggle function that holds (freezes) or releases the current value of a single dimension (when a dimension soft key is pressed) or of all dimensions (when the «All» soft key is pressed)
- **Part?**: Displays a pop-up window for entry of a new part number
- **Fast3**: Refer to the "Fast3" section below this list
- **Cycle**: Advances to the next defined part. Part numbers are cycled in a continuous loop

#### *Using an «Extra» menu function*

- ▶ Select the desired function with the «up» and «down» arrow keys and press «enter».

#### **Fast3** function

The **Fast3** function samples the channel 2 input each time the channel 1 input changes by a specified sample increment.

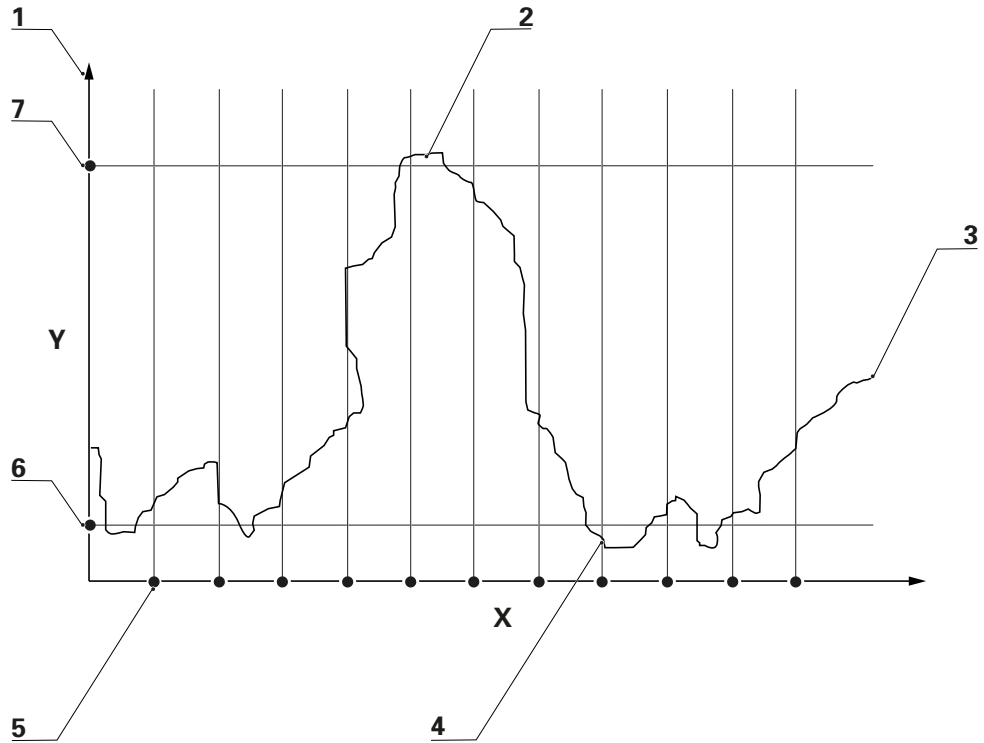
If the sampled value of channel 2 falls outside a specified range, all input values of the base channels (first 1, 4 or 8 channels) will be stored in a dedicated memory array; otherwise samples will not be stored.

This sampling process continues until:

- The user aborts the process by pressing «quit» or «cancel»
- The user clears the memory and restarts the process by pressing «enter»
- The user successfully completes the process and presses «finish»
- The process is automatically completed after 50,000 sets of channel positions have been stored

Example of **Fast3**:  
User-specified limits  
exceeded

For the duration of the **Fast3** function process, the unit adopts an X/Y axis reference system. Channel 1 is referred to as the X axis, and channel 2 as the Y axis.



- 1 Y axis (C2)
- 2 Channel input values stored
- 3 Channel 2 input value
- 4 Channel input values stored
- 5 X axis (C1) with sample increment
- 6 Low limit
- 7 High limit

In the example shown, the channel 2 (Y axis) input values exceed the user-specified limits five times, but channel input values are stored only twice when the channel 2 value exceeds the limits at a sample point between intervals.

When the **Fast3** function is successfully completed, the stored sets of channel input values are processed by dimension formulas in the order that they were collected. The formula results are then stored in the database of the unit. During the processing of formulas, a percentage of completion will be displayed. Since up to 50,000 sets of channel input values can be collected and processed by formulas, considerable time could be required to complete the processing.

**i** Since the values processed by formulas after **Fast3** data collection are contained in memory storage, no user interaction is possible. When the **Fast3** function from the «Extra» menu is used, functions that require user interaction, such as the **Ask** function, must be avoided.

**i** If any key is pressed while the unit is processing formulas, the remaining channel input values will be deleted from memory and formula processing will be aborted.

## Basic Operation

### Menu screen

#### Activating the **Fast3** function

- ▶ Press the «Menu/Extra» soft keys.
- ▶ Use the arrow keys to highlight the **Fast3** function.
- ▶ Press «enter».

Current Value		mm	10	P0
A	Cycle	0.000		
	DMS/DD			
	<b>Fast3</b>			
B	Hold	0.000		
	Part?			
C	Rad/Dia	0.000		
	Recall			
	RsetDyn	0.000		
	Send			
D	SendRec	0.000		

View... in/mm Datum... Extra Setup

#### Entering parameters

- ▶ Enter a Y axis (channel 2) upper limit.
- ▶ Enter a Y axis (channel 2) lower limit.
- ▶ Enter an X axis (channel 1) capture increment.
- ▶ Enter an X axis (channel 1) resolution factor (this is a multiplier of scale resolution).

Once these parameters are entered, the function will begin to read the input values for channels 1 and 2.

### 5.4.3 «Setup» function

The «Setup» function provides screens for entering operating parameters and for creating formulas that define dimension values.

#### Setting operating parameters

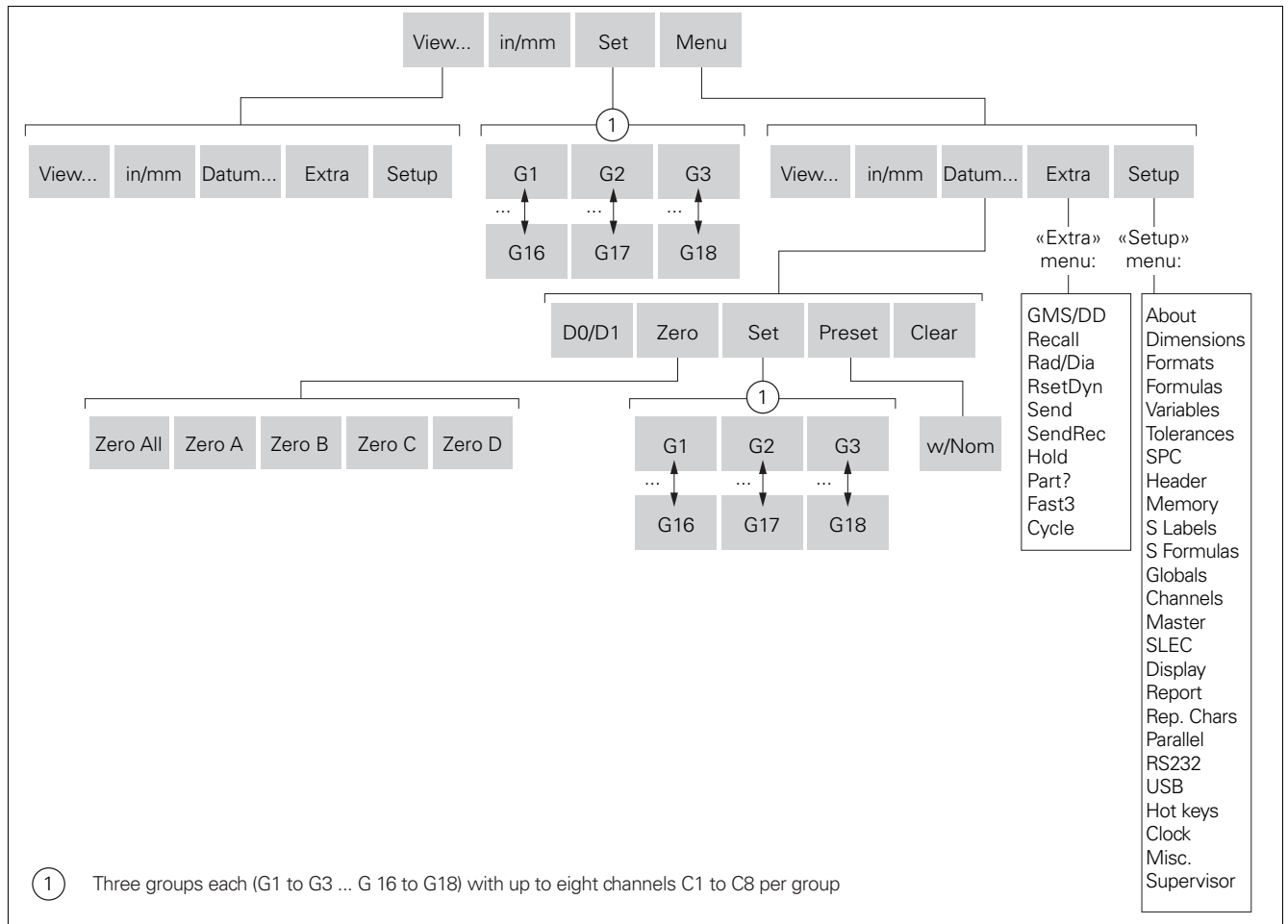
- ▶ Press the «Setup» soft key.

A split screen appears in which the available operating parameters are listed in the selection window on the left.



For more information on the user interface and on setting the operating parameters with the «Setup» function, see "Software setup", page 60.

## 5.5 Menu tree



# 6 Commissioning

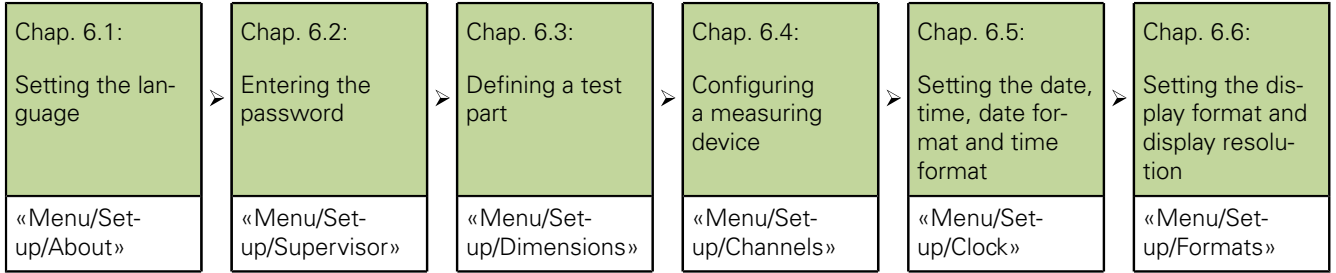
## Personnel requirement



The following steps are only to be performed by qualified personnel!  
For more information see "Personnel qualification", page 10.

### Essential commissioning steps

The following essential commissioning steps are required to provide a basic configuration. They are the first settings to be made after installation:



For information on adapting individual operating parameters to measuring devices, measurements and device settings, see "Software setup", page 60.

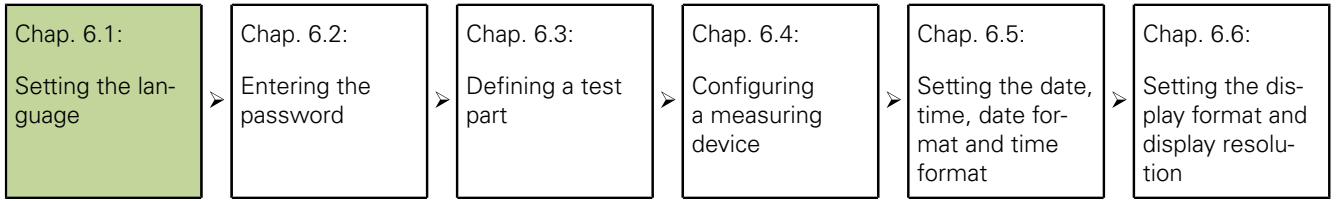
### Accessing setup

- ▶ Switch on the unit and wait until the home screen is displayed.
- ▶ Press «enter».

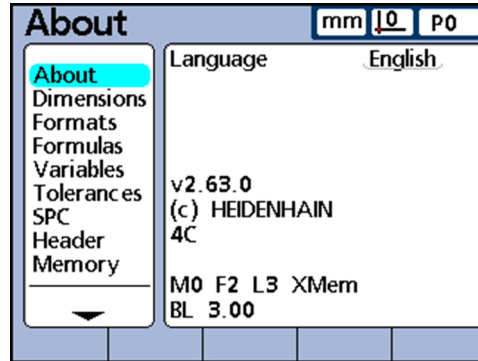
To access the setup from the **DRO** screen:

- ▶ Press the «Menu/Setup» soft keys.

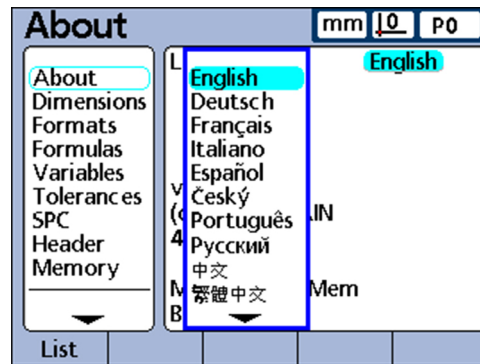
## 6.1 Setting the language



When commissioning the unit, the **About** entry is automatically highlighted in the selection window on the left:



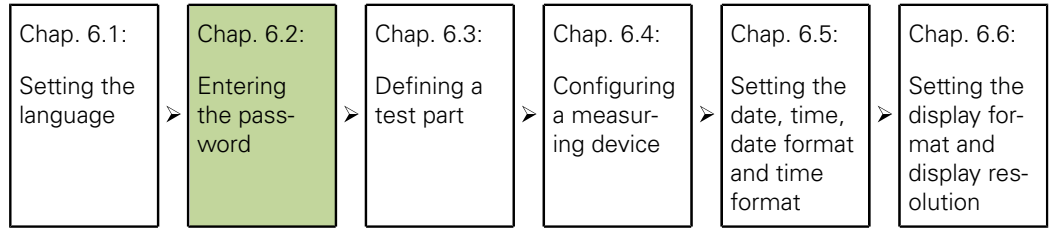
- ▶ Press the «right» arrow key.  
For language selection; the default language (English) is highlighted.
- ▶ Press the «List» soft key.
- ▶ Use the arrow keys to highlight the desired language.



- ▶ Press «finish».  
The «Setup» menu is displayed in the selected language.
- ▶ Press «finish».



## 6.2 Entering the password



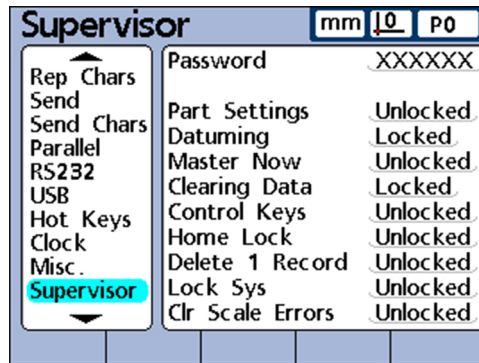
### NOTICE

Incorrect measurement results!

Once the password is entered, settings and programs can be modified. Unauthorized changes may lead to incorrect measurement results.

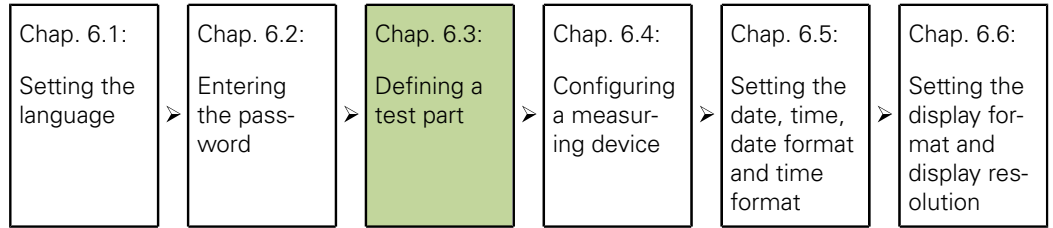
- ▶ Settings and programs must only be changed by qualified personnel. For more information see "Personnel qualification", page 10.

- ▶ In the «Setup» menu, select «Supervisor» with the arrow key:

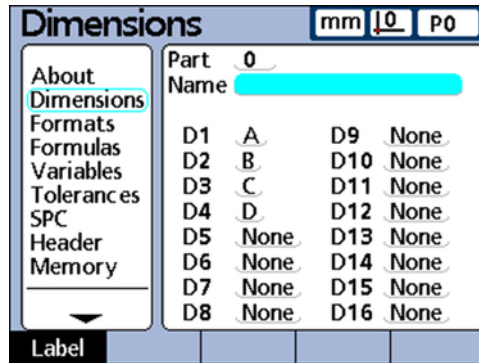


- ▶ Press the «right» arrow key.
- ▶ In the input window on the right (**Password** field is highlighted), enter the default password **070583** with the numeric keypad.
- ▶ Press «finish».

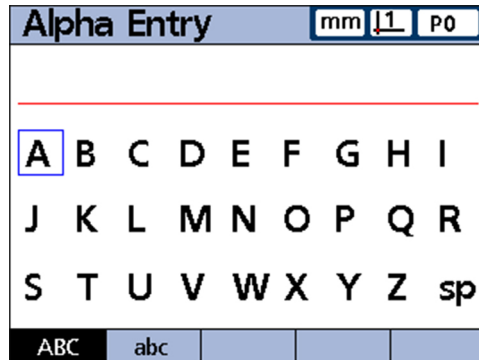
### 6.3 Defining a test part



- ▶ In the «Setup» menu, select **Dimensions** with the arrow key.
- ▶ Press the «right» arrow key.
- ▶ In the **Dimensions** screen, use the arrow keys to select **Name**.

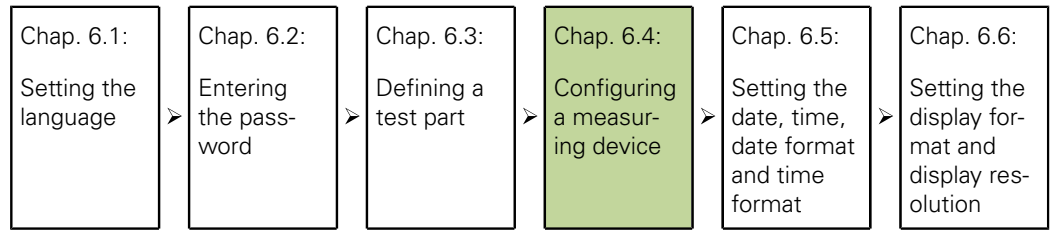


- ▶ Press the «Label» soft key.
- The **Alpha Entry** screen is displayed. **A** is highlighted:



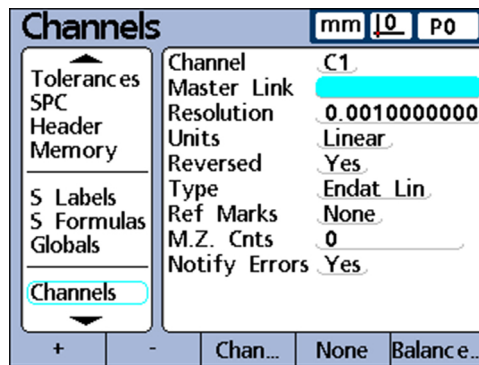
- ▶ Enter the name **TST**. For this, select each character with the arrow keys and confirm it with «enter».
- ▶ Use «cancel» to delete incorrect entries.
- ▶ To switch between upper and lower case, press the «abc» and «ABC» soft keys.
- ▶ Conclude the entry with «finish».

## 6.4 Configuring a measuring device



**Requirement:**Dimension screen is displayed, cursor is on **Name** field.

- ▶ Press the «left» arrow key.
- ▶ Use the arrow keys to highlight **Channels**:



- ▶ Press the «right» arrow key.
- ▶ In the **Channels** screen, use the arrow keys to highlight **Resolution**.
- ▶ Enter a value.

- For EnDat encoders:  
No manual settings required. The information is read from the encoder.
- For 1 Vpp measuring devices:
  - Linear encoders and touch probes: **Resolution** = Signal period in mm / 40
  - Rotary and angle encoders: **Resolution** = 360 / (line count x 40)

Examples:

Series	Signal period
SPECTO ST 128x/308x	20 µm = 0.02 mm
METRO MT 12/25/60/101	10 µm = 0.01 mm
METRO MT 128x/258x	2 µm = 0.002 mm
LS 388C/688C, LS 187/487	20 µm = 0.02 mm

- For TTL measuring devices:
  - Linear encoders and touch probes: **Resolution** = Signal period in mm / 4
  - Rotary and angle encoders: **Resolution** = 360 / (line count x 4)

Examples:

Series	Signal period
SPECTO ST 127x/307x TTLx5	4 µm = 0.004 mm
SPECTO ST 127x/307x TTLx10	2 µm = 0.002 mm
METRO MT 127x/257x TTLx5	0.4 µm = 0.0004 mm
METRO MT 127x/257x TTLx10	0.2 µm = 0.0002 mm
LS 328C/628C	20 µm = 0.02 mm
LS 177/477 TTLx5	4 µm = 0.004 mm
LS 177/477 TTLx10	2 µm = 0.002 mm
LS 177/477 TTLx20	1 µm = 0.001 mm

The values for measuring devices that are not listed in these tables are provided in the catalogs or product information documents.

- ▶ Select **Units** with the arrow keys and press the «List» soft key.
- ▶ Press the arrow key to select the desired unit of measure and confirm your selection with «enter».
- ▶ Select **Reversed** with the arrow keys.
- ▶ Press the «Yes» or «No» soft key.  
 «Yes» = Reverse the direction of count and the polarity  
 «No» = Do not reverse the direction of count and the polarity
- ▶ Select **Type** with the arrow keys and press the «List» soft key.
- ▶ Press the arrow key to select the channel input type and confirm your selection with «enter».
- ▶ Select **Ref Marks** with the arrow keys and press the «List» soft key.

Ref Marks	Description
None	The connected measuring device has no reference marks or no reference mark evaluation is to be performed
Manual	The connected measuring device is manually set to zero by the user and confirmed with «enter»; this option is used for hard stops
Ref	The connected measuring device has one reference mark
Abs AC	The connected measuring device has distance-coded reference marks of the Acu-Rite type (coded like ENC 150 or SENC 150)
Abs HH	The connected measuring device has distance-coded reference marks of the HEIDENHAIN type with a nominal increment of 1000 signal periods
Abs HH2	The connected measuring device has distance-coded reference marks of the HEIDENHAIN type with a nominal increment of 5000 signal periods

## Commissioning

Setting the date, time, date format and time format

- ▶ Press the arrow key to select the reference mark type and confirm your selection with «enter».



The **Ref Marks** field and the list of reference mark types are not available for EnDat encoders!

- ▶ Select **C1** with the arrow keys and press the «+» soft key to select additional measuring devices for configuration. Repeat the steps described above to configure each additional input channel.

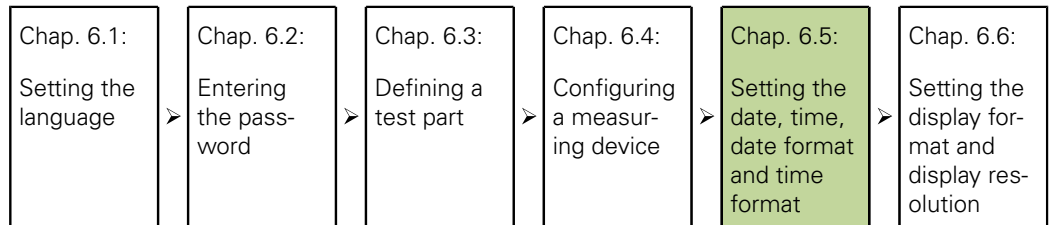
When all input channels have been configured:

- ▶ Press «finish» twice to conclude the configuration of measuring devices and return to the **DRO** screen.



For more information on the **Channels** setup screen and its fields, see "Configuring measuring devices: Channels", page 89.

## 6.5 Setting the date, time, date format and time format



*Setting the date and time*

The «Clock» setup screen contains fields for setting and formatting displays of date and time shown on the LCD and printed on reports.

- ▶ Press the «Menu/Setup» soft keys.
- ▶ Select **Clock** with the arrow keys.
- ▶ Press the «right» arrow key to switch to the input window on the right.
- ▶ Use the numeric keypad to enter the year into the **Year** field and press «enter».

The highlight moves to the **Month** field.

- ▶ Use the numeric keypad to enter the month (without leading zero) and press «enter».

The highlight moves to the next field.

- ▶ Repeat these steps for the **Day**, **Hours**, **Minutes** and **Seconds** fields (each without leading zeros).

After the seconds have been entered, the **Date Format** field is highlighted.

*Setting the date format*

The **Date Format** field specifies the format of the date shown on the LCD and printed on reports.

- ▶ Select **Date Format** with the arrow keys.
- ▶ Press the soft key for the desired date format:

Soft key	Date format display (example)
«M/D/Y:»	9-20-13
«D/M/Y:»	20-9-13

## Commissioning

Setting the display format and display resolution

Soft key	Date format display (example)
«M.D.YY:»	09.20.13
«D.M.YY:»	20.09.13

- ▶ Press «enter».  
The highlight moves to the **Time Format** field.

Setting the time format

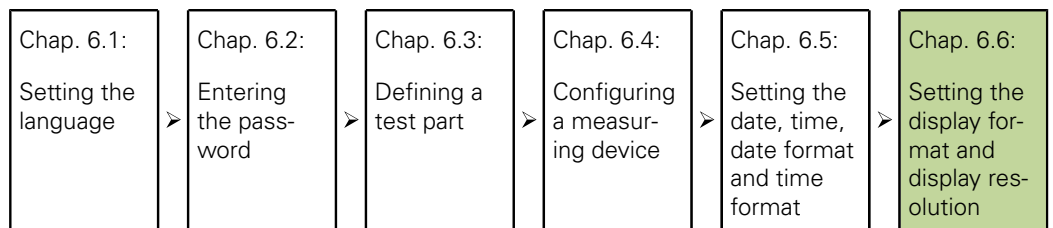
The **Time Format** field specifies the format of the time shown on the LCD and printed on reports.

- ▶ Press the soft key for the desired time format.

Soft key	Time format display (example)
«12»	01.44.37
«24»	13.44.37
«12:»	01:44:37
«24:»	13:44:37

- ▶ Press «finish» to conclude the selection of the time format.

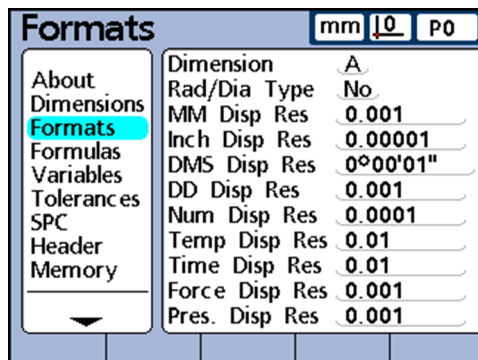
## 6.6 Setting the display format and display resolution



The «Formats» setup screen contains fields for specifying the display format and display resolution for dimensions of the currently selected part. Here you can also choose whether the radius or diameter will be measured.

Calling the «Formats» setup screen

- ▶ Press the «Menu/Setup» soft keys.
- ▶ In the «Setup» menu, use the arrow keys to highlight **Formats**.



## Commissioning

Setting the display format and display resolution

- Selecting a dimension*
- ▶ Press the «right» arrow key.  
**Dimension** is highlighted.
  - ▶ Press the «down» arrow key  
or  
press the «Dec/Inc» soft key to highlight the desired dimension and press «enter» to confirm.

*Specifying radius or diameter*

Radius or diameter measurements can be specified for cylindrical and spherical parts or parts with curved surfaces. When radius or diameter measurements are specified, the corresponding symbol will be displayed near the associated dimension on the **DRO** screen.

To specify radius or diameter:

- ▶ Use the arrow keys to highlight **Rad/Dia Type**.
- ▶ Press the «Radius» or «Diam.» soft key to specify whether the radius or diameter is to be measured.
- ▶ If desired, press the «Apply All» soft key to apply the setting (radius or diameter) of the currently selected part to all parts.
- ▶ Press «enter».

*Display resolution*

The display resolution fields are used to specify how numbers are shown on the **DRO** screen. Displayed numbers will be rounded as the display resolution is decreased. This table illustrates how the display of numbers is governed by the display resolution setting.

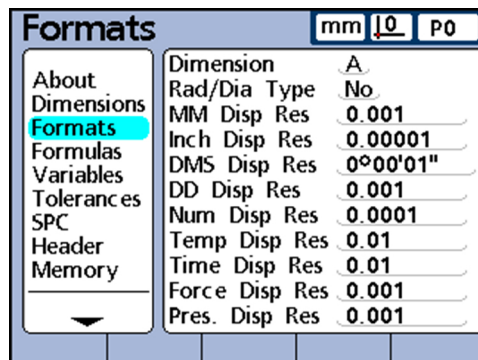
Channel input value	Display resolution	Number displayed
1.567	0.0001	1.5670
1.567	0.001	1.567
1.567	0.01	1.57
1.567	0.1	1.6
1.567	1	2



The measurement resolution should not be higher than the input channel resolution. Specifying display resolutions that are higher than the input channel resolutions can lead to misleading displays of dimension values.

*Specifying display resolution*

- ▶ Use the arrow keys to highlight a display resolution (**DispRes**) field.
- ▶ Enter the desired display resolution with the numeric keypad.



- ▶ Press «enter».

# 7 Software setup

## Personnel requirement



The following steps are only to be performed by qualified personnel!  
For more information see "Personnel qualification", page 10.

## Overview

This chapter contains a complete description of all the setup parameters for the unit. It is designed as a reference guide.

The basic settings required to display measured values and to prepare the unit for simple measurements are described in "Commissioning", page 51 .

The operating parameters must be configured prior to using the unit for the first time, and any time part measurement, reporting or communication requirements change.

Day to day use of the unit does not require reconfiguration of system settings.



Parameter changes made in any of the setup screens can change the operation of the unit. For this reason critical setup parameters are password-protected. Only qualified personnel should be given password access to setup screen parameters. For more information on unlocking password-protected setup functions, see "Locking or unlocking critical functions: Supervisor", page 139.

The unit can be configured manually using the Setup menu screens, or automatically by loading a settings file saved after a previous setup session.

Settings files are loaded from USB drives.

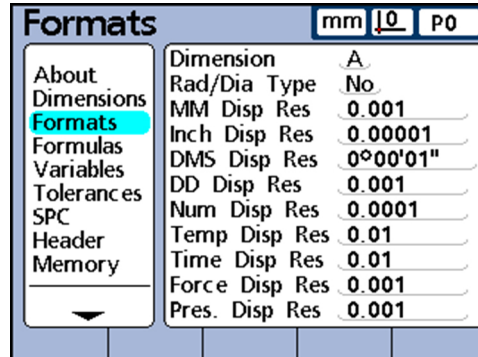
Parameters configured in setup screens will be retained until:

- The data-backup battery is changed
- The data and settings are cleared intentionally or accidentally
- The parameters in the setup screens are changed
- Software upgrades are performed
- Previously saved settings files are loaded



## 7.1 «Setup» menu

Most operating parameters are configured using screens and data fields accessed from the «Setup» menu. Highlighting «Setup» menu items on the left side of the screen displays the corresponding parameter data fields and choice fields on the right side of the screen.



«Setup» menu features

- Left screen window: Setup screen name
- Right screen window:
  - «Setup» choice field: Setup choices are made
  - «Setup» data field: Setup data are entered

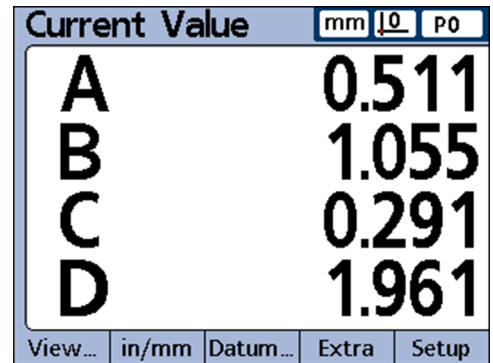
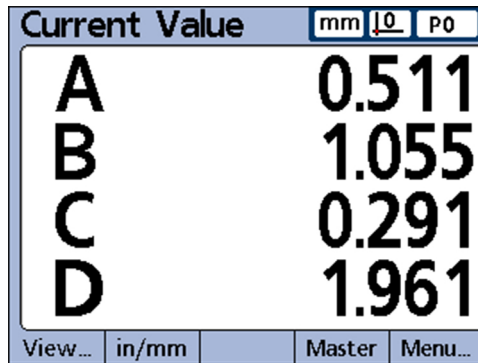


Starting from section 7.2 in this chapter, the setup screen descriptions are presented in the order of their appearance in the «Setup» menu. When the unit is set up for the first time, the setup screens should be configured as described in chapter "Commissioning", page 51 . The setup procedure can then be continued in the order that best satisfies the application or the user's preferences. A subsequent reconfiguration of parameters in the «Setup» menu will mainly be necessary after hardware changes.

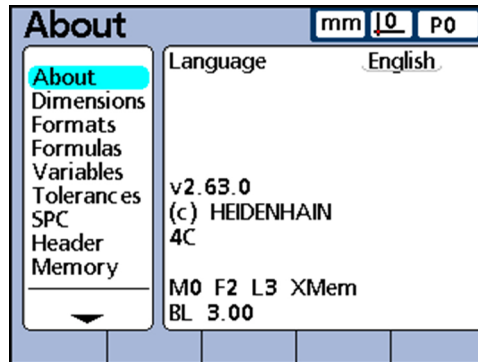
## 7.1.1 Accessing the «Setup» menu and screens

Accessing the «Setup» menu

- ▶ Press the «Menu» soft key.
- ▶ Press the «Setup» soft key.

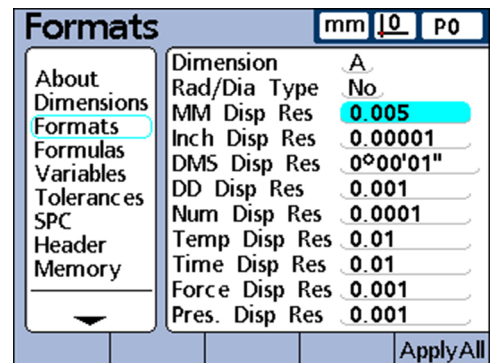
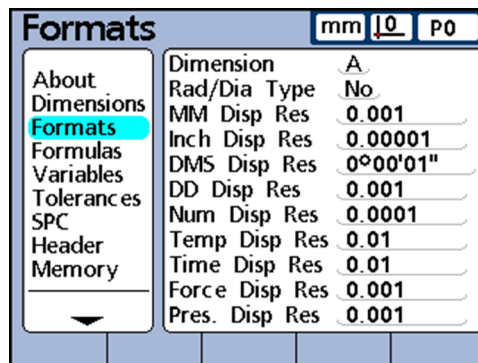


The «Setup» menu is displayed and shows the first setup screen:



Accessing the «Setup» menu screens

- ▶ Use the «up» and «down» arrow keys to scroll through the «Setup» menu and highlight the desired setup screen.
- ▶ Press the «right» arrow key to access the selected setup screen.



- ▶ Use the «up» and «down» arrow keys to scroll through the setup screen and select the desired parameter.

## Software setup

«Setup» menu

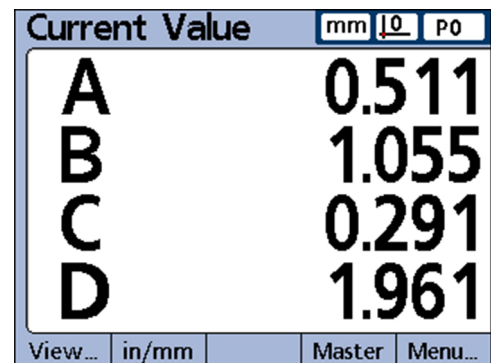
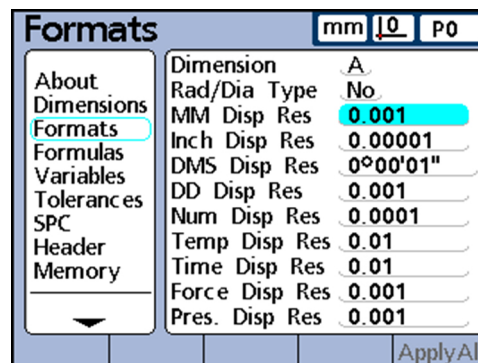
Using dimension keys in the «Setup» mode

The functions of the dimension keys change to speed up setup screen navigation when the «Setup» menu is displayed. Dimension keys can be used to move to the top or bottom of the «Setup» menu or to page up or down through the «Setup» menu. For more information on dimension keys, see "Keys", page 32.

Dimension key	Setup mode function
1	Menu top
2	Page up
3	Page down
4	Menu bottom

### 7.1.2 Leaving the «Setup» menu

- Press the «finish» key repeatedly to conclude the «Setup» session and return to the home screen.



### 7.1.3 Entering setup parameters

Overview

The following topics are dealt with in this chapter:

- Changing the channel or dimension number
- Entering parameters
- Copying parameters to other parts, dimensions or channels
- Saving a parameter and advancing to the next
- Saving a parameter and returning to the «Setup» menu
- Discarding changes and returning to the «Setup» menu

#### Changing the channel or dimension number

Setup parameters and functions are often related to specific channels or dimensions. When a channel or dimension is highlighted on the «Setup» screen, the channel or dimension number can be increased or decreased by pressing the «Inc» or «Dec» soft key or by pressing the fast track keys. For more information on keys, see "Keys", page 32.

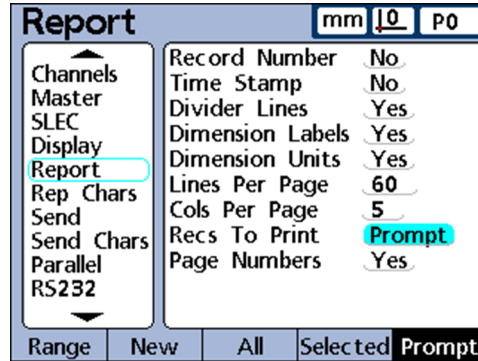


Some parameters can only be modified after the supervisor password is entered. For more information see "Password", page 139

## Entering parameters

- ▶ Highlight a setup parameter.  
Available options are displayed in the soft-key row at the bottom of the screen.
- ▶ Press the desired soft key.

The selected option is entered into parameter field.

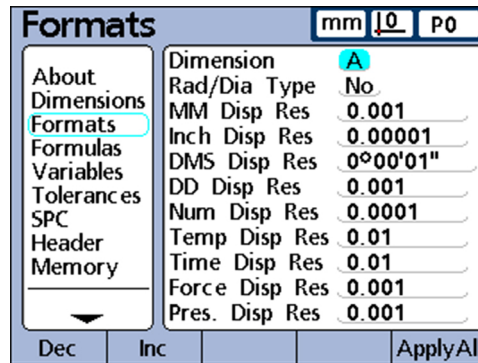


## Copying parameters to other parts, dimensions or channels

*If parameters differ*

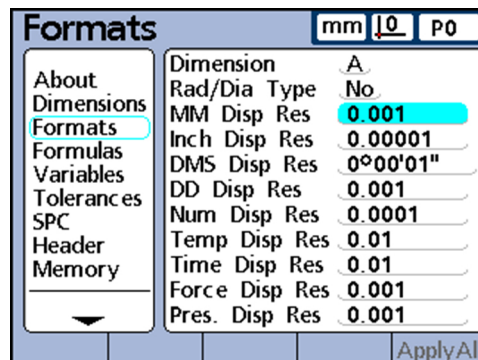
A single highlighted parameter or all parameters of the current part, dimension or channel can be copied to all others:

- ▶ Press the «Apply All» soft key.



*If parameters are identical*

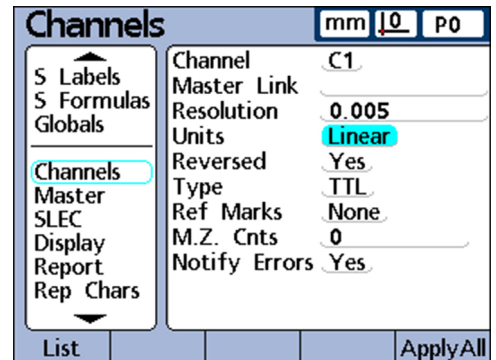
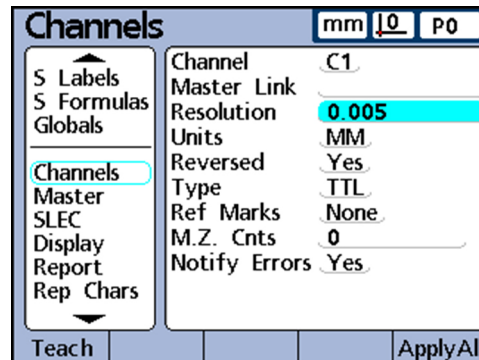
If all part, dimension or channel parameters are already the same for the selected setup category, the «Apply All» soft key will be grayed-out.



### Saving a parameter and advancing to the next

To save the entered parameter value and advance to the next parameter field:

- Press «enter».

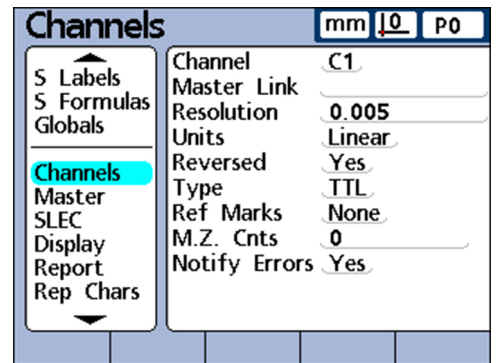
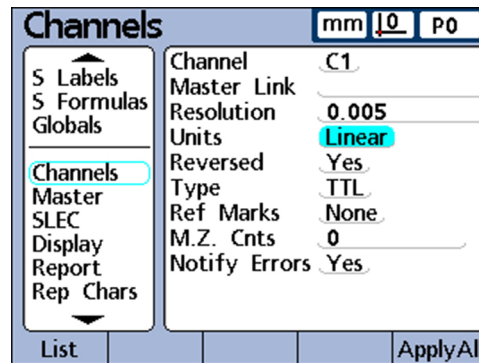


### Saving a parameter and returning to the «Setup» menu

To return to the «Setup» menu:

- Press «finish».

The settings are stored.

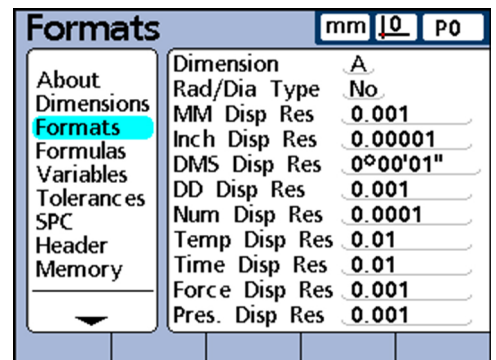
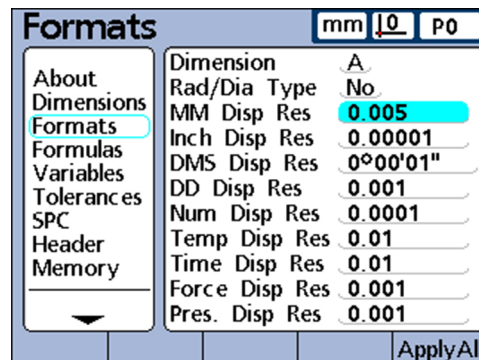


### Discarding changes and returning to the «Setup» menu

To return to the «Setup» menu:

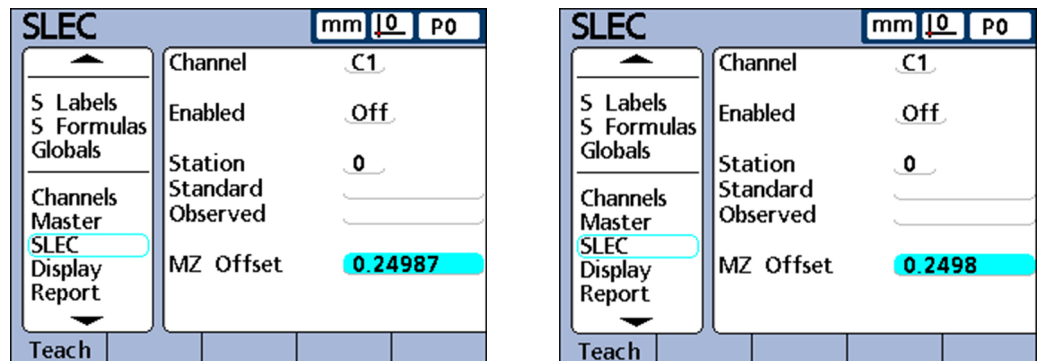
- Press «quit».

The changes made are discarded.



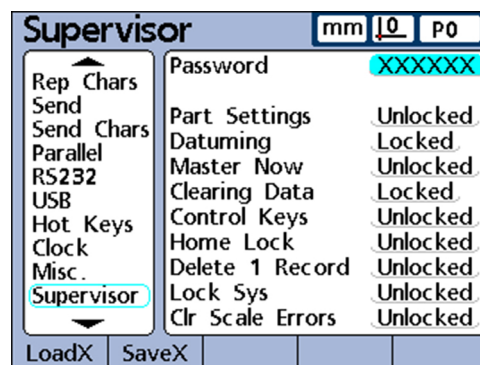
## 7.1.4 Deleting data entries

- ▶ Highlight a data field.
- ▶ Press «cancel» to erase the rightmost character.



## 7.1.5 Saving or loading configurations

- ▶ Insert a USB drive into the USB port.
- ▶ Navigate to the «Supervisor» setup screen.



- ▶ Highlight the **Password** field and enter the password if necessary.
- ▶ Press the «SaveX» soft key to save the current configuration as an .xml file  
or  
Press the «LoadX» soft key to load a previously saved .xml configuration file from the USB drive.

## 7.1.6 Printing setup configurations

All configuration settings and formulas of the unit can be printed as a text file while displaying any «Setup» screen:

- ▶ Press «Send».

## Software setup

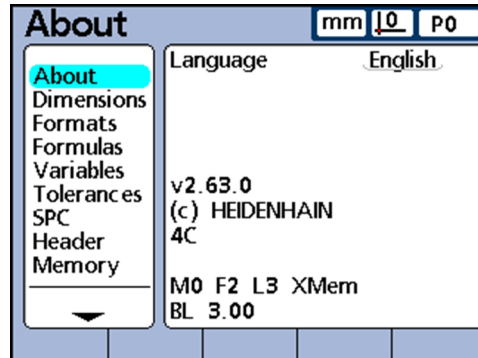
Defining part and dimension labels: «Dimensions»

---

### 7.2 Selecting the language: «About»

*Activation* «Menu/Setup» soft keys

*Short description* The «About» setup screen contains selections for changing the language of text displayed on the LCD, included in transmitted data and printed on reports. Software and hardware version information and the number of input channels are displayed on the bottom of the screen.



*Selecting the displayed language*

- ▶ Highlight the **Language** field.
- ▶ Press the «List» soft key.
- ▶ Select the desired language with the arrow keys.
- ▶ Press «enter».  
The ««Setup»» menu is displayed in the selected language.
- ▶ Press «finish».

### 7.3 Defining part and dimension labels: «Dimensions»

*Overview* This section describes the following functions:

- Structure and format of part numbers
- Creating part numbers
- Selecting part numbers
- Labeling parts and dimensions
- Defining visible and hidden dimensions
- Copying dimension parameters to other parts
- Deleting parts

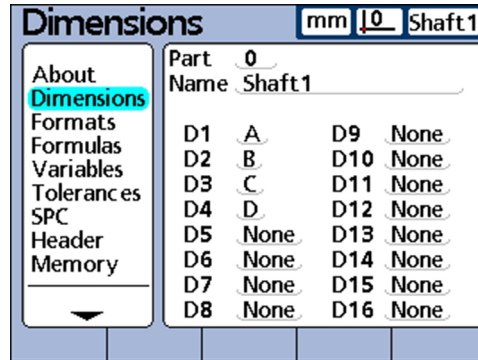
*Activation* «Menu/Setup» soft keys, «Dimensions» setup screen

*Short description* The «Dimensions» setup screen contains fields for defining the part and dimension labels displayed on the screen, included in transmitted data, printed on reports and stored in the unit's database for up to 100 different parts. Dimensions must be defined prior to other setup activities and conducting tests.

## Structure and format of parts

Part numbers consist of two numeric digits in the range from 0 to 99 assigned by the system in sequence as new parts are added. Part names consist of up to 8 alphanumeric characters entered from the Alpha Entry screen and the numeric keypad. Part names are shown in reports, but only part numbers are shown in formulas. Completed dimension labels of one part can be copied and applied to another.

Visible and hidden dimensions use the same naming convention. For each part, 16 visible and 16 hidden dimensions can be freely assigned and used.



Deleting a part number will erase all the data on this part and all the data associated with its dimensions from the database of the unit. Deleting a part number also decrements the part numbers of any higher numbered parts. As a result, the data associated with these part numbers will change as the respective part numbers now contain the data from a previously higher numbered part.

## Creating part numbers

Up to 100 (software) parts can be created in the unit. Creating multiple parts is useful for various reasons:

- If the number of measurements performed on one physical part is large and can be divided into categories
- If different physical parts must be measured or
- If more dimensions are needed to measure a part than can be provided by a single part (step functions)

*Creating a new part number*

- ▶ Highlight the **Part** field.
- ▶ Press the «New» soft key.

## Selecting part numbers

*Selecting an existing part number*

- ▶ To navigate down through a list of parts: Press the «left fast track key» or the «Dec» soft key.
- ▶ To navigate up through a list of parts: Press the «right fast track key» or the «Inc» soft key.



### Labeling parts and dimensions

Part labels contain up to 8 alphanumeric characters. Dimension labels contain up to 3 alphanumeric characters. Alphabetic characters are in the range from A to Z and can be upper or lower case. Numeric characters are in the range from 0 to 9. The order of alphabetic and numeric characters in a label is defined by the user. The process of labeling a part or dimension is identical.

#### *Labeling a part or dimension*

- ▶ Highlight the **Name** field or a dimension field.
- ▶ Press the «Label» «» soft key .  
The Alpha Entry screen is displayed.
- ▶ Create the desired label using the Alpha Entry screen and/or the numeric keypad.
- ▶ Press «finish».



Labels should be meaningful by reflecting the measurement application when possible.

### Defining visible and hidden dimensions

Dimensions are initially placeholders to which a value can subsequently be assigned by formulas. Dimensions are visible by default. Visible dimensions are displayed on the screen and stored in the database.

Dimensions can also be defined as hidden for use in operations without displaying them. Hidden dimensions are not printed on reports or sent to computers as data files.

Visible and hidden dimensions use the same naming convention. For each part, 16 visible and 16 hidden dimensions can be freely assigned and used.

#### *Creating a visible dimension*

- ▶ Highlight a dimension field.
- ▶ Press the «Visible» soft key.  
Visible dimensions are displayed.
- ▶ Press the «Label» soft key.
- ▶ Create a label using the Alpha Entry screen and/or the numeric keypad.
- ▶ Press «finish».

#### *Creating a hidden dimension*

- ▶ Highlight a dimension field.
- ▶ Press the «Hidden» soft key.  
Hidden dimensions are displayed.
- ▶ Press the «Label» soft key.
- ▶ Create a label using the Alpha Entry screen and/or the numeric keypad.
- ▶ Press «finish».

For more information on using hidden dimensions, see "Custom programming", page 142.

### Copying dimension parameters to other parts

Dimensions assigned to one part can be copied to another to save setup time when similar or identical measurements must be performed on new parts. The labels, formulas and all other parameters will be copied to the next new part. Database records will not be copied.

*Copying dimensions to a new part*

- ▶ Highlight the **Part** field.
- ▶ Press the «Copy to» soft key.  
A pop-up window shows the next part number.
- ▶ Press the «OK» soft key to start copying.
- ▶ Press the «OK» soft key to return to the «Dimensions» setup screen.

### Deleting parts

Parts can be deleted when it is no longer necessary to store old measurement results in the unit. Deleting old part data makes more system memory available for new data and dimension formulas.

*Deleting a part*

- ▶ Highlight the **Part** field.
- ▶ Press the «Inc» or «Dec» soft key to highlight the desired part.
- ▶ Press the «Del» soft key.
- ▶ Press the «Yes» soft key to delete the part.

## 7.4 Specifying the display format and display resolution: «Formats»

*Overview*

This section describes the following functions:

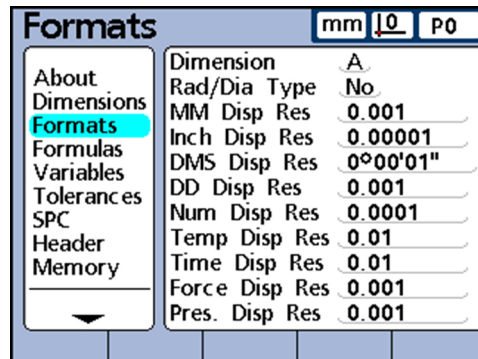
- Selecting a dimension
- Specifying radius or diameter
- Display resolution

*Activation*

«Menu/Setup» soft keys, «Formats» setup screen

*Short description*

The «Formats» setup screen contains fields for specifying the display format and display resolution for dimensions of the currently selected part. Selections of radius and diameter measurement types are also provided.



### Selecting a dimension

- ▶ Highlight the **Dimension** field.
- ▶ Press the «Dec» or «Inc» soft key to highlight the desired dimension.
- ▶ Press «enter».

## Specifying radius or diameter

Radius or diameter measurements can be specified for cylindrical and spherical parts or parts with curved surfaces. When radius or diameter measurements are specified, the corresponding symbol will be displayed near the associated dimension on the **DRO** screen.

The display can be toggled between Radius and Diameter later from the Home screen using the «Extra» menu. The selected display mode remains in effect until the system power is cycled off and then on again. The default display mode upon power-up is specified in the «Formats» setup screen.

*Specifying radius or diameter*

- ▶ Highlight the **Rad/Dia Type** field.
- ▶ Press the «Radius», «Diam.» or «No» soft key to specify the desired measurement type.
- ▶ Press «enter».

## Display resolution

The display resolution fields are used to specify how numbers are shown on the **DRO** screen. Displayed numbers will be rounded as the display resolution is decreased.

Channel input value	Display resolution	Number displayed
1.567	0.0001	1.5670
1.567	0.001	1.567
1.567	0.01	1.57
1.567	0.1	1.6
1.567	1	2



The measurement resolution should not be higher than the input channel resolution. Specifying display resolutions that are higher than the input channel resolutions can lead to misleading displays of dimension values.

*Specifying display resolution*

- ▶ Highlight a display resolution (Disp Res) field. The following display resolutions are available:
  - **MM Disp Res**
  - **Inch Disp Res**
  - **DMS Disp Res**
  - **DD Disp Res**
  - **Num Disp Res**
  - **Temp Disp Res**
  - **Time Disp Res**
  - **Force Disp Res**
  - **Pres. Disp Res**
- ▶ Enter the desired display resolution with the numeric keypad.
- ▶ Press «enter».

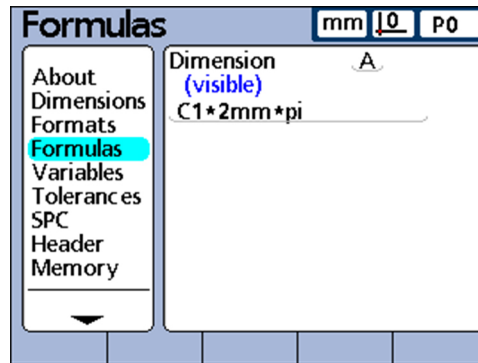
## 7.5 Creating formulas: «Formulas»

*Activation* «Menu/Setup» soft keys, «Formulas» setup screen

*Short description* When conducting measurements, formulas are used to define and display dimensions based on the channel inputs from the measuring devices.

These formulas are constructed by the user to display:

- One dimension based on one channel, e.g.  $A=C1$
- One dimension based on multiple channels, e.g.  $A=C1+C2$
- Multiple dimensions based on one channel, e.g.  $A=C1$   $B=2*\pi*C1$
- Multiple dimensions based on multiple channels, e.g.  $A=C1$   $B=C2$   $C=C1*C2$



Formulas can be constructed that display a channel as a dimension, or that calculate a dimension from one or more channels using powerful mathematical, logic or other functions.

Dimension formulas only apply to the part they are created in. For example, a dimension formula created in part 0 can only be used in part 0. In contrast, system dimensions can be used across all parts. They are described later in this chapter.



For more information on formulas, see "Custom programming", page 142.

## 7.6 Defining variables: «Variables»

*Activation* «Menu/Setup» soft keys, «Variables» setup screen

*Short description* Formulas use variables as symbols or names that represent values.  
For example, in the expression:

### **C1+Var1()**

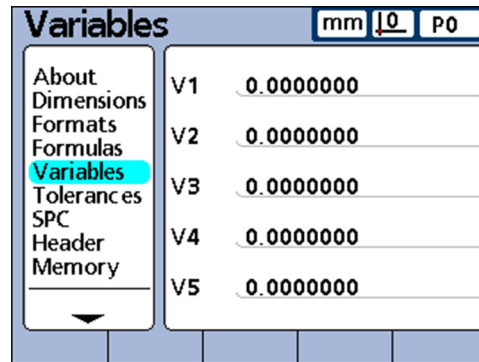
Var1() is a variable, its value is flexible and is determined by operations on a different formula line for the current part.

Variables can represent numeric constants, channel input values, dimension values or the results of a wide variety of mathematical operations.

*Application* Variables are important in formula creation because they enable users to create flexible formulas. Rather than including data directly into a formula, a user can use variables to represent the data. Then, when the formula is executed, the variables are replaced with the current actual values. This makes it possible for the same formula to process different sets of data as conditions change.

The «Variables» setup screen allows the user to see the current value of any of the 20 possible variables. Variables that are not defined elsewhere by formulas can be set to constant values in this setup screen. Variables that are defined by formulas cannot be changed in the «Variables» setup screen.

- Setting variables to constant values*
- ▶ Highlight a variable field.
  - ▶ Enter the desired value.
  - ▶ Press «enter».



Variables only apply to the part they are created in. For example, a variable created in part 0 can only be used in part 0. In contrast, global variables can be used across all parts. They are described later in this chapter.



For more information on variable functions, see "Defining variables: Var", page 201. For a detailed description of formulas, see "Custom programming", page 142.

## 7.7 Defining tolerance values: «Tolerances»

*Overview*

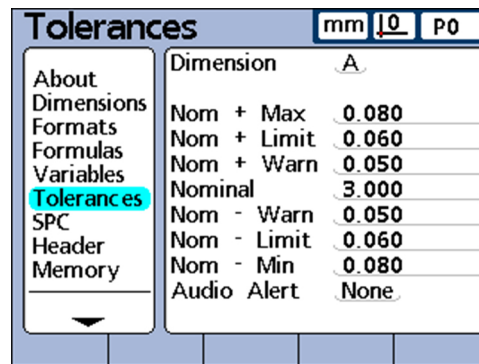
This section describes the following functions:

- Nominal values with tolerances
  - Nominal with +/- tolerances
  - Nominal with ++ tolerances
  - Nominal with – tolerances
- Nominal with fixed limits
- Specifying an audio alert
- Mirroring values

*Activation*

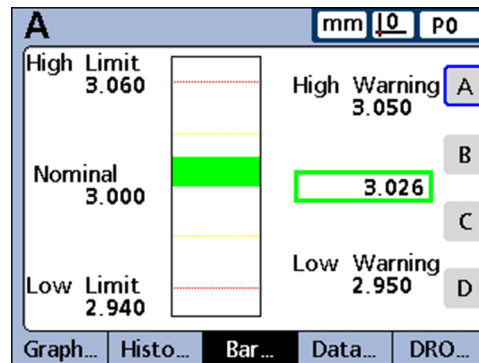
«Menu/Setup» soft keys, «Tolerances» setup screen

*Short description*



The «Tolerances» setup screen contains fields for specifying nominal values, upper/lower warnings, upper/lower limits and minimum/maximum bar graph levels for each dimension. An audio alert can also be specified for warnings, limits, or both.

*Representation of tolerance ranges*



Tolerance ranges are indicated numerically and by bands of color in the Current Value bar and dial displays. The default bar and dial displays show Pass values in green, Warning values in yellow, and Fail values in red.

## Software setup

Defining tolerance values: «Tolerances»

The defined pass, warning and fail levels are shown next to the bar graph. They have the following meanings:

Tolerances	Description
Pass	Above <b>low warning</b> and below <b>high warning</b> . Pass values fall within the specified range of acceptable values.
Warning	Within the range of acceptable values, but close to the fail level. Warnings indicate the need to evaluate the process to prevent the future generation of unacceptable or failed parts.
Fail	Outside the specified range of acceptable values.
Max/Min	Highest and lowest values in the graph. These values determine the range of values plotted on the graph. This range should be greater than the specified range limits of acceptable values.



For more information on indicating pass, warning and fail, see "Configuring the display: Display", page 110.

*Specifying a dimension for tolerancing*

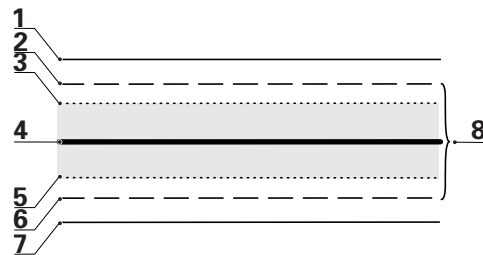
- Highlight the **Dimension** field.
- Press the «Dec» or «Inc» soft key to highlight the desired dimension.

## Nominal values with tolerances

Nominal values with tolerances can be specified as a nominal value between +/- tolerances, or as a nominal value with + + / - tolerances distributed entirely on the plus side or entirely on the minus side of the nominal value.

## Nominal with +/- tolerances

A nominal value is displayed between plus and minus tolerances.



- 1 0.080 Nom + Max
- 2 0.060 Nom + Limit
- 3 0.050 Nom + Warning
- 4 3.000 mm nominal
- 5 -0.050 Nom - Warning
- 6 -0.060 Nom - Limit
- 7 -0.080 Nom - Min
- 8 Acceptable range of values

## Software setup

Defining tolerance values: «Tolerances»

*Specifying a nominal value with +/- tolerances*

- ▶ Highlight the **Dimension** field.
- ▶ Press the «+/-» soft key to specify a nominal value with +/- tolerances.
- ▶ Highlight the desired tolerance field.
- ▶ Enter the desired tolerance value.
- ▶ Press «enter».
- ▶ Repeat until all tolerances are entered.

This example screen contains the nominal value and tolerances listed below:

Tolerances		mm	P0
Dimension	A		
Nom + Max	0.080		
Nom + Limit	0.060		
Nom + Warn	0.050		
Nominal	3.000		
Nom - Warn	0.050		
Nom - Limit	0.060		
Nom - Min	0.080		
Audio Alert	None		

- Nominal = 3.000 mm
- Warning tolerance =  $\pm 0.050$  mm
- Limit tolerance =  $\pm 0.060$  mm
- Max. tolerance =  $\pm 0.080$  mm

This is the displayed Min/Max limit in the bar graph

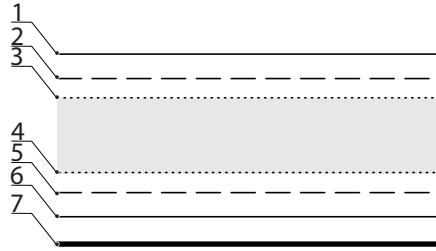


Values specified using the +/- Tolerances setup screen will also be converted to fixed limits if the «Limits» soft key is pressed.

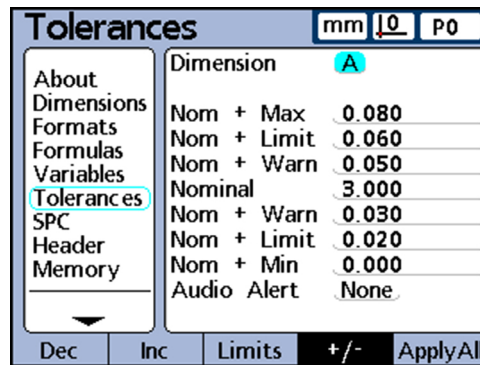


## Nominal with ++ tolerances

A nominal value is displayed with tolerances entirely on the plus side of the nominal value.



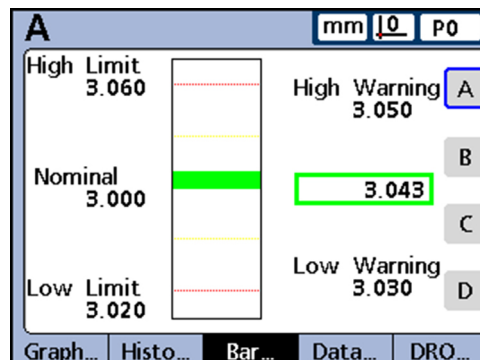
- 1 0.080 Nom + Max
- 2 0.060 Nom + Limit
- 3 0.050 Nom + Warning
- 4 0.030 Nom + Warning
- 5 0.020 Nom + Limit
- 6 0.000 Nom + Min
- 7 3.000 mm nominal



*Specifying a tolerance range above the nominal value (+ Tolerance)*

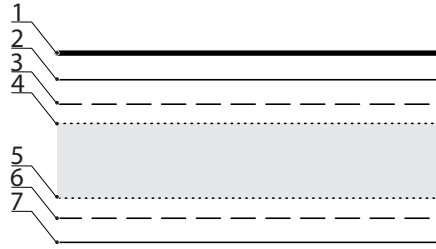
- ▶ Press the «+/-» soft key.
- ▶ Enter the high end of the positive tolerance range into the **+ Max**, **+ Limit** and **+ Warn** fields.
- ▶ Enter the nominal value.
- ▶ Enter the respective low end of the positive tolerance range into the **- Warn** field.
- ▶ Press the «+ +/–» soft key to change the field to **+ Warn**.
- ▶ Repeat this procedure for the **- Limit** and **- Min** fields.

This establishes the low end of the positive range of tolerances.

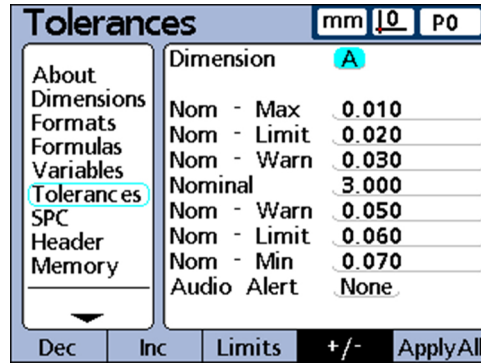


## Nominal with -- tolerances

A nominal value is displayed with tolerances entirely on the minus side of the nominal value.



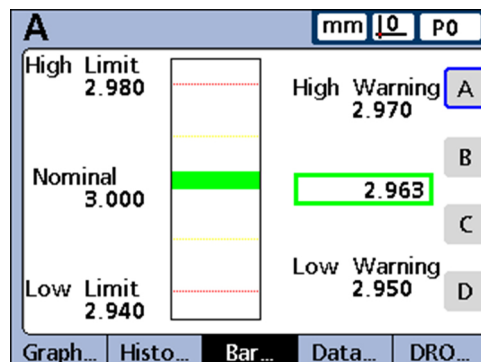
- 1 3.000 mm nominal
- 2 -0.010 Nom - Max
- 3 -0.020 Nom - Limit
- 4 -0.030 Nom - Warning
- 5 -0.050 Nom - Warning
- 6 -0.060 Nom - Limit
- 7 -0.070 Nom - Min



*Specifying a tolerance range below the nominal value (-Tolerance)*

- ▶ Press the «+/-» soft key.
- ▶ Enter the low end of the negative tolerance range into the - **Max**, - **Limit** and - **Warn** fields.
- ▶ Enter the nominal value.
- ▶ Enter the respective high end of the negative tolerance range into the + **Warn** field.
- ▶ Press the «+/-» soft key to change the field to - **Warn**.
- ▶ Repeat this procedure for the + **Limit** and + **Max** fields.

This establishes the high end of the negative range of tolerances.



## Software setup

Defining tolerance values: «Tolerances»

### Nominal with fixed limits

A nominal value is displayed between plus and minus fixed limits.

*Specifying fixed limits above and below a nominal value*

- ▶ Press the «Limits» soft key.
- ▶ Highlight the desired tolerance field.
- ▶ Enter the desired tolerance value.
- ▶ Repeat for all tolerance values.
- ▶ Press «finish».

Tolerances		mm	0	P0
About	Dimension	A		
Dimensions	Bar Gr. Max	3.005		
Formats	High Limit	3.004		
Formulas	High Warning	3.002		
Variables	Nominal	3.000		
Tolerances	Low Warning	2.998		
SPC	Low Limit	2.996		
Header	Bar Gr. Min	2.995		
Memory	Audio Alert	None		
Dec	Inc	Limits	+/-	ApplyAll

The following example of 3 mm ± 0.005 mm shows a nominal value with fixed limits.

- **Nominal** = 3.000 mm
- **High warning** = 3.002
- **Low warning** = 2.998
- **High limit** = 3.004
- **Low limit** = 2.996
- Bar graph max = 3.005
- Bar graph min = 2.995

A		mm	0	P0
High Limit	3.004			
Nominal	3.000	3.001		
Low Limit	2.996			
High Warning	3.002			A
Low Warning	2.998			D
Graph...	Histo...	Bar...	Data...	DRO...

## Specifying an audio alert

Audio alerts can be specified that sound when a dimension reaches warning and limit values.

The audio alert sounds when a warning or limit threshold is crossed, and will not sound again until the alert is reset by crossing the threshold again in the opposite direction.

Soft key	Description
«None»	No audio alerts
«Warning»	Audio alerts for tolerance or limit warnings
«Limits»	Audio alerts for limit failures
«Both»	Audio alerts for both; warnings and limit failures

### *Specifying an audio alert*

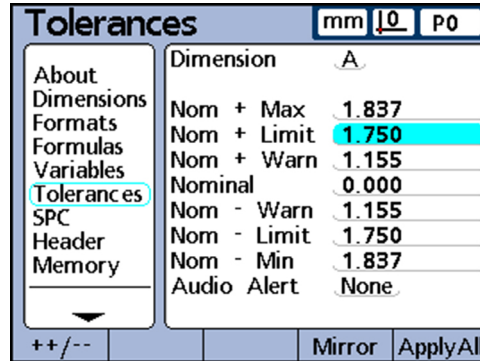
- ▶ Highlight the **Audio Alert** field.
- ▶ Press the soft key for the desired audio alert option: «None», «Warning», «Limits» or «Both».

## Mirroring values

Positive and negative **Max**, **Min** and **Warn** values can be set automatically depending on the **Nom + Limit** value. The limits will also be entered into the «SPC» setup screen.

New values will be:

- - **Limit = + Limit**
- **Max, Min = + Limit + 5 %**
- **Warn = SPC Warning Per. (%) of + Limit**
- **SPC UCL and SPC LCL = + Limit**



*Setting positive and negative **Max** and **Warn** values automatically*

- ▶ Highlight the **Nom + Limit** field.

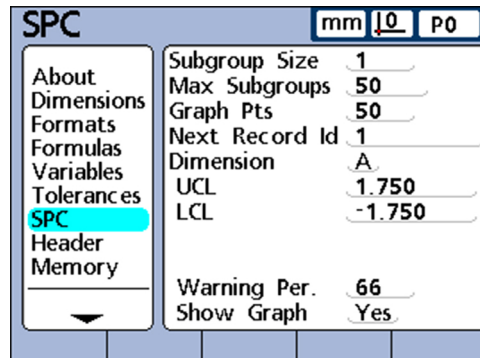


The Mirror function will only be executed if the **Nom + Limit** field is highlighted.

- ▶ Use the numeric keypad to enter a limit tolerance.
- ▶ Press the «Mirror» soft key.
- ▶ Press «finish».

In this example, the **+ Limit** is changed to 1.750. The resulting changes are:

- **Max = + Limit + 5 % = 1.837**
- **Warn = SPC Warning Per. (%) of + Limit = 66 % of + Limit = 1.155**
- **SPC UCL and SPC LCL = + Limit = 1.750**



## 7.8 Defining statistical parameters: «SPC»

*Overview* This section describes the following functions:

- Subgroup Size
- Max Subgroups
- Graph Pts
- Next Record ID
- Dimension
- UCL and LCL
- $\bar{x}$  Ucl,  $\bar{x}$  Lcl, r Ucl and r Lcl
- UCL and LCL
- Recalculating  $\bar{x}$  Ucl and  $\bar{x}$  Lcl
- r Ucl and r Lcl
- Recalculating r Ucl and r Lcl
- Warning limits
- Showing and hiding statistical graphs

*Activation* «Menu/Setup» soft keys, «SPC» setup screen

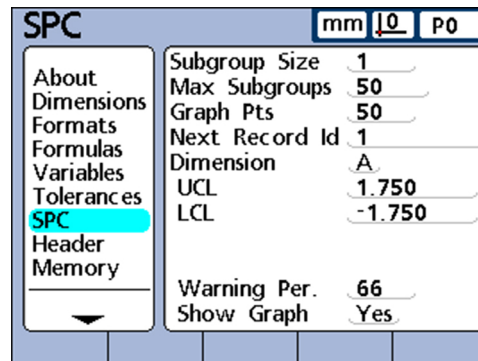
*Short description* The «SPC» setup screen contains fields for specifying statistical process control parameters including the subgroup size, the maximum number of subgroups stored, upper and lower mean control limits, and upper and lower range control limits. Record ID numbers can also be viewed or changed.

### Subgroup Size

*Specifying a subgroup size*

- ▶ Highlight the **Subgroup Size** field.
- ▶ Enter the desired subgroup size from 1 to 10 samples.
- ▶ Press «enter».

«SPC» parameters in the lower half of the screen and graphs of data displayed on the screen are different for subgroup sizes of 1 and subgroup sizes greater than 1.



## Software setup

Defining statistical parameters: «SPC»

Field	Value
Subgroup Size	2
Max Subgroups	50
Graph Pts	50
Next Record Id	1
Dimension	A
$\bar{x}$ Ucl	2.000
$\bar{x}$ Lcl	-2.000
r Ucl	1.000
r Lcl	0.000
Warning Per.	66
Show Graph	Yes

The differences between subgroups of 1 and subgroups greater than 1 are described in detail later in this «SPC» section.

### Max Subgroups

The **Max Subgroups** parameter specifies the maximum number of subgroups to be stored for the specified dimension. For each dimension, samples can be stored in from 2 to 1000 subgroups.

*Specifying the maximum number of subgroups*

- ▶ Highlight the **Max Subgroups** field.
- ▶ Enter the maximum number of subgroups to be stored for the specified dimension. For each dimension, samples can be stored in from 2 to 1000 subgroups.
- ▶ Press «enter».

### Graph Points

**Graph Pts** is the maximum number of points that will be plotted on graphs of subgroups for the specified part.

*Specifying graph points*

- ▶ Highlight the **Graph Pts** field.
- ▶ Enter the maximum number points to be graphed.
- ▶ Press «enter».



When there are fewer graph points specified than subgroups, the resulting dimension graphs might need to be scrolled to view all the subgroup data. For more information about displaying and scrolling graphs, see "Basic Operation", page 28.

### Next Record ID

Record ID numbers are displayed on graphs and can be included in printed reports and transmitted data.

The **Next Record Id** field normally starts at 1 and is automatically incremented by the system each time a new record is stored. However, the **Next Record Id** field can be set to any value by the user to restart a new database at a specified record number, or for a variety of other reasons. By entering a **Next Record Id**, the database can be restarted at a new number. Entering 999,999,999 will prevent any data from being recorded in the database.

*Specifying the next record ID*

- ▶ Highlight the **Next Record Id** field.
- ▶ Use the numeric keypad to enter the desired ID for the next record.
- ▶ Press «enter».

*Specifying the dimension used for the current SPC settings*

### Dimension

- ▶ Highlight the **Dimension** field.
- ▶ Press the «Dec» or «Inc» soft key until the desired dimension is displayed in the field.
- ▶ Press «enter».

### UCL and LCL

The **UCL** and **LCL** fields are displayed when the subgroup size is 1. If the subgroup size is greater than 1, the lower half of the screen changes to display mean and range control limits that are described later in this section. By default, the **UCL** and **LCL** fields display the Upper and Lower Control Limits specified earlier on the «Tolerances» setup screen. The limits are used by the unit's graphing software to scale the value axis of SPC graphs.



The **UCL** and **LCL** values shown on the «SPC» setup screen should not be altered after commissioning unless other values are essential for the application.

### $\bar{x}$ Ucl, $\bar{x}$ Lcl, r Ucl and r Lcl

The  $\bar{x}$  **Ucl** and  $\bar{x}$  **Lcl** fields and the **r Ucl** and **r Lcl** fields are displayed when the subgroup size is greater than 1.

### $\bar{x}$ Ucl and $\bar{x}$ Lcl

The  $\bar{x}$  **Ucl** and  $\bar{x}$  **Lcl** fields indicate the likely limits of the values of  $\bar{x}$  in future subgroups. These limits are either entered manually or, on pressing the «Recalc» soft key, are calculated from existing subgroup data. The  $\bar{x}$  **Ucl** and  $\bar{x}$  **Lcl** values are displayed as horizontal lines on the  $\bar{x}$  chart and used to generate SPC limit alarms.

*Manually specifying  $\bar{x}$  Ucl and  $\bar{x}$  Lcl*

- ▶ Highlight the  $\bar{x}$  **Ucl** or  $\bar{x}$  **Lcl** field.
- ▶ Use the numeric keypad to enter the desired  $\bar{x}$  **Ucl** or  $\bar{x}$  **Lcl**.
- ▶ Press «enter».

### $\bar{x}$ Ucl and $\bar{x}$ Lcl recalculation

Once subgroup data has been collected, the upper and lower control limits can be simultaneously recalculated.

*$\bar{x}$  Ucl and  $\bar{x}$  Lcl recalculation*

- ▶ Highlight the  $\bar{x}$  **Ucl** or  $\bar{x}$  **Lcl** field.
- ▶ Press the «Recalc» soft key.
- ▶ Press «enter».

### r Ucl and r Lcl

The **r Ucl** and **r Lcl** fields indicate the likely limits of the values of **r** in future subgroups. The calculation is based on existing subgroup data. These limits are either entered manually or, on pressing the «Recalc» soft key, are calculated from existing subgroup data. The **r Ucl** and **r Lcl** values are displayed as horizontal lines on the chart and used to generate SPC limit alarms.



## Software setup

Defining statistical parameters: «SPC»

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### *Manually specifying r Ucl and r Lcl*

- ▶ Highlight the **r Ucl** or **r Lcl** field.
- ▶ Use the numeric keypad to enter the desired **r Ucl** or **r Lcl**.
- ▶ Press «enter».

## r Ucl and r Lcl recalculation

Once subgroup data has been collected, the upper and lower control limits can be simultaneously recalculated.

### *r Ucl and r Lcl recalculation*

- ▶ Highlight the **r Ucl** field.
- ▶ Press the «Recalc» soft key.
- ▶ Press «enter».

## Warning limits

The **Warning Per.** field is used to specify the upper and lower warning limits on the  $\bar{x}$  and r SPC charts as a percentage of upper and lower control limits.

Example:

When the Warning Per = 66

and	then
$\bar{x}$ Ucl = 2.0000	$\bar{x}$ upper warning = 1.3200
$\bar{x}$ Lcl = -2.0000	$\bar{x}$ lower warning = -1.3200
r Ucl = 1.0000	r upper warning = 0.6600
r Lcl = 0.0000	r lower warning = 0.0000

### *Specifying warning limits*

- ▶ Highlight the **Warning Per.** field.
- ▶ Use the numeric keypad to enter the desired warning limits.
- ▶ Press «enter».

Warnings and exceeded limits are indicated on  $\bar{x}$  and r SPC charts by color changes to yellow for warnings, and red for exceeded limits. These colors can be changed in the «Display» setup screen.

## Showing and hiding SPC graphs

The SPC graph for each dimension can be shown or hidden. Hiding SPC graphs for dimensions reduces system resource consumption and increases throughput speed.

### *Showing SPC graphs*

- ▶ Highlight the **Show Graph** field.
- ▶ Press the «Yes» soft key.
- ▶ Press «enter».

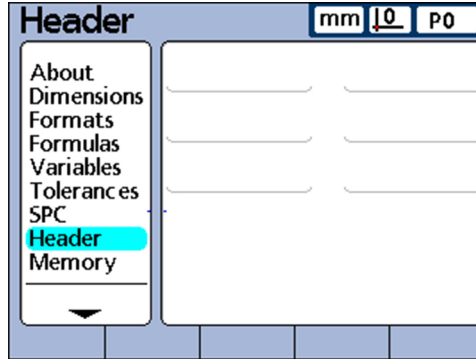
### *Hiding SPC graphs*

- ▶ Highlight the **Show Graph** field.
- ▶ Press the «No» soft key.
- ▶ Press «enter».

## 7.9 Creating header labels and user prompts: «Header»

*Activation* «Menu/Setup» soft keys, «Header» setup screen

*Short description* The «Header» setup screen contains fields for creating header labels and user prompts for text that will be included on printed reports. Header information is printed in text fields at the top of all reports and is arranged as shown on the «Header» setup screen.



Each header text field can be defined as a «Label» or «Prompt».

- Label:  
A label is fixed text printed on reports.
- Prompt:  
A prompt is also printed on reports but, in contrast to labels, elicits additional information from the user when the «Send» key is pressed. The user's response is printed next to the prompt on the report.

*Creating a label or prompt*

- ▶ Highlight the desired header field.
- ▶ Press the «Label» soft key to define the field as a label  
or  
Press the «Prompt» soft key to define the field as a prompt.
- ▶ Press the «Change» soft key to display the Alpha Entry screen.
- ▶ Use the arrow keys to select the desired character.
- ▶ Press «enter» to append the selected character to the message line.  
To switch between upper and lower case,  
press the «abc» and «ABC» soft keys.  
Use the **sp** character to include spaces.  
Use the numeric keypad to enter numbers.
- ▶ Press «finish» to return to the «Header» setup screen.

## 7.10 Allocating and using memory: «Memory»

*Activation* «Menu/Setup» soft keys, «Memory» setup screen

*Short description* The «Memory» setup screen contains fields that describe memory allocations and use for the total system and the current part.

## Software setup

Labeling system dimension formulas: «S Labels»

Memory		mm	0	P0
About	Total Available	975886		
Dimensions	Total Allocated	11884		
Formats	Part	0		
Formulas	Amt Available	9600		
Variables	Amount Used	0		
Tolerances	Percent Used	0		
SPC	Num Records	0		
Header	Max Records	100		
<b>Memory</b>				

Memory allocations are changed by the system when the user changes:

- The number of parts
- The number of measurements performed
- Formula complexity
- Parameters in the «SPC» setup screen



The «Memory» setup screen is provided only as a convenience for determining the system's memory usage. The user cannot change memory allocations, beyond reducing the number of parts used or database records stored.

## 7.11 Labeling system dimension formulas: «S Labels»

*Activation*

«Menu/Setup» soft keys, «S Labels» setup screen

*Short description*

The «S Labels» setup screen is used for creating dimension formulas. They are used in the same way as system formulas (see "Creating system formulas: S Formulas", page 88). However, unlike system formulas, dimensions formulas cannot be used across all parts.

The «S Labels» setup screen provides fields for labeling up to 16 system dimension formulas. Labels contain up to 3 alphanumeric characters. Alphabetic characters are in the range from A to Z and can be upper or lower case. Numeric characters are in the range from 0 to 9. The order of alphabetic and numeric characters in a label is defined by the user.

S Labels		mm	0	P0
Dimensions	L1	S1	L9	None
Formats	L2	None	L10	None
Formulas	L3	None	L11	None
Variables	L4	None	L12	None
Tolerances	L5	None	L13	None
SPC	L6	None	L14	None
Header	L7	None	L15	None
Memory	L8	None	L16	None
<b>S Labels</b>				

*Labeling a system dimension*

- ▶ Highlight a system dimension field.
- ▶ Press the «Label» soft key to display the Alpha Entry screen.
- ▶ Enter the desired characters.
- ▶ Press «finish».

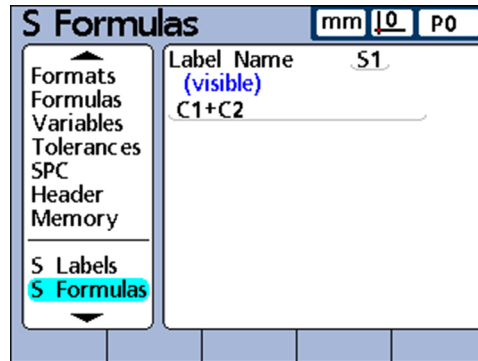
## Software setup

Creating system formulas: «S Formulas»

### 7.12 Creating system formulas: «S Formulas»

*Activation* «Menu/Setup» soft keys, «S Formulas» setup screen

*Short description* The «S Formulas» setup screen is used for constructing system formulas. System dimensions are created in system formulas, which are used in the same way as dimension formulas (see "Labeling system dimension formulas: S Labels", page 87). However, unlike dimension formulas, the system dimensions created in system formulas can be used by any part.



*Creating a system formula*

- ▶ Highlight the **Label Name** field.
- ▶ Use the «Inc» or «Dec» soft key to select a system label.
- ▶ Press «enter».
- ▶ Enter the desired formula.
- ▶ Press «finish».

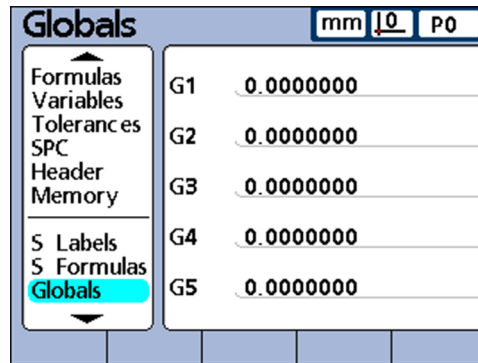


For more information on formulas, see "Custom programming", page 142.

## 7.13 Displaying the states of global variables: «Globals»

*Activation* «Menu/Setup» soft keys, «Globals» setup screen

*Short description* The «Globals» setup screen shows the current state of global variables and is used like the «Variables» setup screen discussed earlier in this chapter. Global variables are used like variables except that, unlike variables, globals can be used by any part.



For more information about global variable functions, see "Defining global variables: Global", page 204. For a detailed description of formulas, see "Custom programming", page 142.

## 7.14 Configuring measuring devices: «Channels»

*Overview* The «Channels» setup screen contains fields for selecting, configuring and calibrating the measuring devices. The following table illustrates the setup procedure for the measuring devices.

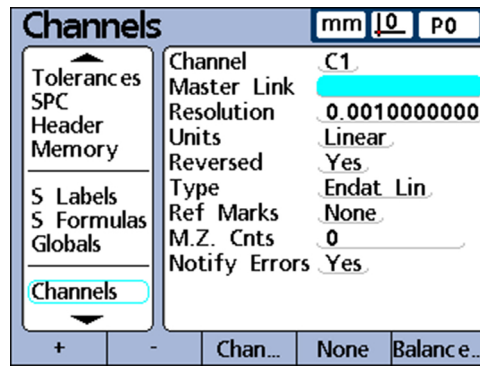
Procedure	Section
Specifying the input channel number	see "Specifying the input channel number", page 89
Selecting the input channel type	see "Selecting the input channel type", page 90
Specifying and, if required, calibrating the channel parameters	see "Specifying setup parameters for input channels", page 91

*Activation* «Menu/Setup» soft keys, «Channels» setup screen

### Specifying the input channel number

*Specifying the input channel number*

- ▶ Highlight the **Channel** field.
- ▶ Press the «+» or «-» soft key to select the desired channel.
- ▶ Press «enter».



## Selecting the input channel type

Measuring devices are connected to the channel inputs provided on the rear panel of the unit. The number and type of the measuring devices are specified when the unit is purchased, but might need to be specified again in the field.

Type	Description
TTL	TTL square wave encoder
Analog	Sinusoidal analog encoder
D1311	RS-232/V.24 thermocouple
HBT	Analog input from half-bridge transducers
LVDT	Analog input from full-bridge transducers
Albion	RS-232/V.24 temperature compensation for gage materials
A2D	Analog input from a wide variety of analog-to-digital devices
A2E	Analog input from air gage devices
AEK	Analog input from AEK air gage devices
SerAxis	RS-232/V.24 single probe input to primary or secondary RS-232/V.24 port
MTISer	Data byte inputs from single MTI probes
D5451	RS-232/V.24 serial thermocouple probe network
Orbit	RS-232/V.24 Solartron Orbit probe network
Marposs	RS-232/V.24 serial probe network
SonyMG	RS-232/V.24 Sony probe network
DMX	RS-232/V.24 multiplexer
MPLX	RS-232/V.24 multiplexer
Micro II	RS-232/V.24 port
Endat Lin	EnDat linear encoder
Endat Rot	EnDat rotary encoder
AccuScan	RS-232/V.24 laser scanning interface

## Software setup

Configuring measuring devices: «Channels»

---

*Selecting the input channel type*

- ▶ Highlight the **Type** field.
- ▶ Press the «List» soft key to display the list of available input channel types.
- ▶ Use the «up» or «down» arrow key to select the desired input channel type.
- ▶ Press «enter».

## Specifying setup parameters for input channels

The available setup parameters for the input channels depend on the selected input channel type. Some measuring devices share common parameters, and others require unique setup parameters.

Available setup parameters:

- «Master Link» probe balancing
- Setting the resolution for the linked channels
- Specifying the input channel resolution
- Transducers
- Specifying the unit of measure
- Reversing channel input polarity
- Specifying encoder reference marks
- Changing the machine zero position
- Enabling scale error notification
- Calibrating LVDT and HBT transducer gain
- Centering (zeroing) LVDT and HBT transducers
- Selecting an external RS-232/V.24 channel
- Specifying an RS-232/V.24 input port
- EnDat 2.2 encoder interface

These setup parameters are described in the following sections.

## Master Link probe balancing

The «Master Link» function masters two opposing probes for balanced probe measurements, as shown in this example of thickness measurement.

*Balancing two opposing probes*

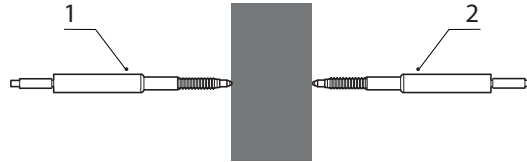
- ▶ Confirm that the **Reversed** settings of the two probes are the same in the «Channels» setup screen for each channel. Change the setting of one if necessary.
- ▶ Confirm that the **Master Type** parameter in the «Master» setup screen is set to **Min-Max**. Change the setting to **Min-Max** if necessary.
- ▶ In the «Channels» setup screen for the first channel, highlight the **Master Link** field.
- ▶ Press the «+» soft key.
- ▶ Press the «Chan» soft key.
- ▶ Enter the number of the second linked channel.
- ▶ Press the «OK» soft key.
- ▶ Place the desired reference standard between the two probes.
- ▶ Press the «Balance» soft key.
- ▶ Follow the prompt to move the reference standard (artifact) to one extreme of the measurement range.
- ▶ Press «enter».
- ▶ Follow the prompt to move the reference standard (artifact) to the opposite extreme of the measurement range.

## Software setup

Configuring measuring devices: «Channels»

---

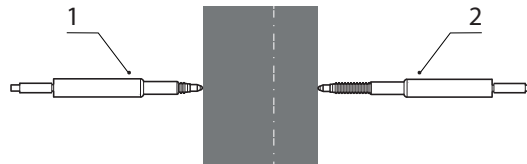
- ▶ Press «enter».  
Balance scalars are displayed.
- ▶ Press the «OK» soft key to save the balance scalars.
- ▶ Press «enter» to move to another field  
or  
Press «finish» to exit the screen.



- 1** Channel 1
- 2** Channel 2

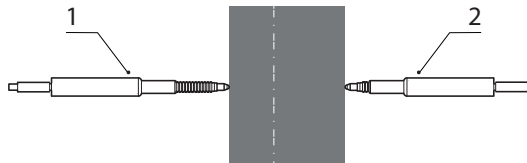
Material thickness is measured by two balanced probes.

- ▶ Place the reference standard between the two probes.



- 1** Channel 1
- 2** Channel 2

- ▶ Move the reference standard to one extreme of the measurement range.



- 1** Channel 1
- 2** Channel 2

- ▶ Move the reference standard to the opposite extreme of the measurement range.



In the «Channels» setup screen of the linked (second) probe, the **Master Link** field will now show the number of the first probe. Do not change the setting in this field.

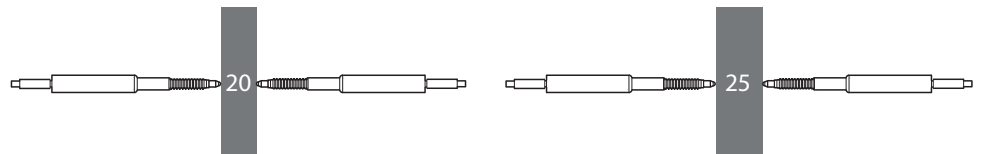


## Setting the resolution for the linked channels

After balancing the master linked channels, the resolution of the first linked channel must be taught. The resulting resolution is applied to both linked channels.

*Teaching the resolution for the linked channels*

- ▶ Confirm that the **Master Type** parameter in the «Master» setup screen is set to **Min-Max**. Change the setting to **Min-Max** if necessary.
  - ▶ Highlight the **Resolution** field of the first linked channel.
  - ▶ Press the «Teach» soft key.
  - ▶ Press the «Min» soft key.
  - ▶ Place the «Min» reference standard between the two probes as shown in the figure below.
  - ▶ Use the numeric keypad to enter the value of the reference standard in the **Min** field of the first linked channel.
  - ▶ Press «enter» to teach the minimum value.
  - ▶ Answer «Yes» to the prompt.
  - ▶ Press the «Max» soft key.
  - ▶ Place the «Max» reference standard between the two probes as shown in the figure below.
  - ▶ Use the numeric keypad to enter the value of the reference standard in the **Max** field of the second linked channel.
  - ▶ Press «enter» to teach the maximum value.
  - ▶ Answer «Yes» to the prompt.
- The resolution is now taught for the linked channels.
- ▶ Press «finish» to exit the resolution teach.



## Specifying the input channel resolution

The **Resolution** field defines the input resolution for encoders, transducers, thermocouples, RS-232/V.24 probe networks and other measuring devices. Resolution values can either be manually entered if they are known, as in the case of encoders or taught, as in the case of transducers.

*Specifying the resolution if the value is known*

- ▶ Highlight the **Resolution** field.
- ▶ Use the numeric keypad to enter the resolution.
  - For EnDat encoders:  
No manual settings required. The information is read from the encoder.
  - For 1 Vpp measuring devices:
    - Linear encoders and touch probes: **Resolution** = Signal period in mm / 40
    - Rotary and angle encoders: **Resolution** = 360 / (line count x 40)
  - For TTL measuring devices:
    - Linear encoders and touch probes: **Resolution** = Signal period in mm / 4
    - Rotary and angle encoders: **Resolution** = 360 / (line count x 4)
- For examples see "Configuring a measuring device", page 55
- ▶ Press «enter».

*Teaching the resolution if the value is not known*

- ▶ Confirm that the **Master Type** parameter in the «Master» setup screen is set to **Min-Max**. Change the setting to **Min-Max** if necessary.
- ▶ Highlight the **Resolution** field.
- ▶ Press the «Teach» soft key.
- ▶ Press the «Min» soft key.
- ▶ Position the «Min» reference standard.
- ▶ Use the numeric keypad to enter the value of the reference standard in the **Min** field.
- ▶ Press «enter» to teach the minimum value.
- ▶ Answer «Yes» to the prompt.
- ▶ Press the «Max» soft key.
- ▶ Position the «Max» reference standard.
- ▶ Use the numeric keypad to enter the value of the reference standard in the **Max** field.
- ▶ Press «enter» to teach the maximum value.
- ▶ Answer «Yes» to the prompt.  
The input channel resolution is now taught.
- ▶ Press «finish» to exit the resolution teach.

## Transducers

Transducer gain must be calibrated before setting the transducer resolution. For more information on calibration, see "Calibrating encoders and transducers: Master", page 100. After transducer gain is calibrated, the resolution for LVDT and HBT transducers is set by performing a full calibration using the «Master» function. For more information on the calibration of channels, see "Master function", page 44.

## Specifying the unit of measure

The **Units** field is used to specify the unit of measure for the channel input. Displacement units of measure can be inches, millimeters, angular or numeric. Thermocouple units of measure can be Celsius, Fahrenheit or numeric.

*Specifying the unit of measure*

- ▶ Press the «List» soft key.
- ▶ Highlight the desired unit of measure.
- ▶ Press «enter» to confirm the selection.
- ▶ Press «enter» to move to the next parameter.

## Reversing channel input polarity

The **Reversed** field is used to reverse the direction of count for each specified input, and will also reverse the polarity of serial inputs.

Normally, displacement counts increase as the device is compressed or rotated clockwise. Serial input polarity can be reversed to suit the requirements of the application.

*Reversing channel input polarity*

- ▶ Highlight the **Reversed** field.
- ▶ Press the «Yes» soft key.
- ▶ Press «enter».

## Specifying encoder reference marks

Encoder reference marks can be used to home the unit when it is started. The unit can be configured to prompt the user to cross reference marks or to perform a hard stop machine zero prior to measurements.



The **Ref Marks** setup parameter is

- not available on EnDat devices!
- not effective when an RS-232/V.24 device is specified as the input channel.

*Specifying encoder reference marks*

- ▶ Highlight the **Ref Marks** field.
- ▶ Press the «List» soft key.

Ref Marks	Description
None	The connected measuring device has no reference marks or no reference mark evaluation is to be performed
Manual	The connected measuring device is manually set to zero by the user and confirmed with «enter»; this option is used for hard stops
Ref	The connected measuring device has one reference mark
Abs AC	The connected measuring device has distance-coded reference marks of the Acu-Rite type (coded like ENC 150 or SENC 150)
Abs HH	The connected measuring device has distance-coded reference marks of the HEIDENHAIN type with a nominal increment of 1000 signal periods

## Software setup

Configuring measuring devices: «Channels»

Ref Marks	Description
Abs HH2	The connected measuring device has distance-coded reference marks of the HEIDENHAIN type with a nominal increment of 5000 signal periods

- ▶ Highlight the desired reference mark type.
- ▶ Press «enter» to confirm the selection.
- ▶ Press «enter» to move to the next parameter.

If **Manual** is selected, the user will be prompted when switching on the unit to move the axes to the desired zero point. If **Ref**, **Abs AC** or **Abs HH** is selected, the user will be prompted to cross a reference mark of the encoder.



Once a reference has been defined, a password is required to skip the reference initialization when the unit is switched on.

## Changing the machine datum

The **M.Z.Cnts** field can be used to specify an offset value for shifting the machine datum.

*Shifting the machine datum*

- ▶ Highlight **M.Z.Cnts**.
- ▶ Use the numeric keypad to enter the required offset counts.
- ▶ Switch the unit off and on again.
- ▶ Cross the reference marks when prompted during power-up.



The **M.Z.Cnts** setup parameter is

- not available on EnDat devices!
- not effective when an RS-232/V.24 device is specified as the input channel.

## Enabling scale error notification

If the **Notify Errors** parameter is enabled, scale errors for the specified channel will be reported on the **DRO** screen.

*Enabling scale error notification*

- ▶ Highlight the **Notify Errors** field.
- ▶ Press the «Yes» soft key.
- ▶ Press «finish».

## Calibrating LVDT and HBT transducer gain

The unit includes hardware and software for automatically calibrating the system to accommodate variations in transducer output level.

*Calibrating LVDT and HBT transducer gain*

- ▶ Highlight the **Gain** field.
- ▶ Press the «Teach» soft key.
- ▶ Follow the instructions on screen to calibrate the system for the output level of the transducer connected to the selected channel.

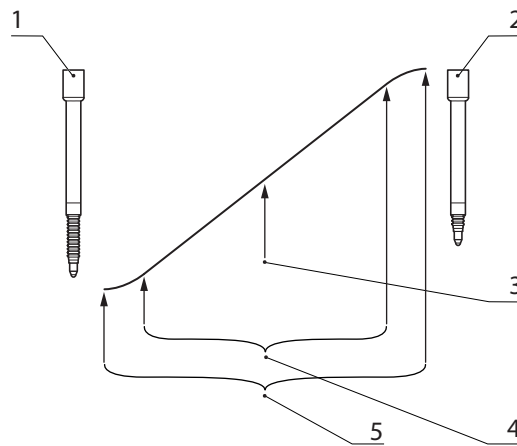
## Centering (zeroing) LVDT and HBT transducers

Transducer outputs are most linear in the central portion of their total range of movement. Each LVDT and HBT transducer must be positioned at the center of its range of movement (zeroing) in the gage and against a nominal reference surface to ensure the best possible measurement accuracy. The bar graph at the bottom of the «Channels» setup screen for transducers displays the relative position of the transducer tip between the two extremes of the movement range.

*Zeroing transducers*

**Requirement:** Prior to conducting measurements, the transducer gain must be calibrated. For more information on the «Master» function for calibrating the resolution of transducers, see "Basic Operation", page 28.

- ▶ Insert and secure the transducer in the gage.
- ▶ Position the transducer against the nominal reference surface.
- ▶ Adjust the transducer in the gage so that it is zeroed against the nominal reference surface.
- ▶ Lock the transducer in place.



- 1 Transducer fully extended
- 2 Transducer fully compressed
- 3 Transducer adjusted to zero against the nominal reference surface
- 4 Linear range
- 5 Total range

When the transducer gain has been calibrated and zero adjustment against the nominal reference surface has been completed, the transducer resolution can be calibrated using the «Master» function. The transducer is then ready to measure.

Transducer resolution is usually calibrated periodically on a schedule determined by the application and the measurement environment. For more information on calibrating the resolution, see "Basic Operation", page 28.

### Selecting an external RS-232/V.24 channel

RS-232 input networks include multiple inputs that are numbered to reflect the manufacturers' module identification system. These numbers must be entered into the **Ext Num** field of the «Channels» setup screen for each input. For more information on the module identification system, please refer to the documentation supplied with the RS-232 network.

*Specifying an input channel number*

- ▶ Highlight the **Ext Num** field.
- ▶ Use the numeric keypad to enter the manufacturers' module ID number for the input.
- ▶ Press «enter».

## Specifying an RS-232/V.24 input port

Multiple RS-232/V.24 serial ports are provided on units that include RS-232/V.24 input channels. In most instances the secondary port should be used as the input channel for measuring devices. However, the primary port can be specified if desired.

*Specifying an RS-232/V.24 serial input port*

- ▶ Highlight the **Uart Id** field.
- ▶ Press the «Dec» or «Inc» soft key.
- ▶ Press «finish».



Communication with computers and other serial devices takes place over the primary serial port. Use of the primary serial port for the connection of serial measuring devices will make serial communication with other devices impossible.

## EnDat 2.2 encoder interface

When EnDat 2.2 encoders are connected to channel inputs, Information, Diagnostics, Errors and Warnings information can be accessed through the «Channels» setup screen.

EnDat information	Description
<b>Info</b>	Displays the ID number, serial number, name, transfer cycles, signal periods, measuring steps and measuring length or maximum revolutions.
<b>Diag</b>	Shows the function reserves of the encoder: <ul style="list-style-type: none"> <li>■ Absolute track</li> <li>■ Incremental track</li> <li>■ Position value calculation</li> </ul>
<b>Error</b>	Displays errors that can occur for that type of connected encoder, and shows if errors have occurred. A color-filled square after the respective error indicates the status: <ul style="list-style-type: none"> <li>■ <b>Gray</b> means that this diagnostic feature is not supported</li> <li>■ <b>Green</b> means that no error has occurred</li> <li>■ <b>Red</b> indicates that an error has occurred</li> </ul>
<b>Warn</b>	Displays the warnings that may be generated by the connected encoder. A color-filled square after the respective warning indicates the status: <ul style="list-style-type: none"> <li>■ <b>Gray</b> means that this diagnostic feature is not supported</li> <li>■ <b>Green</b> means that no warning is output</li> <li>■ <b>Red</b> indicates that a warning is output</li> </ul>

*Accessing information, diagnostic data and error messages*

- ▶ Highlight the **Channel** field.
- ▶ Press the «Info», «Diag» or «Error» soft key.

*Accessing warnings*

- ▶ Press the «Error» soft key again.

## 7.15 Calibrating encoders and transducers: «Master»

*Overview*

This section describes the following functions:

- Specifying the number of calibration points
- Selecting the calibration type
- Locking the calibration process if warnings occur
- Specifying a calibration interval
- Using dynamic Min/Max values for calibration
- Setting the slew limit for warning messages
- Specifying Min and Max calibration warnings

*Activation*

«Menu/Setup» soft keys, «Master» setup screen

*Short description*

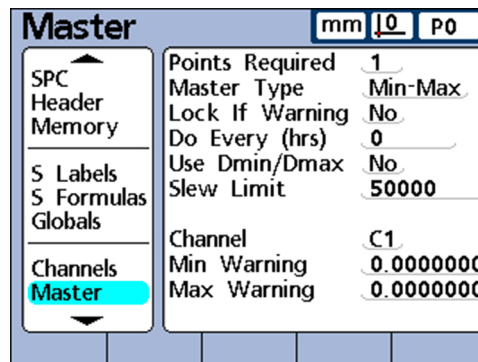
The «Master» setup screen contains fields for setting up and calibrating encoders and transducers.

### Specifying the number of calibration points

Calibrations can be based on a single data point, or on an average of up to 10 data points. Averaging data points is useful when calibrations are performed in the presence of vibration, surface irregularities or electrical noise. For more information about the procedure for encoder and transducer calibration using the «Master» function, see "Establishing a measurement reference (calibrating)", page 232.

*Specifying the required number of points*

- ▶ Highlight the **Points Required** field.
- ▶ Use the numeric keypad to enter the required number of data points (between 1 and 10).
- ▶ Press «enter».



### Selecting the calibration type

Input channels are calibrated using the **Min-Max** or **Mean** function.

**Min-Max** calibrations use data points on the low and high ends of the measurement range to define the input channel resolution. LVDT and HBT transducers as well as measuring devices with initially undefined measurement resolutions require **Min-Max** calibrations.

**Mean** calibrations are used to preset input channels that have been calibrated or have defined resolutions. Encoders and other measuring devices with defined resolutions can be preset at any device state the user wishes by using the **Mean** function.

After **Min-Max** calibration, transducer input values can also be preset using the **Mean** function. For more information on the procedure for calibrating the input channels, see "Establishing a measurement reference (calibrating)", page 232.



## Locking the calibration process if warnings occur

The calibration process can be locked automatically when a calibration fails and a warning is displayed. Once locked, the calibration process can only be completed by performing a new calibration that is successful or by entering the supervisor password to abort the calibration process.

*Locking the calibration process if warnings occur*

- ▶ Highlight the **Lock If Warning** field.
- ▶ Press the «Yes» soft key.
- ▶ Press «enter».

## Specifying a calibration interval

The «Master» calibration screen can automatically be displayed at regular intervals to support a schedule of periodic input device calibrations. The **Master** screen will be displayed at the specified intervals unless a setup screen is being displayed to configure the unit.

*Specifying a calibration interval*

- ▶ Highlight the **Do Every (hrs)** field.
- ▶ Use the numeric keypad to enter the amount of time in hours.
- ▶ Press «enter».

## Using dynamic Min/Max values for calibration

Dynamic minimum and maximum measurements can be used in place of static measurements using reference standards, when the calibrations must be performed in a gage system using rotary standard parts or rock step masters.

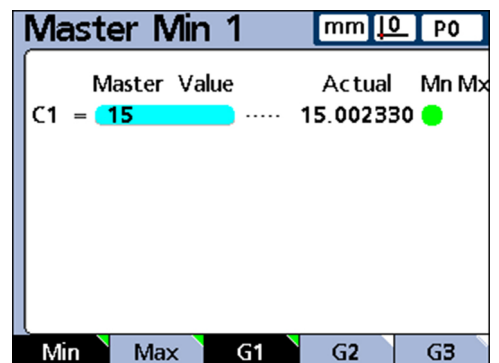
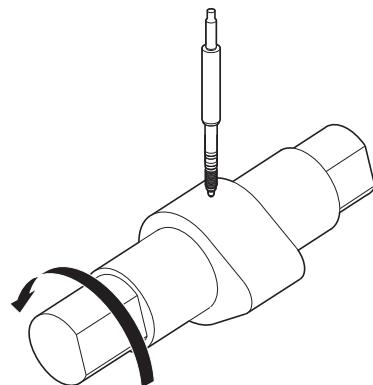
*Using dynamic minimum and maximum values for calibration*

- ▶ Highlight the **Use Dmin/Dmax** field.
- ▶ Press the «Yes» soft key.
- ▶ Press «enter».

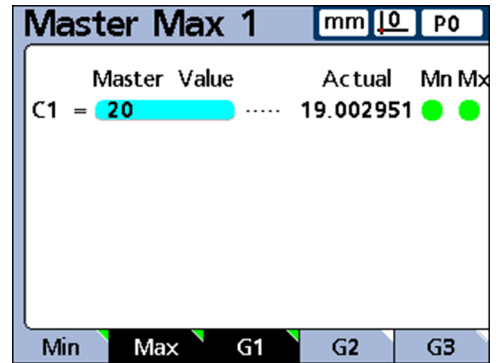
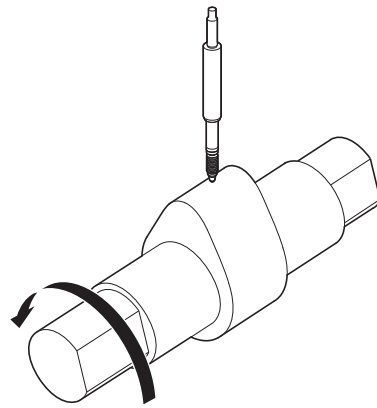
When dynamic minimum or maximum measurements are used for calibration, the Actual value on the **Master Min/Max** screen changes as a standard part is rotated until the minimum and maximum values are found. Once the minimum and maximum values are displayed, the user enters the values for the calibration and presses «enter».

When **Mean** calibrations are performed, the calibration of the minimum value establishes a channel preset.

When **Min-Max** calibrations are performed, the minimum value establishes a preset. In addition, the combination of the minimum and maximum values is used to define the resolution of the input channel.



1.5 cm Dmin is measured and set in **Master Min 1**.



2.0 cm Dmax is measured and set in **Master Max 1**.

### Setting the slew limit for warning messages

High input slew rates from rapid encoder motion can result in erroneous measurements. Erroneous measurements are avoided by displaying encoder error messages when encoder values change at very high rates.

In the **Slew Limit** field, a traversing speed limit can be specified at which a warning message will be displayed. The value to be entered depends on the selected input channel resolution.

For example, at a channel resolution of 0.001, a slew limit of **500** will result in a warning message at encoder motion rates higher than 50 mm per second.

*Specifying the slew limit*

- ▶ Highlight the **Slew Limit** field.
- ▶ Use the numeric keypad to enter the slew limit in counts (resolution increments per second).
- ▶ Press «enter».

### Specifying Min and Max calibration warnings

Periodic calibrations of measuring devices are sometimes performed on a regular schedule using the same reference standards for each calibration. The **Min/Max Warning** supports these activities by validating each calibration. Warnings apply only to user-specified linear measuring devices, not to angular or time-oriented measuring devices. The channel is specified by decrementing or incrementing to the desired channel number.

Calibrations are validated by comparing each new set of calibration values to the original calibration values. Significant differences between the new and original values indicate incorrect reference standards, equipment malfunctions or measurement errors. The acceptable difference between the new and original calibration values is entered into the **Min Warning** and **Max Warning** fields.

If new values fall outside the acceptable range during calibration, the calibration is invalidated and a warning is displayed. When a new calibration is invalidated, the user can correct the problem and attempt another new calibration, accept the value as a preset or conduct measurements using the original (unchanged) calibration values.

## Software setup

### Compensating measurement errors: «SLEC»

---

*Specifying the acceptable range for new calibration values*

When **Mean** calibrations are performed, only the **Min Warning** value is required.

- ▶ Highlight the **Min Warning** field.
- ▶ Enter the acceptable deviation from the original minimum master calibration value.
- ▶ Press «enter».

When **Min-Max** calibrations are performed, **Min Warning** and **Max Warning** values are required.

- ▶ Highlight the **Max Warning** field.
- ▶ Enter the acceptable deviation from the original maximum master calibration value.
- ▶ Press «enter».



The **Min/Max Warnings** will be applied to the next set of calibration values obtained using the «Master» function; see "Establishing a measurement reference (calibrating)", page 232 for a detailed description.

## 7.16 Compensating measurement errors: «SLEC»

*Overview*

The following topics are dealt with in this chapter:

- Linear error correction (LEC)
- Segmented linear error correction (SLEC)
- SLEC setup procedure

*Activation*

«Menu/Setup» soft keys, «SLEC» setup screen

*Error correction*

There are two types of error correction:

- Linear error correction (LEC)
- Segmented linear error correction (SLEC)

Any measuring device can include slight nonlinearities over its measurement range. LEC compensates for nonlinearities by applying a single linear correction coefficient to the entire range of measurement. SLEC compensates for nonlinearities by applying multiple correction coefficients to individual nonlinear segments within the measurement range.

LEC is easy to set up, but does not provide correction for local nonlinearities that could be present over only small portions of the measurement range. SLEC requires a greater investment of time to set up, but results in more accurate measurements.

If an overall nonlinearity exists without significant local errors, LEC can be applied as a correction method. However, if measuring devices are found to have significant local nonlinearities, SLEC should be applied as a correction method.



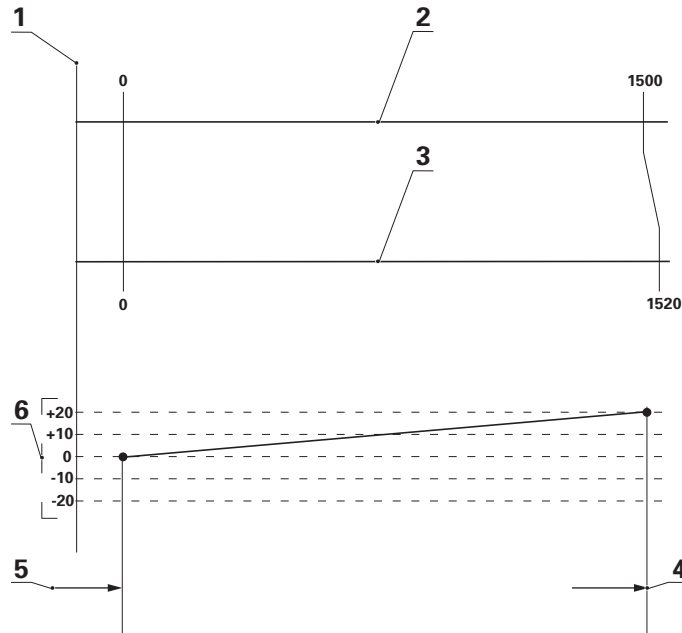
SLEC and LEC require a repeatable machine datum.

## Linear error correction (LEC)

The LEC correction coefficient is created by the unit using data provided by the user in the «SLEC» setup screen. The LEC setup data provided by the user consists of the nominal and actual values of a reference standard at the two extreme ends of the measurement range.

*Example*

The following illustration shows the nominal (Standard) and actual (Observed) values of a reference standard. A small error occurs across the entire measurement range:



- 1 Machine 0,0 (Reference)
- 2 Nominal (Standard)
- 3 Actual (Observed)
- 4 Station 1
- 5 Station 0
- 6 Deviation

The nominal and actual values at the two ends of the measurement range are entered as data for stations 0 and 1 in the «SLEC» setup screen.

The nominal and actual values at the beginning of the range are 0 because this end of the standard is the measurement reference. **0** is entered for both values of **Station 0**.

## Software setup

### Compensating measurement errors: «SLEC»

At the end of the range, the nominal value is 1500 and the actual value is 1520 in this example (see figures below). This indicates a linearity error of 20 over the entire measurement range. These values are entered into **Station 1**.

SLEC		mm	10	P0
Header Memory	Channel	C1		
S Labels	Enabled	Off		
S Formulas	Station	0		
Globals	Standard	0.000000		
Channels Master	Observed	0.000000		
SLEC	MZ Offset	0.3552400		
Teach				

SLEC		mm	10	P0
Header Memory	Channel	C1		
S Labels	Enabled	Off		
S Formulas	Station	1		
Globals	Standard	1500.0000		
Channels Master	Observed	1520.0000		
SLEC	MZ Offset	0.3552400		
Teach				

When the procedure is complete and the data has been entered, a correction coefficient is calculated for the measuring device.



The LEC setup procedure is a subset of steps required for SLEC setup and requires a repeatable machine datum. Only the data for the first and last station needs to be entered.

## Segmented linear error correction (SLEC)

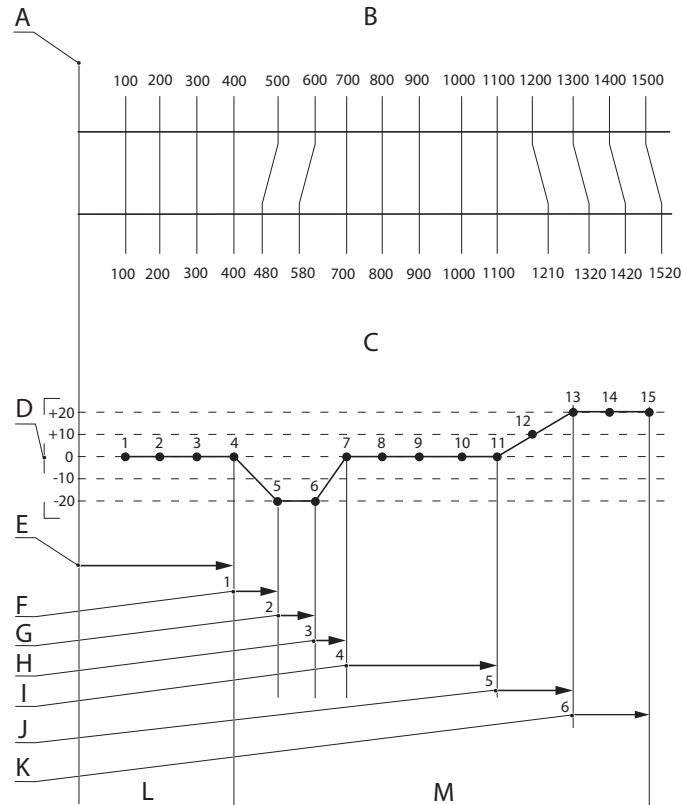
SLEC compensates for nonlinearities of the measuring device by applying correction coefficients only to the segments that require them. The SLEC correction coefficients are created by the unit using data provided by the user in the «SLEC» setup screen. The SLEC setup data provided by the user consists of the nominal and actual values of one or more reference standards that cover the entire range of the measuring device.

### Example

The measurements performed divide the range of the measuring device into up to 60 user-defined segments. The following figure shows nominal (Standard) values compared to actual (Observed) values. The deviation (difference between the nominal and actual values) is shown as a graph. In this example, segments are defined as any straight line on the graph, beginning with segment 0:

## Software setup

Compensating measurement errors: «SLEC»



- A** Machine 0,0 (Reference)
- B** Nominal (Standard)
- C** Actual (Observed)
- D** Deviation
- E-K** Segment 0 to Segment 6
- L** Station 0
- M** Stations 1 to 6

The nominal and actual values at the end of each segment are entered as data for the respective **Station** in the «SLEC» setup screen. For example, the nominal and actual values at the end of segment 0 are both 400, and are entered for **Station 0**.

SLEC		mm	10	P0
Header Memory	Channel	C1		
S Labels	Enabled	Off		
S Formulas	Station	0		
Globals	Standard	400.00000		
Channels Master	Observed	400.00000		
SLEC	MZ Offset	0.0000000		
Teach				

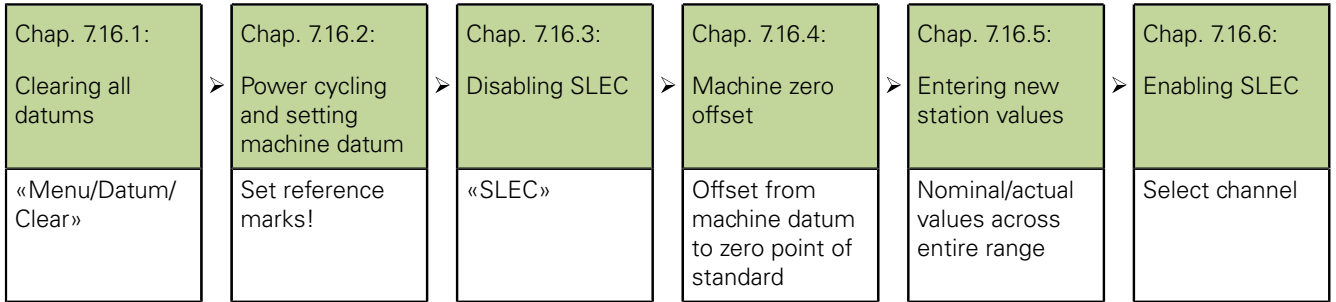
## SLEC setup procedure



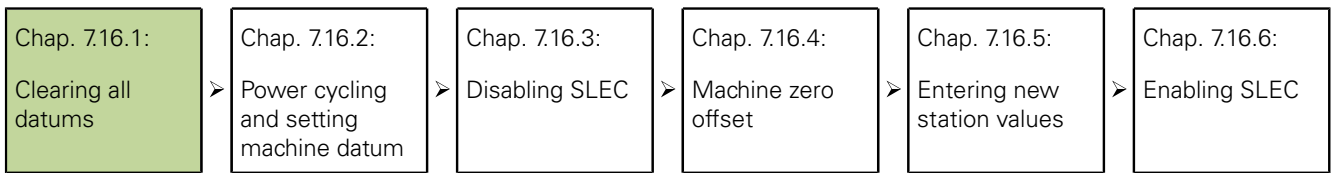
Make sure that the resolutions and the references to the machine datum are properly configured for all measuring devices, and that any required settings using the «Master» function have been completed for the measuring devices prior to configuring the SLEC feature.

For more information see "Configuring measuring devices: Channels", page 89 and see "Establishing a measurement reference (calibrating)", page 232.

The following sections provide a step-by-step guide to configuring the SLEC feature, including all preparations to be made:



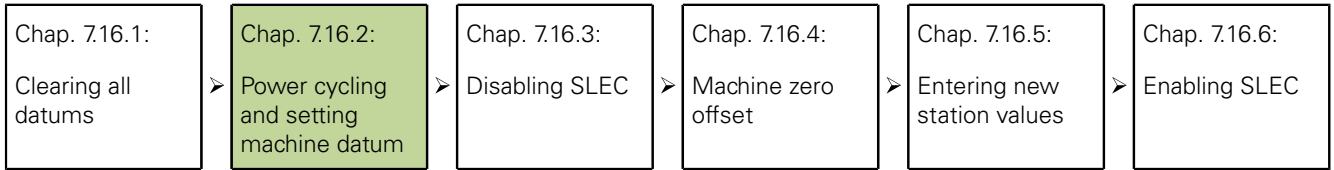
### 7.16.1 Clearing all datums



The following steps clear datums in preparation for SLEC measurements of the reference standard:

- ▶ Navigate to the «Supervisor» setup screen.
- ▶ Enter the **Password**.
- ▶ Unlock **Datuming** and **Clearing Data**.
- ▶ Press «finish».
- ▶ Press the «Menu» soft key.
- ▶ Press the «Datum» soft key.
- ▶ Press the «Clear» soft key.
- ▶ Confirm with the «YES» soft key.

## 7.16.2 Power cycling and setting machine datum



Power cycling reestablishes fresh machine datums for all input channels.

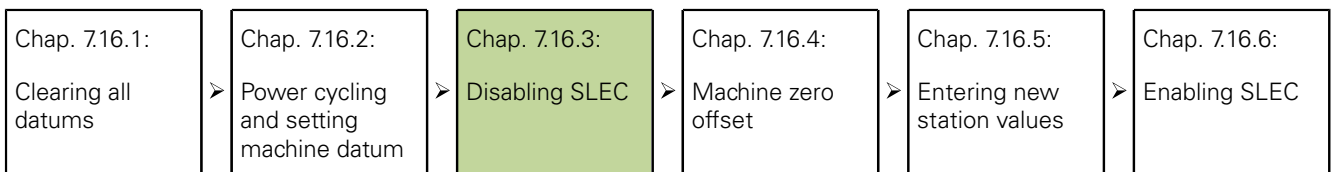
*Power cycling and setting machine datums*

**Requirement:** A machine datum can only be established on switch-on, if reference marks have been specified in the «Channels» setup screen.

- ▶ Turn the power switch off, wait for a few seconds and turn the power switch on again.
- ▶ Press «finish» or «quit» to initiate the display of the unit.
- ▶ When prompted, cross the reference marks of encoders or perform a hard stop zero on all measuring devices.
- ▶ Set the machine datum for each measuring device.

**i** If a hard stop zero is performed, the same stop will be required each time the unit is switched on.

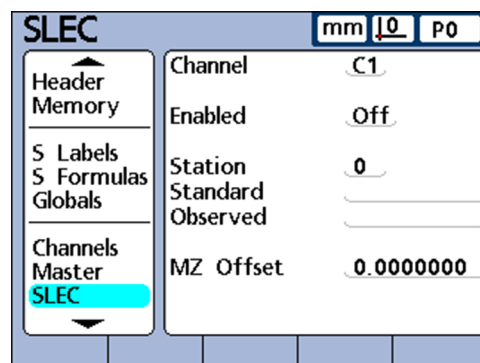
## 7.16.3 Disabling SLEC



The following steps disable the SLEC feature to isolate the SLEC data fields during the data entry process:

- ▶ Navigate to the «SLEC» setup screen.

The «SLEC» setup screen contains fields for configuring and enabling segmented linear error correction (SLEC) or linear error correction (LEC) for each input channel:



- ▶ Highlight the **Channel** field.

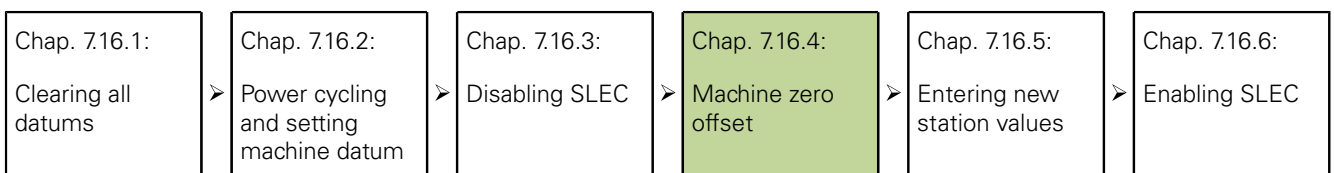
**i** If this is the first time that SLEC compensation is being configured, or if new SLEC values are being created for all measuring devices, then SLEC must be disabled for all channels. Any existing SLEC values must also be cleared. However, if only specific channels require new SLEC values, only those channels must be disabled and cleared of old values.

- ▶ Use the «Dec» or «Inc» soft key to select the channel to be configured.
- ▶ Highlight the **Enabled** field.



- ▶ Press the «Off» soft key to disable SLEC for the selected channel.
- ▶ Highlight the **Station** field.
- ▶ Use the «Dec» or «Inc» soft key, if necessary, to display **Station 0**.
- ▶ If the fields for the nominal (Standard) and actual (Observed) values contain data, press the «Remove» soft key to clear the data.
- ▶ The old data from **Station 0** will be replaced by data from **Station 1**.
- ▶ Continue pressing the «Remove» soft key until the **Standard** and **Observed** fields are empty.
- ▶ Highlight the **MZ Offset** field.
- ▶ Use the numeric keypad to enter **0** into the **MZ Offset** field.
- ▶ Repeat these steps for each measuring device channel to be configured for SLEC.

### 7.16.4 Machine zero offset

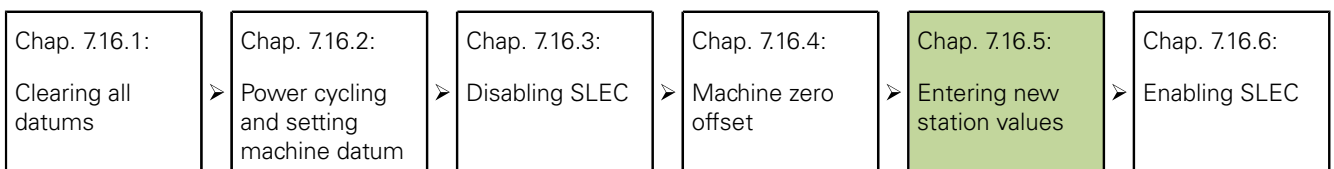


The following steps enter the offset from the machine datum to the zero point of the reference standard.

#### *Entering the machine zero offset*

- ▶ Highlight the **MZ Offset** field of the channel being configured.
- ▶ Position the probe connected to this channel at the reference surface for the zero point of the reference standard.
- ▶ Press the «Teach» soft key.
- ▶ Press «enter» to apply the machine zero offset.

### 7.16.5 Entering new station values



The following steps enter nominal and actual values across the entire measurement range:

The **Station 0** data is used as the reference for all subsequent SLEC segment measurements and is derived from the zero point of the reference standard. The data in the **Standard** and **Observed** fields of **Station 0** must be identical or entered as zeros to initiate the reference position of the reference standard.

#### *Entering new station values*

- ▶ Highlight the **Standard** field.
- ▶ Use the numeric keypad to enter **0**.
- ▶ Press «enter».

The **Observed** field is highlighted.

- ▶ Use the numeric keypad to enter **0**.
- ▶ Press «enter».

Now that the reference data has been entered into the **Standard** and **Observed** fields of **Station 0**, subsequent actual values can be measured and entered.

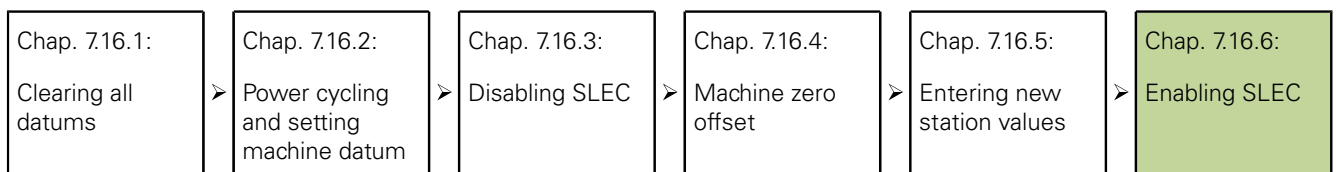
- ▶ Highlight the **Station** field.

## Software setup

Configuring the display: «Display»

- ▶ Press the «Inc» soft key to select the next station number.
- ▶ Highlight the **Standard** field.
- ▶ Use the numeric keypad to enter the value marked on the reference standard.
- ▶ Press «enter» to confirm the value.  
The **Observed** field is highlighted.
- ▶ Position the probe against the surface of the reference standard.
- ▶ Press the «Teach» soft key.  
The appropriate measured value is displayed in the **Observed** field.
- ▶ Press «enter» to confirm the value.
- ▶ Repeat these steps to enter nominal (Standard) and actual (Observed) values across the entire range of the measuring device.

### 7.16.6 Enabling SLEC



When all station data for the measuring device has been entered, the SLEC function must be enabled.

*Enabling SLEC*

- ▶ Highlight the **Enabled** field for any channel.
- ▶ Press the «On» soft key to enable SLEC or LEC for that channel.

## 7.17 Configuring the display: «Display»

*Overview*

This section describes the following functions:

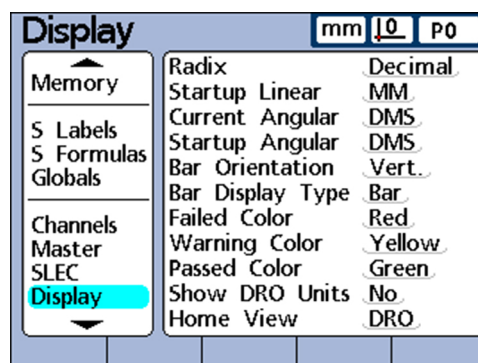
- Radix for numeric displays
- Display mode for angles
- Startup angular and linear display modes
- Bar graph orientation
- Bar graph or dial displays
- Colors that indicate measurement results
- Units of measure
- Home screen

*Activation*

«Menu/Setup» soft keys, «Display» setup screen

*Short description*

The «Display» setup screen contains fields for configuring the LCD.



### Radix for numeric displays

The **Radix** field is used to specify the separator displayed in numeric fields.

*Specifying the separator*

- ▶ Highlight the **Radix** field.
- ▶ Press the «Decimal» or «Comma» soft key.
- ▶ Press «enter».

### Display mode for angles

The **Current Angular** field is used to specify the display mode for angles. The setting is retained until the system is switched off. After switch-on, the display mode for angles specified in the **Startup Angular** field will be active again. In the **Current Angular** field, the display of measured angles can be set to decimal degrees (**DD**) or to degrees, minutes and seconds (**DMS**).

*Specifying the display mode for angles*

- ▶ Highlight the **Current Angular** field.
- ▶ Press the «DD» or «DMS» soft key.
- ▶ Press «enter».

### Specifying default angular and linear display modes

The **Startup Angular** and **Startup Linear** fields are used to specify the default display of angular and linear measurements when the system is switched on. These display settings can be changed temporarily but will revert to the startup defaults unless the **Last** setting is selected. The **Last** setting can be selected to start the system using the last units that were active at shutdown.

Linear measurements can be displayed in English or metric units of measure. Angular measurements can be displayed in degrees, minutes and seconds or in decimal degrees.

*Specifying Startup Linear settings*

- ▶ Highlight the **Startup Linear** field.
- ▶ Press the «MM», «Inch» or «Last» soft key.
- ▶ Press «enter».

*Specifying Startup Angular settings*

- ▶ Highlight the **Startup Angular** field.
- ▶ Press the «DD», «DMS» or «Last» soft key.
- ▶ Press «enter».

### Bar graph orientation

The **Bar Orientation** field is used to specify a horizontal or vertical orientation for dimension bar graphs.

*Specifying the bar orientation*

- ▶ Highlight the **Bar Orientation** field.
- ▶ Press the «Horz.» or «Vert.» soft key.
- ▶ Press «enter».

### Bar graph or dial displays

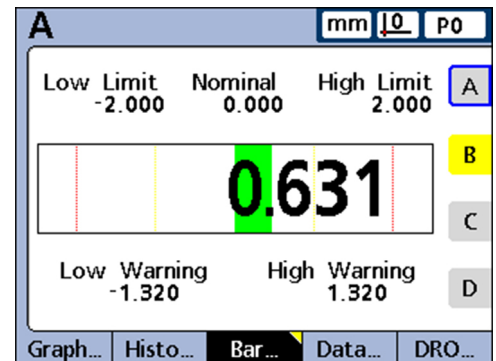
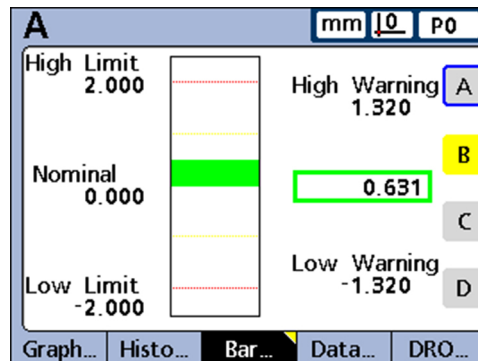
The **Bar Display Type** field is used to specify a bar graph or dial for dimension current value readings from a single channel.

## Software setup

Configuring the display: «Display»

*Specifying the bar display type*

- ▶ Highlight the **Bar Display Type** field.
- ▶ Press the «Bar» or «Dial» soft key.
- ▶ Press «enter».

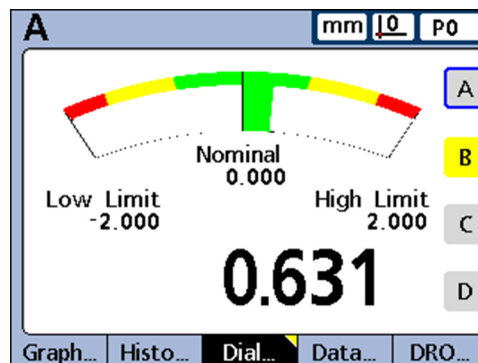


## Colors that indicate measurement results

In the **Failed/Warning/Passed Color** fields, different colors can be assigned to indicate the status of measurement results on **DRO**, **Graph**, **Data** and **SPC** screens.

*Specifying Failed, Warning and Passed Color settings*

- ▶ Highlight the **Failed Color**, **Warning Color** or **Passed Color** field.
- ▶ Press the «Red», «Yellow», «Green», «Cyan» or «Magenta» soft key to specify the desired color.
- ▶ Press «enter».



## Software setup

Configuring the display: «Display»

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### Units of measure

Units of measure can be displayed near dimension labels on the **DRO** screen to increase clarity.

*Displaying units of measure on the DRO screen*

- ▶ Highlight the **Show DRO Units** field.
- ▶ Press the «Yes» soft key.
- ▶ Press «enter».

The screenshot shows a screen titled "Current Value" with a status bar at the top right displaying "mm | 0. | P0". The main display area shows four dimensions with their units and values:

Dimension	Unit	Value
A	mm	0.631
B	mm	1.893
C	°C	19.25°
D	°F	68.25°

At the bottom of the screen, there are four soft keys: "View...", "in/mm", "Master", and "Menu...".

### Home screen

The **Home View** field is used to specify the first screen that will be displayed when the unit is switched on. The home screen will also be displayed when «finish» is pressed from another view.

*Specifying the home screen*

- ▶ Highlight the **Home View** field.
- ▶ Press the «List» soft key.
- ▶ Highlight the screen you would like to use as the home screen.
- ▶ Press «enter».
- ▶ Press «finish».

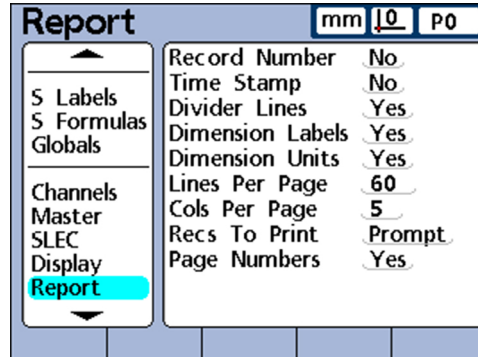
## Software setup

Setting the print format and report contents: «Report»

# 7.18 Setting the print format and report contents: «Report»

*Activation* «Menu/Setup» soft keys, «Report» setup screen

*Short description* The «Report» setup screen contains fields for formatting and specifying the contents of printed reports.



## Report features with Yes/No values

The following table shows the report features that can be enabled or disabled by pressing the «Yes» or «No» soft key.

Field	Description
Record Number	Prints the record number, see "Record number", page 115
Time Stamp	Prints date and time information
Divider Lines	Prints row and column lines
Dimension Labels	Prints the dimension labels at the top of column
Dimension Units	Prints the units of measure for values
Page Numbers	Prints the page numbers on reports

*Enabling Yes/No features*

- ▶ Highlight the desired field.
- ▶ Press the «Yes» or «No» soft key.
- ▶ Press «enter».

## Software setup

Setting the print format and report contents: «Report»

### Assignment of report sections

1	2	3			
Rec No.	Time/Date	A	B	C	D
9	8.07.19 AM 1-21-03	0.7090 mm	0.7390 mm	0.7660 mm	0.7840 mm
8	8.07.16 AM 1-21-03	0.7100 mm	0.7390 mm	0.7670 mm	0.7870 mm
7	8.07.14 AM 1-21-03	0.7080 mm	0.7380 mm	0.7650 mm	0.7840 mm
6	8.07.12 AM 1-21-03	0.7090 mm	0.7390 mm	0.7660 mm	0.7840 mm
5	8.07.10 AM 1-21-03	0.7130 mm	0.7420 mm	0.7700 mm	0.7890 mm
4	8.07.08 AM 1-21-03	0.7120 mm	0.7420 mm	0.7700 mm	0.7890 mm
3	8.07.06 AM 1-21-03	0.7090 mm	0.7390 mm	0.7670 mm	0.7860 mm
2	8.07.04 AM 1-21-03	0.7080 mm	0.7380 mm	0.7650 mm	0.7830 mm
1	8.07.00 AM 1-21-03	0.7110 mm	0.7400 mm	0.7680 mm	0.7870 mm

Page 1 5

- 1 Record Number
- 2 Time Stamp
- 3 Dimension Labels
- 4 Dimension Units
- 5 Page Numbers
- 6 Divider Lines

## Record number

Two numbers are displayed below the date and time in the title bar of the **Data** screen. The left number is the record ID and the right number is the value of the selected dimension. In this example, the value of dimension A in record number 250 is 0.8013.

2.03.30 PM 11-19-12				
#45 0.615				
A	B	C	D	
0.369	0.566	0.615	0.314	A
0.369	0.566	0.615	0.314	
0.123	0.460	0.820	0.418	B
0.123	0.460	0.820	0.418	
0.492	0.354	1.024	0.314	
0.492	0.354	1.024	0.314	C
0.615	0.319	1.127	0.366	
0.615	0.319	1.127	0.366	
0.492	0.283	1.024	0.314	D
0.492	0.283	1.024	0.314	

Summary:  $\bar{x}$ ... r... Bar... Data... DRO...

The record ID shows the relative position of the highlighted record within the total database of records. The most recent record appears at the top of the list, and is assigned the highest record ID number. When the number of records stored in the database equals the maximum records specified in the «SPC» setup screen, storing a new record replaces the oldest record. The record database is a pushdown queue.

### Specifying record number settings

- ▶ Highlight the **Record Number** field.
- ▶ Press the «No» soft key to omit record ID numbers from reports.
- ▶ Press the «Yes» soft key to include the absolute record ID number or
  - ▶ Press the «Relative» soft key to include the relative record ID number.
- ▶ Press «enter».

## Software setup

Setting the print format and report contents: «Report»

---

### Lines per page

Horizontal divider lines and lines of text are considered lines.

*Specifying the lines per page*

- ▶ Highlight the **Lines Per Page** field.
- ▶ Use the numeric keypad to enter the desired number of lines per report page.
- ▶ Press «enter».

### Columns per page

Only vertical columns of text are considered columns. The example report shown on page 115 contains 6 columns of text.

*Specifying the number of columns per page*

- ▶ Highlight **Cols per page**.
- ▶ Use the numeric keypad to enter the desired number of columns per report page.
- ▶ Press «enter».

### Records to be printed

The following records to be printed can be selected for a report:

- A user-defined range of records
- All records not yet printed (New)
- All records in the database
- Only the selected records

Soft key	Description
«Range»	The user will be prompted to specify the number of records to print
«New»	Only records that have not yet been printed will be printed.
«All»	All records in the database will be printed.
«Selected»	The highlighted record will be printed.
«Prompt»	The user will be prompted to select records to be printed.

*Specifying the records to be printed*

- ▶ Highlight the **Recs To Print** field.
- ▶ Press the soft key for the type of records to be printed.
- ▶ Press «enter».

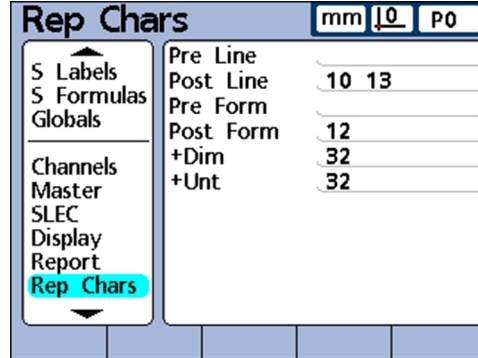


## 7.19 Setting ASCII codes for printing: «Rep Chars»

*Activation*

«Menu/Setup» soft keys, «Rep Chars» setup screen


Report data can include ASCII codes such as Carriage Return, Line Feed and others to control printer functions and customize the print formatting to suit printer requirements. Multiple ASCII codes can be included in a single field when separated by spaces.



Field	Description
Pre Line	Before lines of text
Post Line	After lines of text
Pre Form	Before the form
Post Form	After the form
+Dim	After each dimension value
+Unt	After each unit of measure

*Entering ASCII codes*

- ▶ Highlight one of the parameter fields in the «Rep Chars» setup screen.
- ▶ Use the numeric keypad to enter the desired ASCII code.
- ▶ Repeat the process until all desired ASCII codes have been entered.
- ▶ Press «finish».

 To enter a space, use the «Decimal Point» key on the numeric keypad.

## Software setup

Setting ASCII codes for printing: «Rep Chars»

### Table of ASCII codes

Code	Character	Code	Character	Code	Character	Code	Character
8	Backspace	37	%	66	B	95	_
9	Horizontal tab	38	&	67	C	96	'
10	Line feed	39	'	68	D	97	a
11	Vertical tab	40	(	69	E	98	b
12	Form feed	41	)	70	F	99	c
13	Carriage return	42	*	71	G	100	d
14	SO	43	+	72	H	101	e
15	SI	44	,	73	I	102	f
16	DIE	45	-	74	J	103	g
17	DC1	46	.	75	K	104	h
18	DC2	47	/	76	L	105	i
19	DC3	48	0	77	M	106	j
20	DC4	49	1	78	N	107	k
21	NAK	50	2	79	O	108	l
22	SYN	51	3	80	P	109	m
23	ETB	52	4	81	Q	110	n
24	CAN	53	5	82	R	111	o
25	EM	54	6	83	S	112	p
26	SUB	55	7	84	T	113	q
27	ESC	56	8	85	U	114	r
28	FS	57	9	86	V	115	s
29	GS	58	:	87	W	116	t
30	RS	59	;	88	X	117	u
31	US	60	<	89	Y	118	v
32	Space	61	=	90	Z	119	w
33	!	62	>	91	[	120	x
34	"	63	?	92	\	121	y
35	#	64	@	93	]	122	z
36	\$	65	A	94	^		

## Software setup

Selecting fields for record transmission: «Send»

### 7.20 Selecting fields for record transmission: «Send»

#### Overview

This section describes the following functions:

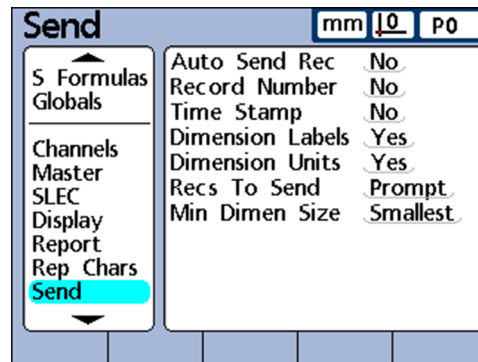
- Sending records automatically
- Specifying the record number
- Specifying the record date, label and units of measure
- Selecting the records to be sent
- Specifying placeholders for dimension data

#### Activation

«Menu/Setup» soft keys, «Send» setup screen

#### Short description

The «Send» setup screen contains fields for selecting the contents to be included in record files transmitted to computers.



### Sending records automatically

Record data can be transmitted automatically as each record is entered into the database.

#### Enabling Auto Send Rec

- ▶ Highlight the **Auto Send Rec** field.
- ▶ Press the «Yes» soft key.
- ▶ Press «enter».

### Specifying the record number

#### Specifying the record number

- ▶ Highlight the **Record Number** field.
- ▶ Press the «Yes» or «Relative» soft key.
- ▶ Press «enter».



For more information on the selection options for record numbers, see "Setting the print format and report contents: Report", page 114.

## Software setup

Selecting fields for record transmission: «Send»

### Specifying the record date, label and units of measure

The following three fields provide the opportunity to include or omit record data by selecting «Yes» or «No».

Field	Description
Time Stamp	Indicates the date and time the data was collected
Dimension Labels	Includes dimension labels at the top of column
Dimension Units	Transmits the units of measure with the values

*Transmitting the record date, label and units of measure*

- ▶ Highlight the desired field.
- ▶ Press the «Yes» soft key.
- ▶ Press «enter».

### Selecting the records to be sent

The following records can be selected for transmission:

- A user-defined range of records
- All records not yet transmitted (New)
- All records in the database
- The currently selected record

Soft key	Description
«Range»	The user will be prompted to specify the number of records to be transmitted
«New»	Only records that have not yet been transmitted will be transmitted
«All»	All records in the database will be transmitted
«Selected»	The highlighted record will be transmitted
«Prompt»	The user will be prompted to select records to be transmitted

*Specifying the records to be sent*

- ▶ Highlight the **Recs To Send** field.
- ▶ Press the soft key for the type of records to be sent.
- ▶ Press «enter».

## Software setup

Entering ASCII code for transmitted data: «Send Chars»

### Specifying placeholders for dimension data

Dimension data can be transmitted over the RS-232/V.24 connection with or without formatting placeholders.

Option	Description	Example
<b>Largest</b>	Sends data spaces for a sign character, 8 digits and a decimal point	8 .2 1 7
<b>Smallest</b>	Sends only the required 5 data spaces	8 .2 1 7

*Specifying the minimum size for dimension data*

- ▶ Highlight the **Min Dimen Size** field.
- ▶ Press the «Largest» or «Smallest» soft key.
- ▶ Press «enter».

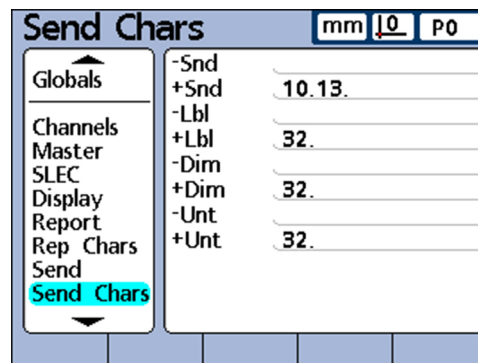
## 7.21 Entering ASCII code for transmitted data: «Send Chars»

*Activation*

«Menu/Setup» soft keys, «Send Chars» setup screen

*Short description*

Transmitted data can include ASCII codes such as **Carriage Return** (ASCII code 13), **Line Feed** (ASCII code 10) and others to provide formatting based on the requirements of the receiving computer software. Multiple ASCII codes can be included in a single field when separated by spaces.



The parameters have the following meanings:

Field	Description
-Snd	Before record data
+Snd	After record data
-Lbl	Before the form
+Lbl	After the form
-Dim	Before each dimension value
+Dim	After each dimension value
-Unt	Before each unit of measure
+Unt	After each unit of measure

## Software setup

Setting the I/O interface: «Parallel»

---

- Entering ASCII codes*
- ▶ Highlight one of the parameter fields in the «Send Chars» setup screen.
  - ▶ Use the numeric keypad to enter the desired ASCII code.
  - ▶ Press «enter» to move to the next parameter.
  - ▶ Repeat the process until all desired ASCII codes have been entered.
  - ▶ Press «finish».

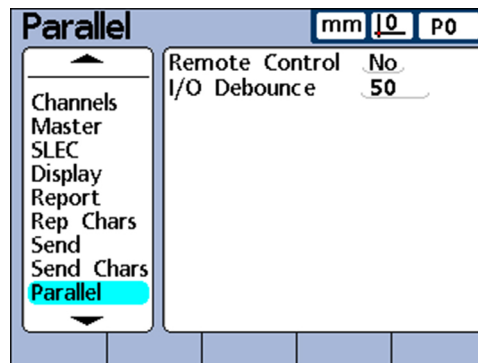


For the ASCII codes table see "Setting ASCII codes for printing: Rep Chars", page 117.

## 7.22 Setting the I/O interface: «Parallel»

*Activation* «Menu/Setup» soft keys, «Parallel» setup screen

*Short description* The «Parallel» setup screen contains fields for enabling remote control of the unit and specifying a debounce interval for the I/O interface.



### Remote control

Remote control of the unit is limited to measurements conducted under the supervision of a user. The unit will accept commands only while displaying the Home screen or one of the View screens.

To facilitate this remote control feature, a **receive ready** flag is set on Dout (1), pin 2 of the I/O interface when the Home or a View screen is displayed. The remote computer or other controlling device can send commands upon detecting the **receive ready** flag. Commands sent to the unit when Dout (1) is logic level 0 will be ignored.

- Enabling remote control*
- ▶ Highlight the **Remote Control** field.
  - ▶ Press the «Yes» soft key.
  - ▶ Press «enter».

### I/O Debounce

The I/O interface is used as a GPIO (General Purpose I/O). The source of logic levels applied at the I/O interface pins can be solid state or hard contact switching devices.

When hard contact switching devices are used, switching noise is often generated by contact bounce. The effects of switching noise are eliminated by validating the input logic levels for a short debounce time after the first level change occurs at the interface.

- Specifying the I/O Debounce interval*
- ▶ Highlight the **I/O Debounce** field.
  - ▶ Enter the debounce time in milliseconds.
  - ▶ Press «finish».

## 7.23 Setting the RS-232 interface: «RS232»

*Overview*

This section describes the following functions:

- Uart Id
- Baud rate
- Word length
- Stop bits
- Parity
- Handshaking
- End of character (EOC) delay
- End of line (EOL) delay
- Serial port data type

*Activation*

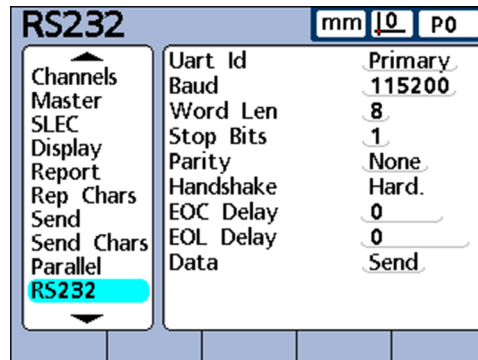
«Menu/Setup» soft keys, «RS232» setup screen

*Short description*

The «RS232» setup screen contains fields for configuring the RS-232/V.24 serial port settings for communication with a computer or RS-232/V.24 measuring device.

The factory default settings are:

- Baud rate: 115 200
- Word length: 8 bits
- Stop bits: 1 bit
- Parity: None



### Uart Id

Units that include a second RS-232/V.24 serial port for connecting RS-232/V.24 measuring devices must be configured to communicate with computers on either the primary or secondary port. Typically, computer communication takes place on the primary port, and RS-232/V.24 probe networks are attached to the secondary port. However, either port can be designated as the communication port.

*Entering the Uart ID*

- ▶ Highlight the **Uart Id** field.
- ▶ Press the «Inc» or «Dec» soft key to highlight the desired port.
- ▶ Press «enter».

### Baud rate

The **Baud** field is used to specify the baud rate of serial data.

## Software setup

Setting the RS-232 interface: «RS232»

---

*Specifying the baud rate*

- ▶ Highlight the **Baud** field.
- ▶ Press the «Inc» or «Dec» soft key to set the baud rate in a range from 1200 to 115200.
- ▶ Press «enter».

### Word length

The **Word Len** field is used to specify the number of bits contained in each data word.

*Specifying the word length*

- ▶ Highlight the **Word** field.
- ▶ Press the «7» or «8» soft key to specify the word length.
- ▶ Press «enter».

### Stop bits

The **Stop Bits** field is used to specify the number of stop bits included after each data word.

*Specifying the number of stop bits*

- ▶ Highlight the **Stop Bits** field.
- ▶ Press the «1» or «2» soft key to specify the number of stop bits.
- ▶ Press «enter».

### Parity

The **Parity** field is used to specify odd or even parity for error checking, or to omit parity error checking.

*Specifying parity*

- ▶ Highlight the **Parity** field.
- ▶ Press the «None», «Odd» or «Even» soft key to select the desired parity error checking option.
- ▶ Press «enter».

### Handshaking

The **Handshake** field shows the type of synchronous signaling used by the system to prevent data collisions on the serial port. This field is set to **Hard**. (hardware) and cannot be changed.

### End of character (EOC) delay

The **EOC Delay** field is used to specify the delay inserted after each character is transmitted. This delay can be increased or decreased to accommodate various serial devices.

*Setting EOC delay*

- ▶ Highlight the **EOC Delay** field.
- ▶ Use the numeric keypad to specify delays (in milliseconds) from 0 to 10 seconds between characters.
- ▶ Press «enter».

### End of line (EOL) delay

The **EOL Delay** field is used to specify the delay inserted after each line is transmitted. This delay can be increased or decreased to accommodate various serial devices.



## Software setup

Setting the USB port: «USB»

---

### Setting EOL delay

- ▶ Highlight the **EOL Delay** field.
- ▶ Use the numeric keypad to specify delays (in milliseconds) from 0 to 10 seconds between lines.
- ▶ Press «enter».

## Serial port data type

Data can be sent to the serial port as a report formatted in the «Report» setup screen, or as record data formatted in the «Send» setup screen, or as both. The serial port can also be disabled for data transmission by selecting the «None» soft key.

### Specifying the serial port data type

- ▶ Highlight the **Data** field.
- ▶ Press the soft key for the type of data to be sent.
- ▶ Press «enter».

## 7.24 Setting the USB port: «USB»

### Overview

This section describes the following functions:

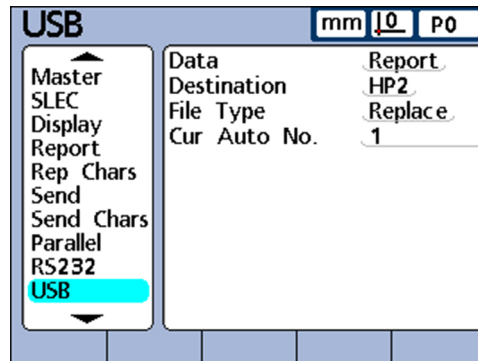
- Selecting the type of data
- Specifying the destination
- Setting the file type
- Specifying the current automatic (file) number

### Activation

«Menu/Setup» soft keys, «USB» setup screen

### Short description

The USB port can send data to a USB flash drive or to a USB printer. The «USB» setup screen contains data and choice fields for configuring communication parameters of the USB port.



## Selecting the type of data

Data can be sent to the USB port as a report formatted in the «Report» setup screen, or as record data formatted in the «Send» setup screen, or as both. The USB port can also be disabled for data transmission by selecting «None».

### Selecting the type of data

- ▶ Highlight the **Data** field.
- ▶ Press the soft key for the type of data to be sent.
- ▶ Press «enter».

### Specifying the destination

Data can be sent through the USB port to be printed on a printer (HP2) or to be stored as a file (File) on a USB flash drive. Files stored on flash drives are named «DataN.txt» by the ND 2100G system, where **N** denotes the number of the data file.

*Specifying the destination*

- ▶ Highlight the **Destination** field.
- ▶ Press the «File» or «HP2» soft key.
- ▶ Press «enter».

### Setting the file type

The file type of the USB port can be specified to replace existing files (of the same name) on the USB flash drive, append to the existing file or create new files that are automatically numbered sequentially in ascending order (Data1.txt, Data2.txt.....DataN.txt).

*Setting the file type*

- ▶ Highlight the **File Type** field.
- ▶ Press the «Replace», «Append» or «AutoNo.» soft key.
- ▶ Press «enter».

### Specifying the current automatic (file) number

When the USB file type is specified as «AutoNo.», the file number of the next file saved to the USB drive can be manually specified.

For example, entering a 2 into the **Cur Auto No** field will cause the next data file saved on the USB drive to be named Data2.txt. Any file that already exists on the USB flash drive with the same name will be overwritten.

*Setting the current automatic number*

To specify the current automatic number:

- ▶ Highlight the **Cur Auto No.** field.
- ▶ Use the numeric keypad to enter the desired number of the next file.
- ▶ Press «finish».

## 7.25 Configuring hot keys: «Hot Keys»

*Overview*

This section describes the following functions:

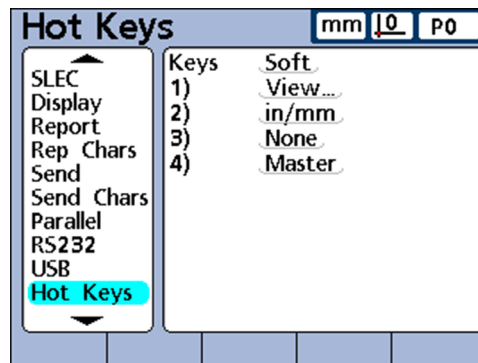
- Front panel keys for hot key mapping
- Remote switches and I/O interface pins for hot key mapping
- Assigning hot key functions

*Activation*

«Menu/Setup» soft keys, «Hot Keys» setup screen

*Short description*

The «Hot Keys» setup screen is used to map frequently used functions to front panel keys, the remote keypad and the foot switch. Hot keys can save time by eliminating the need to navigate through menus to initiate a function. They also make a function quickly accessible through a foot switch or remote keypad.



### 7.25.1 Front panel keys for hot key mapping

Front panel keys available for hot key mapping are shown in the table below and provided in menus of hot key types.

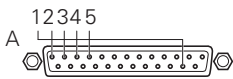
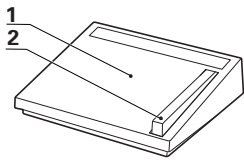
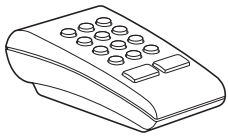
Name	Description
<b>Fast track keys</b>	Both fast track keys are available for hot key mapping. Hot key functions assigned to the fast track keys can be invoked at any time.
<b>Soft keys</b>	The left 4 soft keys are available for hot key mapping. The right soft key under the LCD is used to access menus and is unavailable for hot key mapping. Hot key functions assigned to soft keys can be invoked only when the home screen is displayed. In all other screens, soft-key functions are permanently assigned by the system for the selection of menus, screens, functions and dimensions.
<b>Numerical keys</b>	All keys on the numeric keypad, except the decimal point and «+/-» keys, are available for hot key mapping. Hot key functions assigned to numerical keys can be invoked at any time unless the system expects a numeric entry to complete a task.
<b>Dimension keys</b>	The 4 dimension keys at the right of the LCD are available for hot key mapping.

### 7.25.2 Remote switches and I/O interface pins for hot key mapping

The foot switch, hand switch and remote keypad as well as specific pins of the I/O interface are also available for hot key mapping.

## Software setup

Configuring hot keys: «Hot Keys»



Name	Description
Remote keys	All numeric keys on the remote keypad are available for hot key mapping. Hot key functions assigned to numeric remote keys can be invoked at any time unless the system expects a numeric entry to complete a task.
1 Foot switch 2 Foot switch	The foot switch is used interchangeably with the hand switch. Both foot switch keys are available for hot key mapping. Hot key functions assigned to foot switch keys can be invoked at any time.
Pins of the I/O interface	The I/O interface is used as a GPIO (General Purpose I/O). The 5 input pins (Din 1 through Din 5) of the I/O interface are available for hot key mapping.

### 7.25.3 Assigning hot key functions

The method used to assign hot key functions is identical for all hot key types.

The following function categories are available:

Category	Function
<b>None</b>	No assignment will be made; this will not be a hot key.
<b>Key</b>	A front panel key function will be assigned by pressing one of the front panel keys.
<b>Special</b>	A system function of the unit will be assigned from the «Special» list.
<b>Func.</b>	A custom function will be assigned. These user-defined functions can be assigned to all hot-key types except dimensions (Dimens).

*Assigning hot key functions*

- ▶ Highlight the **Keys** field.
- ▶ Press the «List» soft key to display the available hot key types.
- ▶ Use the arrow keys to highlight a hot key type.
- ▶ Press «enter».
- ▶ Use the arrow keys to select a key to which the hot key function will be assigned.
- ▶ Select a function category from the soft keys displayed at the bottom of the screen.
- ▶ Follow the instructions for the selected function category, which are outlined in the following pages.

#### Key

*Assigning a front panel key function as a hot key*

- ▶ Press the «Key» soft key.
- ▶ Press the desired front panel key to assign that front panel key's function to the specified hot key.

## Special

Functions from the «Special» list are slightly different between:

- Soft keys
- Dimension keys
- Numerical keys, fast track keys, foot keys, hand keys, keys on the remote keypad, and **Din** pins

The system functions mapped to dimension keys (Dimens) are limited to typical dimension activities, and apply only to the associated dimension. For example, when the «Send» function is mapped to the «Dimension A» soft key, only the current value of Dimension A is transmitted when the «Dimension A» soft key is pressed.

*Assigning a system function as a hot key*

- ▶ Press the «Special» soft key.
- ▶ Highlight the system function you wish to assign.
- ▶ Press «enter».

The display shows a list of system functions that can be assigned as hot keys.

- ▶ Press «enter».

The following table shows what functions from the «Special» menu can be assigned to the different key types.

System function	Di-mens	Din	Foot	Hand	Re- mote	Soft	Unit	Wide
Auto	X							
Bar...	X	X	X	X	X		X	X
Clear	X							
Clr All	X					X		
Clr Part	X					X		
Cycle	X							
D0/D1	X							
Data...	X	X	X	X	X		X	X
DMS/DD	X							
Dout	X							
DRO	X	X	X	X	X		X	X
Fast3	X							
Force	X							
Graph...	X	X	X	X	X		X	X
Histo...	X	X	X	X	X		X	X
Hold	X	X	X	X	X	X	X	X
in/mm	X							
Master	X							



## Software setup

Configuring hot keys: «Hot Keys»

System function	Di-mens	Din	Foot	Hand	Re-remote	Soft	Unit	Wide
Part No.	X							
Part?	X							
Preset								
Pressure	X							
Rad/Dia	X							
Recall								
Relay	X							
RsetDyn								
r...	X	X	X	X	X		X	X
Send								
SendRec	X							
View...	X							
Zero								
̄x...	X	X	X	X	X		X	X

## Description of system functions in the «Special» menu

System function	Description
<b>Auto</b>	The <b>Auto</b> function toggles the Trip function on and off. For more information see "Measurement automation: trip function", page 178.
<b>Bar...</b>	The <b>Bar...</b> function selects the bar graph view of current values on the «DRO» screen.
<b>Clear</b>	The <b>Clear</b> function clears the incremental datums for all dimensions.
<b>Clr All</b>	The <b>Clr All</b> function clears the unit's database. All records for all parts are deleted completely.
<b>Clr Part</b>	The <b>Clr Part</b> function clears the records for the specified part from the unit's database. All records for the specified part are deleted completely.
<b>Cycle</b>	The <b>Cycle</b> advances to the next part number. Part numbers are cycled in a continuous loop.
<b>D0/D1</b>	The <b>D0/D1</b> function toggles between the display of current values for the absolute datum (datum 0) and the incremental datum (datum 1).
<b>Data...</b>	The <b>Data...</b> function selects the data table view of stored records.
<b>DMS/DD</b>	The <b>DMS/DD</b> function toggles between the current presentation of degrees/minutes/seconds and decimal degrees for angular measurements.

System function	Description								
<b>Dout</b>	<p>The <b>Dout</b> function defines the logic state of one of the 12 I/O output pins to:</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="background-color: #d9ead3;">State</th> <th style="background-color: #d9ead3;">Description</th> </tr> </thead> <tbody> <tr> <td>Off</td> <td>Logic 0 (0 volts)</td> </tr> <tr> <td>On</td> <td>Logic 1 (5 volts)</td> </tr> <tr> <td>Toggle</td> <td>Changes from one logic level to the other on a specified output pin.</td> </tr> </tbody> </table> <p>When the <b>Dout</b> function is selected, additional screens are provided for pin and logic level assignment.</p> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">  Logic levels are referred to ground on pins 18 through 25.                 </div>	State	Description	Off	Logic 0 (0 volts)	On	Logic 1 (5 volts)	Toggle	Changes from one logic level to the other on a specified output pin.
State	Description								
Off	Logic 0 (0 volts)								
On	Logic 1 (5 volts)								
Toggle	Changes from one logic level to the other on a specified output pin.								
<b>DRO</b>	The <b>DRO</b> function selects the <b>DRO</b> view of current values.								
<b>Fast3</b>	<p>The <b>Fast3</b> function samples the channel 2 input each time the channel 1 input changes by a specified sample increment. If the sampled value of channel 2 falls outside a specified range, all input values of the base channels (first 1, 4 or 8 channels) will be stored in a dedicated memory array; otherwise samples will not be stored.</p> <p>This sampling process continues until one of the following occurs:</p> <ul style="list-style-type: none"> <li>■ The user aborts the process by pressing «quit» or «cancel».</li> <li>■ The user clears the memory and restarts the process by pressing «enter».</li> <li>■ The user successfully completes the process and presses «finish».</li> <li>■ The process is automatically completed after 50,000 sets of channel positions have been stored.</li> </ul> <div style="border: 1px solid black; padding: 5px; margin-top: 10px;">  For more information on Fast3 see "Basic Operation", page 28.                 </div>								
<b>Force</b>	<p>The <b>Force</b> function cycles through the available of units of force as the hot key is repeatedly pressed. If the <b>Force</b> function is assigned to a soft key, the selected unit of force is displayed in the soft-key row at the bottom of the LCD. If the <b>Force</b> function is assigned to a hot key type other than a soft key, the <b>Show DRO Units</b> function must be enabled in the «Display» setup screen to display the units of measure on the <b>DRO</b> screen.</p> <p>The following units of force can be selected:</p> <ul style="list-style-type: none"> <li>■ N: Newtons</li> <li>■ gf: Grams force</li> <li>■ lbf: Pounds force</li> </ul>								
<b>Graph...</b>	The <b>Graph...</b> function selects the line graph view of stored records.								
<b>Histo...</b>	The <b>Histo...</b> function selects the histogram view of stored records for display on the <b>DRO</b> screen.								
<b>Hold</b>	The <b>Hold</b> function toggles between holding (freezing) and releasing the current value displayed on the LCD for this dimension.								

## Software setup

Configuring hot keys: «Hot Keys»

System function	Description																
<b>in/mm</b>	The <b>in/mm</b> function toggles the display of dimension values between <b>inch</b> and <b>mm</b> .																
<b>Master</b>	The <b>Master</b> function displays the «Master» setup screen for calibrating and presetting inputs.																
<b>Part No.</b>	Using the <b>Part No.</b> function, the part number selected by the user when assigning the hot key can be displayed as the current part by pressing the hot key.																
<b>Part?</b>	The <b>Part?</b> function displays a pop-up window for entry of a new part number.																
<b>Preset</b>	The <b>Preset</b> function presets this dimension's datum.																
<b>Pressure</b>	<p>The <b>Pressure</b> function cycles through the available of units of pressure as the hot key is repeatedly pressed. If the <b>Pressure</b> function is assigned to a soft key, the selected unit of pressure is displayed in the soft-key row at the bottom of the LCD. If the <b>Pressure</b> function is assigned to a hot key type other than a soft key, the <b>Show DRO Units</b> function must be enabled in the «Display» setup screen to display the units of measure on the <b>DRO</b> screen.</p> <p>The following units of pressure can be selected:</p> <ul style="list-style-type: none"> <li>■ ATM: Atmospheres</li> <li>■ Bar: Bars</li> <li>■ Pa: Pascals</li> <li>■ PSI: Pounds per square inch</li> </ul>																
<b>Rad/Dia</b>	The <b>Rad/Dia</b> function toggles between the <b>Radius</b> and <b>Diameter</b> measurement types on the <b>DRO</b> screen, if radius or diameter was specified in the «Formats» setup screen. When assigned to a dimension key, this function toggles between the radius and diameter measurement types on single dimensions. When assigned to other keys, the function toggles the measurement type on all dimensions.																
<b>Recall</b>	The <b>Recall</b> function recalls and applies the most recently used preset for the dimension's datum.																
<b>Relay</b>	<p>The output states of Relay 1 and Relay 2 can be assigned to hot keys. The output state of each relay is independent of the other, and can be de-energized (0), energized (1) or toggled (0/1).</p> <p>The following relay operations are possible:</p> <ul style="list-style-type: none"> <li>■ R1 0: Relay 1 is de-energized (off, 0)</li> <li>■ R1 1: Relay 1 is energized (on, 1)</li> <li>■ R1 0/1: Relay 1 is toggled between states (on to off, or off to on)</li> <li>■ R2 0: Relay 2 is de-energized (off, 0)</li> <li>■ R2 1: Relay 2 is energized (on, 1)</li> <li>■ R2 0/1: Relay 2 is toggled between states (on to off, or off to on)</li> </ul> <table border="1" style="width: 100%; text-align: center;"> <thead> <tr> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> <th>6</th> <th>7</th> <th>8</th> </tr> </thead> <tbody> <tr> <td>R-1 COM</td> <td>R-1 NC</td> <td>R-1 NO</td> <td>R-2 NO</td> <td>R-2 NC</td> <td>R-2 COM</td> <td>/</td> <td>/</td> </tr> </tbody> </table>	1	2	3	4	5	6	7	8	R-1 COM	R-1 NC	R-1 NO	R-2 NO	R-2 NC	R-2 COM	/	/
1	2	3	4	5	6	7	8										
R-1 COM	R-1 NC	R-1 NO	R-2 NO	R-2 NC	R-2 COM	/	/										

For more information on the relay connector, see "Wiring of switching inputs and outputs", page 26



## Software setup

Configuring hot keys: «Hot Keys»

System function	Description
-----------------	-------------

### NOTICE

Risk of damage to equipment!

Exceeding the maximum voltage and current ratings for the relay contacts can damage the relay of the unit and void the product warranty.

- ▶ Ensure that the maximum ratings for relay contact voltage and current given in "Specifications", page 261 are not exceeded.

<b>RsetDyn</b>	The <b>RsetDyn</b> function resets the minimum or maximum values accumulated during dynamic measurements for this dimension.
<b>r...</b>	The <b>r...</b> function selects the line graph view of ranges of stored records for display on the LCD.
<b>Send</b>	The <b>Send</b> function transmits the current value displayed on the LCD for this dimension.  The <b>Send</b> function transmits data to a printer or a computer or both, depending on parameters configured in the «Parallel» or «RS232» setup screens.
<b>SendRec</b>	The <b>SendRec</b> function transmits the last (most recently stored) record, a range of records, or all records.
<b>View...</b>	The <b>View</b> function changes to the <b>DRO</b> and «SPC» data view for all dimensions.
<b>Zero</b>	The <b>Zero</b> function clears the current datum for all dimensions.
<b><math>\bar{x}</math></b>	The <b><math>\bar{x}</math></b> function selects the line graph view of the mean of stored records for display on the <b>DRO</b> screen.

## Func.

*Assigning a custom function to a hot key*

- ▶ Press the «Func.» soft key.
- ▶ Use the numeric keypad to enter the number of the custom function.

The assigned custom function will be executed when the key is pressed.



Custom functions cannot be mapped to dimension keys. For more information on custom functions, see "Creating custom functions: FnDefine, FnParam and FnCall", page 199.

## Software setup

Setting date and time: «Clock»

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### 7.26 Setting date and time: «Clock»

#### Overview

This section describes the following functions:

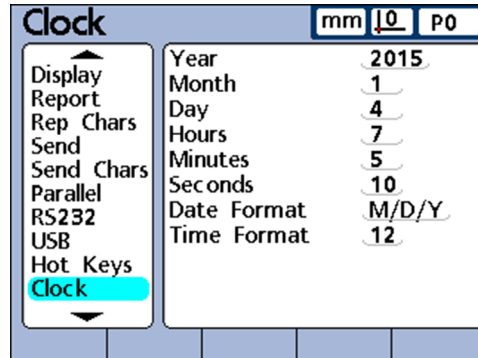
- Setting the date and time
- Setting the date format
- Setting the time format

#### Activation

«Menu/Setup» soft keys, «Clock» setup screen

#### Short description

The «Clock» setup screen contains fields for setting and formatting displays of date and time shown on the LCD and printed on reports.



### Setting the date and time

#### Setting the date

- ▶ Highlight the **Year** field.
- ▶ Use the numeric keypad to enter current year into the field.
- ▶ Press «enter».
- ▶ Repeat these steps for the **Month** and **Day** fields.

#### Setting the time

- ▶ Highlight the **Hours** field.
- ▶ Use the numeric keypad to enter current hour into the field.
- ▶ Press «enter».
- ▶ Repeat these steps for the **Minutes** and **Seconds** fields.

### Setting the date format

The **Date Format** field specifies the format of the date shown on the LCD and printed on reports.

The following overview shows the available date format soft keys and displays:

Date	Soft key	Date format display	
September 10, 2010	«M/D/Y»	<b>A</b>	<b>9-10-10</b>
	«D/M/Y»	<b>A</b>	<b>10-9-10</b>
	«M.D.YY»	<b>A</b>	<b>09.10.10</b>
	«D.M.YY»	<b>A</b>	<b>10.09.10</b>

*Setting the date format*

- ▶ Highlight the **Date Format** field.
- ▶ Press the soft key for the desired date format.
- ▶ Press «enter».

### Setting the time format

The **Time Format** field specifies the format of the time shown on the LCD and printed on reports.

The following overview shows the available time format soft keys and displays:

Time	Soft key	Time format display	
12-hour clock Example: 1:44:37pm	«12»		<b>01.44.37</b>
	«12:»		<b>01:44:37</b>
24-hour clock Example: 13:44:37	«24»		<b>13.44.37</b>
	«24:»		<b>13:44:37</b>

*Specifying the time format*

- ▶ Highlight the **Time Format** field.
- ▶ Press the soft key for the desired time format.
- ▶ Press «enter».

## Software setup

Setting parameters for displays, keys and audio output: «Misc.»

# 7.27 Setting parameters for displays, keys and audio output: «Misc.»

### Overview

This section describes the following functions:

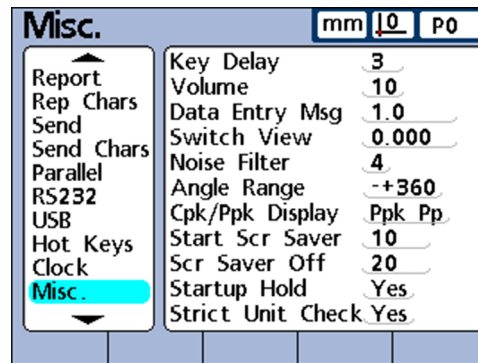
- Setting the key delay
- Setting the speaker volume
- Setting the display duration for the data entry message
- Switching the view
- Setting the angle range display
- Displaying process capability and process performance data
- Activating the screen saver
- Deactivating the screen saver
- Home screen automatically or after key press
- Specifying strict unit check

### Activation

«Menu/Setup» soft keys, «Misc.» setup screen

### Short description

The «Misc.» setup screen contains fields for specifying keypad, LCD display and SPC performance display as well as audio, angle range display and screen saver parameters.



## Setting the key delay

The **Key Delay** field is used to adjust the rate at which front panel key presses will be accepted, and characters will be repeated when a front panel key is pressed and held down.

As the key delay value is increased, the rate of key entry and auto repeat decreases.

### Setting the key delay

- ▶ Highlight the **Key Delay** field.
- ▶ Use the numeric keypad to enter a key delay value.
- ▶ Press «enter».

## Setting the speaker volume

The **Volume** field is used to adjust the loudness of unit's speaker tones that signal key presses and alerts:

- Volume settings range from **0** to **10**.
- A volume setting of **0** disables the audio output.

### Setting the speaker volume

- ▶ Highlight the **Volume** field.
- ▶ Use the numeric keypad to enter the desired volume.
- ▶ Press «enter».

### Setting the display duration for the data entry message

The **Data Entry Msg** field is used to specify the duration that the data entry confirmation message **Data has been added to the database** is displayed each time a record of measured values is saved with «quit» during a measurement.

- The display duration can range from **0** to **9999** seconds with up to three decimal places.
- When **0** is entered, no message will be displayed.



A displayed message can also be closed by pressing «quit».

*Setting the display duration for the data entry message*

- ▶ Highlight the **Data Entry Msg** field.
- ▶ Use the numeric keypad to enter the desired display duration.
- ▶ Press «enter».

### Specifying the range of motion

Views are normally selected by pressing soft keys displayed on the screen.

However, the unit's **DRO**, **Bar** and **Dial** views can be programmed to automatically display the dimension for whose channel input the measured value is included in the formula.

The **Switch View** field is used to specify the range of motion required on any channel input to switch the **DRO**, **Bar** or **Dial** view to the associated dimension.

When **0** is entered, the display will not be switched.

*Specifying the range of motion*

- ▶ Highlight the **Switch View** field.
- ▶ Use the numeric keypad to enter the range of motion required to switch the **DRO** view.
- ▶ Press «enter».

### Setting the angle range display

The **Angle Range** field allows choosing between four display modes for the angle range. The following display modes can be selected by soft key:

- «-+ 360»: Full-revolution display in the positive or negative direction
- «360»: Display from 0 to 360°
- «-+ 180»: Half-revolution display in the positive or negative direction
- «<360>»: Infinite display ( $\pm \infty$ )

*Setting the angle range display*

- ▶ Highlight the **Angle Range** field.
- ▶ Press the «-+ 360», «360», «-+ 180» or «<360>» soft key.
- ▶ Press «enter».

### Displaying process capability and process performance data

The **Cpk/Ppk Display** field is used to select process capability or process performance data to be displayed in the **Data** view for a single dimension.

- The **Cpk Cp** setting will display the process capability index
- The **Ppk Pp** setting will display the process performance index

## Software setup

Setting parameters for displays, keys and audio output: «Misc.»

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*Specifying the display of process capability and process performance data*

- ▶ Highlight the **Cpk/Ppk Display** field.
- ▶ Press the «Ppk Pp» or «Cpk Cp» soft key.
- ▶ Press «enter».

### Activating the screen saver

The **Start Scr Saver** field is used to specify the time of inactivity of the unit (in minutes) before the screen saver is displayed.

A setting of **9999** disables the screen saver.

*Specifying screen saver activation*

- ▶ Highlight the **Start Scr Saver** field.
- ▶ Use the numeric keypad to enter the number of minutes of inactivity before the screen saver is activated.
- ▶ Press «enter».

### Deactivating the screen saver

The **Scr Saver Off** field is used to specify the range of motion (in counts: resolution increments per second) required on any channel to turn the screen saver off.

- For example, if a value of **20** is entered and the channel resolution is 0.001 mm, a movement of 2 mm per second will turn the screen saver off
- If **0** is entered, the screen saver can only be deactivated by pressing a front panel key

*Specifying screen saver deactivation*

- ▶ Highlight the **Scr Saver Off** field.
- ▶ Use the numeric keypad to enter the range of motion required to deactivate the screen saver.
- ▶ Press «enter».

### Home screen automatically or after key press

The startup screen is the first screen that is displayed when the unit is switched on. The **Startup Hold** field is used to specify when the display will change to the home screen.

- When **No** is selected, the LCD will display the startup screen for a few seconds after switch-on and then automatically change to the home screen.
- When **Yes** is selected, the startup screen will be displayed until «enter» is pressed.

*Specifying switchover to the home screen*

- ▶ Highlight the **Startup Hold** field.
- ▶ Press the «Yes» or «No» soft key.
- ▶ Press «enter».

### Specifying strict unit check

The **Strict Unit Check** field is used to specify whether calculations with mixed units of measure will be prevented.

- Selecting **Yes** prevents calculations with mixed units of measure
- Selecting **No** allows calculations with mixed units of measure

*Example*

When **Yes** is selected, the calculation 15 mm+2.0 would not be allowed because it contains mixed units of measure; when **No** is selected, the following calculation would be performed:

## Software setup

Locking or unlocking critical functions: «Supervisor»

15 mm+2.0 = 17.0.

Only numeric coefficients are used.

*Specifying strict unit check*

- ▶ Highlight the **Strict Unit Check** field.
- ▶ Press the «Yes» or «No» soft key.
- ▶ Press «enter».

## 7.28 Locking or unlocking critical functions: «Supervisor»

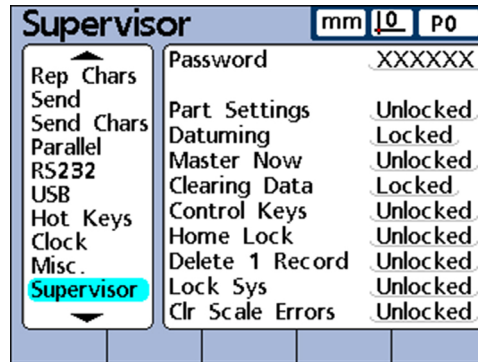
*Activation*

«Menu/Setup» soft keys, «Supervisor» setup screen

*Short description*

The «Supervisor» setup screen provides fields for locking or unlocking various "critical functions" of the unit.

A locked function (and all functions associated with it) will be unavailable for use unless the function is explicitly unlocked. For example, when the «Datuming» function is locked, datums cannot be set, preset or cleared by the user.



### Password

*Entering the supervisor password*

- ▶ Highlight the **Password** field.
- ▶ Use the numeric keypad to enter the supervisor password **070583**.
- ▶ Press «enter».

#### NOTICE

Incorrect measurement results!

Once the password is entered, settings and programs can be modified by the user. Unauthorized changes may lead to incorrect measurement results.

- ▶ Settings and programs must only be changed by qualified personnel. For more information see "Personnel qualification", page 10.



The confirmation of the supervisor password remains in effect until the unit is switched off.

When the unit is switched on again, the supervisor password will need to be re-entered on opening this setup screen.

The system password cannot be changed.

### Unlocking and locking critical functions

Once the supervisor password has been confirmed, the other fields in this setup screen can be highlighted for locking or unlocking.

## Software setup

Locking or unlocking critical functions: «Supervisor»

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- ▶ Highlight the field for the desired function.  
The individual fields and functions are listed in the following table.
- ▶ Press the «Unlocked» or «Locked» soft key.
- ▶ Confirm with «enter» or highlight the next field.
- ▶ Press «finish».

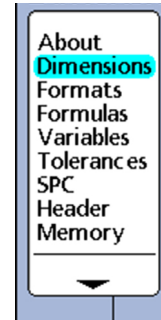
*Critical functions*

Field	Function
-------	----------

**Part Settings**

Lock/Unlock part settings for editing

Part settings are found in the area above the first horizontal dividing line on the left side of the setup screen:



Access to «About» for changing the displayed language is possible even if **Locked** is selected!



## Software setup

Locking or unlocking critical functions: «Supervisor»

Field	Function
<b>Datuming</b>	<p>Lock/Unlock the datum functions for editing</p> <p>The function specifies whether setting, presetting and clearing absolute and incremental datums is allowed.</p> <p>When the function is locked, the soft keys «D0/D1», «Zero...», «Preset» and «Clear» are unavailable in the <b>DRO</b> screen of the «Datum» function.</p>
<b>Master Now</b>	<p>Lock/Unlock access to the «Master» function, see "Establishing a measurement reference (calibrating)", page 232</p> <p>Additional soft keys</p> <ul style="list-style-type: none"><li>■ «Rd.Only»: Values entered with the «Master» function are displayed, but cannot be edited</li><li>■ «Pass.»: The supervisor password must be entered to execute the «Master» function</li><li>■ «no Clr»: Clearing the calibration data is not possible, see "Printing reports, transmitting results to a computer", page 244</li></ul>
<b>Clearing Data</b>	<p>Lock/Unlock the deletion of measurement data</p> <p>When this function is unlocked, the user can remove measurement data from the unit's database, see "Datum function", page 45.</p>
<b>Control Keys</b>	<p>Lock/Unlock the use of command keys</p> <p>In normal operation, the user conducts measurements using the command keys.</p> <p>However, when the unit is operated from a remote computer or PLC, it is often desirable to lock the command keys to eliminate the possibility that key operation by a user will interfere with remotely controlled measurements.</p>
<b>Home Lock</b>	<p>Lock/Unlock the «Menu» soft key (supervisor password)</p> <p>When <b>Locked</b> is selected, the «Menu» soft key (and consequently the «Datum», «Extra» and «Setup» soft keys) will only be available after entry and confirmation of the supervisor password.</p>
<b>Delete 1 Record</b>	<p>Lock/Unlock the deletion of individual records from the current view</p> <p>Single database records can normally be deleted from the current view by the user. When <b>Locked</b> is selected, the deletion of single records is not possible.</p>
<b>Lock Sys</b>	<p>Lock/Unlock global variables and system formulas for editing</p> <p>Selecting <b>Locked</b> prevents changes to global variables and system formulas that are used in formulas across a number of parts.</p>
<b>Clr Scale Errors</b>	<p>Lock/Unlock the deactivation of scale error messages</p> <p>Malfunctions in measuring devices may cause scale error messages that can be disabled by the user. Under some circumstances it can be undesirable to allow the user to disable these messages and continue operation.</p> <p>When <b>Locked</b> is selected, only users with a valid supervisor password are allowed to disable these error messages.</p>

# 8 Custom programming

## Personnel requirement



Custom programming of the unit is only to be performed by qualified personnel!

For more information see "Personnel qualification", page 10.

Formulas define dimensions that are displayed on the LCD screen. Formulas can be constructed to assign the value of a channel input to a dimension or to calculate a dimension from one or more channels using mathematical, logic or other functions.

This section describes how to create formulas for the unit. It starts with an introduction to the creation of formulas that use mathematical, logic and data evaluation functions for calculating dimensions. In addition, this section explains how to use advanced functions for controlling or automating measurements.

### 8.1 Introduction to formulas

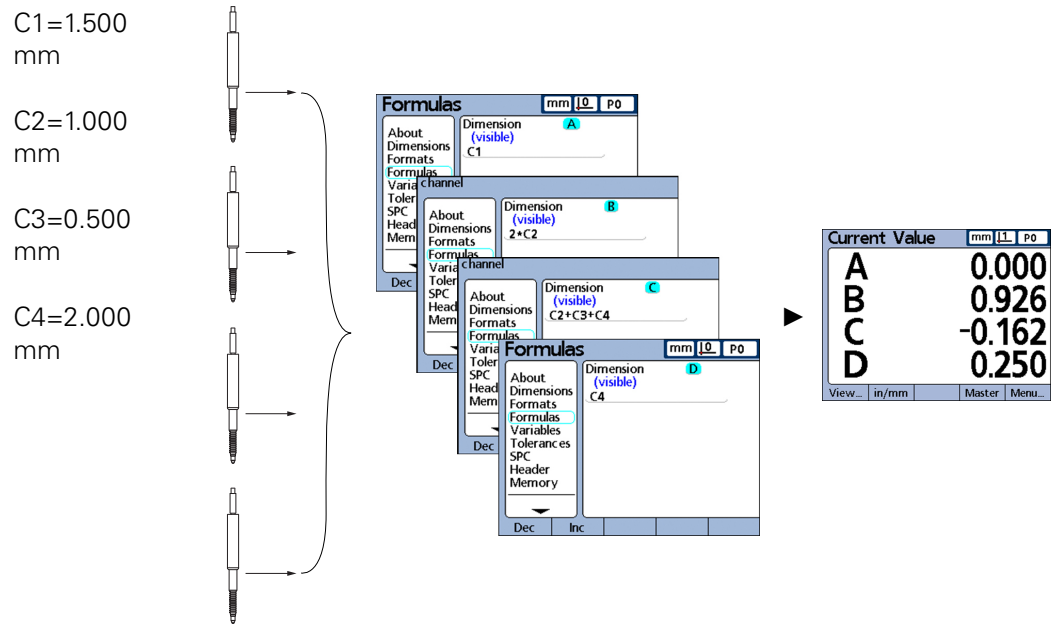
Formulas use channel inputs and formula functions to define visible dimensions, hidden dimensions and custom functions. Formulas contain a dimension label at the top of a formula page. The defining channel functions and constants as well as the mathematical, logic or control functions are arranged below the label.

In general, the formula syntax is typical of algebraic equations, and is similar to the syntax used to define cell values in spreadsheet applications.

The examples below show simple formulas that define the visible dimensions A, B, C and D by using the channel inputs C1, C2, C3 and C4:

Example	Description
$A = C1$	Dimension A is equal to the value of input channel 1
$B = 2 * C2$	Dimension B is equal to 2 times the value of input channel 2
$C = C2 + C3 + C4$	Dimension C is equal to the sum of the values of input channels 2, 3 and 4
$D = C4$	Dimension D is equal to the value of input channel 4

The following figure shows the channel inputs, the «Formulas» setup screens and the resulting display on the **DRO** screen for the examples given above:



Channel inputs are processed by formulas to display dimensions.

### 8.1.1 How do formulas relate inputs to dimensions?

Formulas can be constructed to assign channel input values to dimensions or to calculate dimensions from one or more channels using mathematical, logic or other functions.

Formulas can be constructed by the user to display:

- One dimension based on one measuring device  
A = C1
- One dimension based on multiple measuring devices  
A = C1+C2
- Multiple dimensions based on one measuring device  
A = C1  
B = 2\*pi\*C1
- Multiple dimensions based on multiple measuring devices  
A = C1  
B = C2  
C = C1\*C2

### Visible or hidden dimensions?

Dimensions can be visible to display values or hidden to perform operations.

*Visible dimensions*

Visible dimensions are used with basic and advanced functions to calculate, display and store values in the unit's database.

*Example*

$$A = 2 * \pi * \text{sqrt}(B)$$

This formula uses the visible dimension B in a formula with other functions to calculate and assign a value to the visible dimension A. This value is then stored in the database by pressing «enter» or executing a **trip** function.

*Hidden dimensions*

Hidden dimensions are used with basic and advanced functions to perform operations.

*Example*

$$H1 = \text{if}(\text{fail}(), \text{Relay}(1, 1), \text{Relay}(1, 0))$$

This formula uses the pass/fail state of all tolerance tests to control the state of output relay 1. Since values are not assigned to operations, no value will be stored in the database.

## When are dimensions stored in the unit's database?

*Visible dimensions* Visible dimension values are displayed on the screen and stored as records in the database when «enter» is pressed or when a **trip** function is executed.

*Hidden dimensions* Hidden dimensions are used to perform operations, make decisions or manipulate variables. They are not displayed on the screen or stored in the database.

### 8.1.2 What can formulas do?

Formulas can be constructed to produce a wide variety of results depending on channel input values, tolerance tests, I/O interface conditions, time, temperature and other test and environmental conditions.

Formulas can:

- Assign values to dimensions derived from channel inputs or other dimensions
- Perform operations such as closing a relay contact, sending data to the I/O interface, sending a message on the serial port or printing a report
- Perform conditional tests of measurement results, tolerance test results, I/O interface data or environmental conditions, and make decisions based on the results
- Control the sequence of steps in a measurement process
- Semi-automate a measurement process
- Display messages and prompts for keyboard input
- Define custom functions

### 8.1.3 When are formulas constructed or edited?

Formulas are constructed after the steps for commissioning the unit have been completed and before starting to conduct measurements.



Depending on the version (measuring device interfaces) of the unit, certain formulas may not be available or may be additionally available. The formulas concerned will be indicated in the formula description.

### 8.1.4 How can formulas be recorded for safekeeping?

Formulas and all other settings of the unit can be stored on a USB drive as an .xml file from the «Supervisor» setup screen. Settings can also be stored on a USB drive as a text file by pressing the «Send» key when any setup screen is displayed. For more information see "Locking or unlocking critical functions: Supervisor", page 139.

## 8.2 Constructing and editing formulas

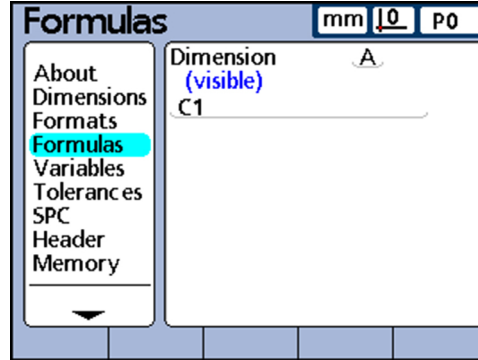
Formulas are constructed in the «Formulas» setup screen.

*Activation* «Menu/Setup» soft keys, «Formulas» setup screen

## 8.2.1 Constructing formulas

### Formulas setup screen

A default screen is shown prior to the construction of any formulas. Initially dimensions are visible, are labeled alphanumerically and are defined to display the unit's channels.



#### Disabling formulas temporarily

Normally, formulas are enabled and being evaluated by the system. However, formulas can be disabled temporarily for editing or troubleshooting.

- ▶ Press the «top dimension key» at the right of the startup screen when the unit is powered up.  
The message **Disable formulas until you've had a chance to modify them?** is displayed.
- ▶ Press the «Yes» soft key.

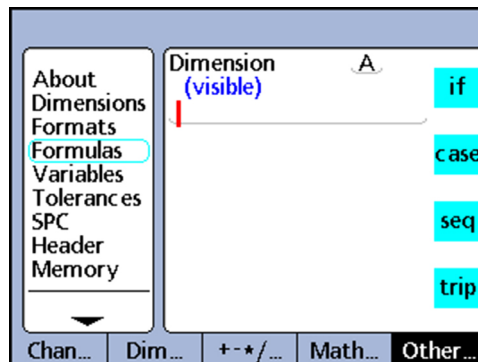
Formulas will be re-enabled upon exiting setup.

#### Selecting a dimension

- ▶ Navigate to the «Formulas» setup screen.
- ▶ Highlight the **Dimension** field.
- ▶ Press the «Dec» or «Inc» soft key to cycle through dimensions.

#### Entering dimension formula functions:

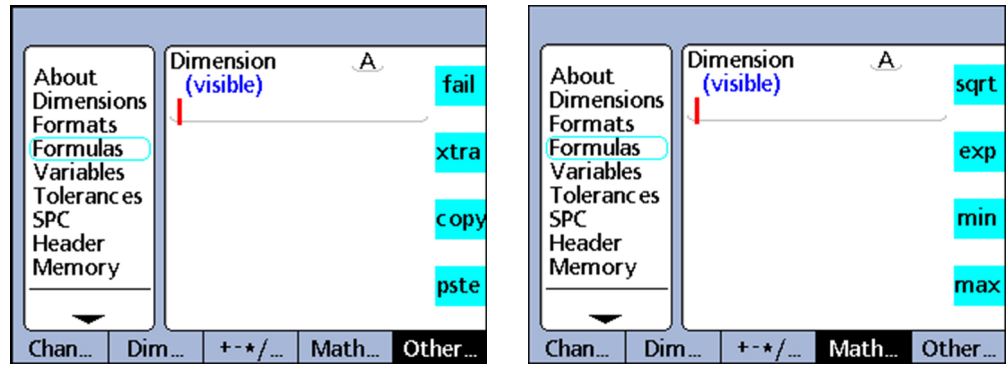
- ▶ Use the «down» arrow key to position the cursor in the formula line.  
A red cursor appears at the extreme left of the formula line. This cursor indicates the insertion point for any new formula function.
- ▶ Move the cursor to the desired insertion point by pressing the «left» or «right» arrow key:



- ▶ Repeatedly press a soft key, such as «Other...» or «Math...», to display the available options for that soft key.

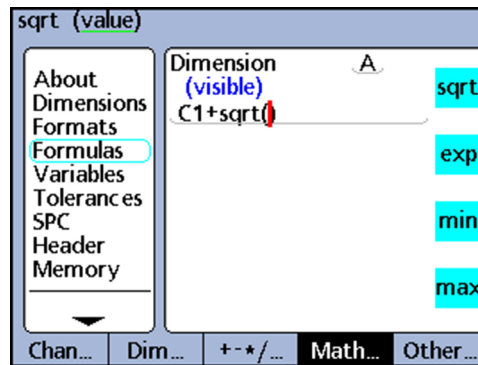
## Custom programming

### Constructing and editing formulas



- ▶ Press the dimension key next to the desired function.

The function is inserted into the formula line.



## 8.2.2 Editing formulas

### Copying and pasting formula functions

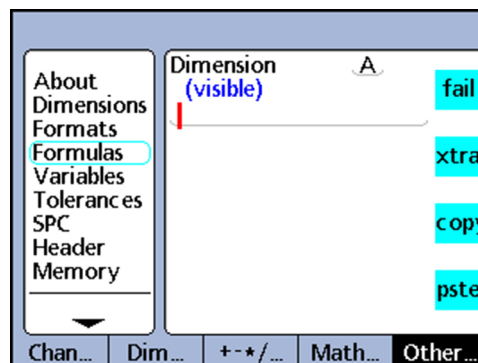
Formulas can be copied from one dimension and pasted into another.

#### Copying formulas

- ▶ Use the arrow keys to position the cursor in the formula line.
- ▶ Repeatedly press the «Other...» soft key until the **copy** function is displayed.
- ▶ Press the «copy» dimension key.

#### Pasting formulas

- ▶ Use the arrow keys to position the cursor in the formula line.
- ▶ Repeatedly press the «Other...» soft key until the **pste** dimension key is displayed.
- ▶ Press the «pste» dimension key.



### 8.2.3 Long formulas

Complex formulas can be entered that require more than a single formula line. When formulas exceed a single line, the formula is continued on subsequent lines. If a formula cannot be displayed on a single screen, the formula can be scrolled using the «up» or «down» arrow keys.

### 8.2.4 Deleting individual elements from a formula

Unwanted formula elements can be deleted from the formula line.

#### *Deleting formula elements*

- ▶ Use the arrow keys to place the cursor directly to the right of the formula element to be deleted in the formula line.
- ▶ Press «cancel».  
This deletes the function to the immediate left of the cursor.
- ▶ Repeat these steps for each formula element to be deleted.

### 8.2.5 Formula functions

This chapter describes the individual formula functions in detail. Each description is accompanied by at least one example of use in a typical formula. Study these examples prior to constructing your formulas.

In addition, ensure that the required setup steps have been completed. For more information on software setup as part of commissioning the unit see "Commissioning", page 51 and for a description of all setup parameters of the unit see "Software setup", page 60.

Initial setup of the unit must be completed prior to formula construction.

## Basic and advanced formula functions

Basic and advanced formula functions are displayed and selected in the «Formulas» setup screen by pressing the soft keys located below the screen in combination with the dimension keys at the right of the screen.

In the following table, the formula functions provided by the unit are listed in columns indicating the soft keys they are assigned to.

Basic functions are indicated in **bold type**.

Chan...	Dim...	+ - * /...	Math...	Other...
Parameters		Functions		
<b>C1</b>	<b>A</b>	<b>+</b>	<b>sqrt</b>	<b>if</b>
<b>C2</b>	<b>B</b>	<b>-</b>	<b>exp</b>	<b>case</b>
<b>C3</b>	<b>C</b>	<b>*</b>	<b>min</b>	<b>seq</b>
<b>C4</b>	<b>D</b>	<b>/</b>	<b>max</b>	<b>trip</b>
The unit is available with 1, 4, 8, or 16 inputs	The number of dimensions is specified for each part in the «Dimensions» setup screen.	<b>(</b>	<b>sin</b>	<b>dmn</b>
		<b>)</b>	<b>asin</b>	<b>dmx</b>
		<b>,</b>	<b>cos</b>	<b>davg</b>
		<b>;</b>	<b>acos</b>	<b>dmd</b>
		<b>&gt;</b>	<b>tan</b>	<b>fail</b>
		<b>&gt;= (≥)</b>	<b>atan</b>	<b>xtra</b>
		<b>&lt;</b>	<b>avg</b>	<b>copy</b>
		<b>&lt;= (≤)</b>	<b>md</b>	<b>pste</b>
		<b>== (=)</b>	<b>abs</b>	
		<b>!= (≠)</b>	<b>mod</b>	
		<b>and (&amp;&amp;)</b>	<b>int</b>	
		<b>or (  )</b>	<b>pi</b>	
			<b>-- (range)</b>	

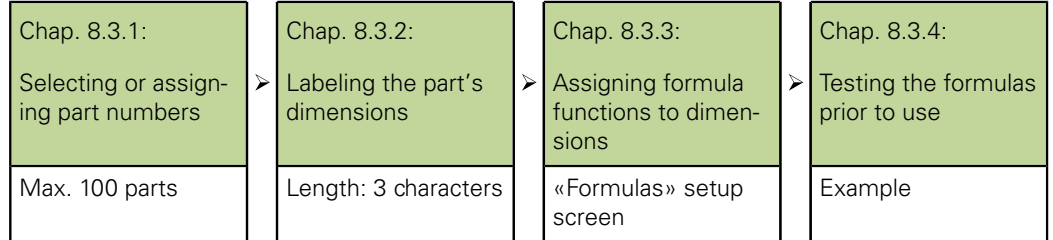


### 8.3 Formula construction example

The exact steps needed to construct or edit formulas are unique to each formula or measurement required for each part. It would be very difficult to present a single set of instructions that adequately cover the topic.

Therefore, this chapter provides a guide to formula editing and construction in the form of an example. More specific instructions and examples regarding the use of constants, channels, dimensions and other functions in formulas are provided later in this chapter.

The four steps required to construct a formula are:



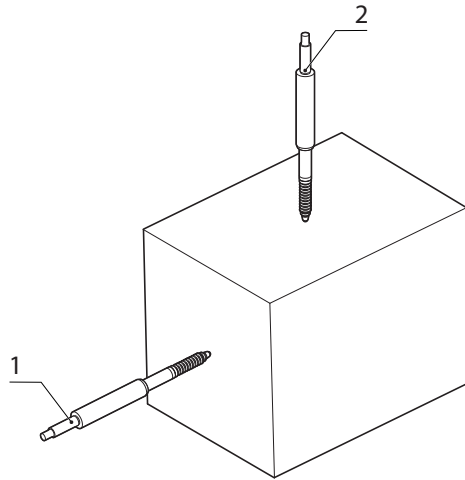
The following example will use the default «Formulas» setup screen to construct a formula that calculates the perimeter of a rectangular block from the measurement of two sides.

The general form of the formula necessary to calculate the perimeter of a rectangular block is:

- $Perimeter = 2 \times (side\ height + base\ length)$

The specific formula that will be constructed in the «Formulas» setup screen is:

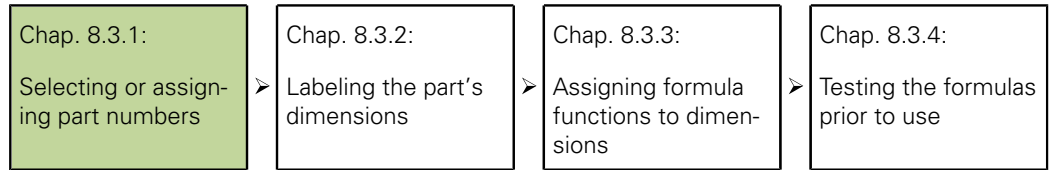
- $P = 2 * (C1 + C2)$



- 1** C1, side channel 1
- 2** C2, end channel 2

### 8.3.1 Selecting or assigning part numbers

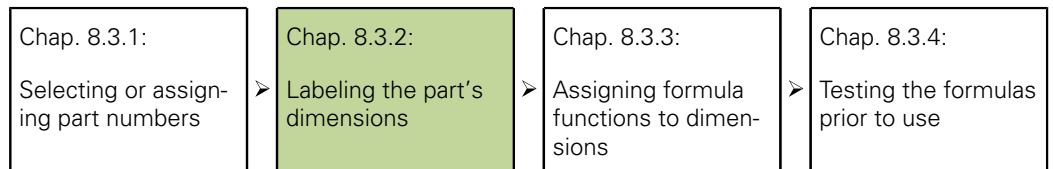
Since separate dimension formulas can be created for each of up to 100 parts, begin by selecting the desired part.



- ▶ Press the «Menu/Setup/Dimensions» soft keys from the home screen.
- ▶ Press the «right» arrow key to highlight the **Part** field.
- ▶ Press the «Dec» or «Inc» soft key to display the desired part number in the **Part** field or
- ▶ Press the «New» soft key to create a new part.

### 8.3.2 Labeling the part's dimensions

Each dimension label should reflect the purpose of the formula.



Each dimension needs to be relabeled first. Dimension labels can include up to 3 characters.

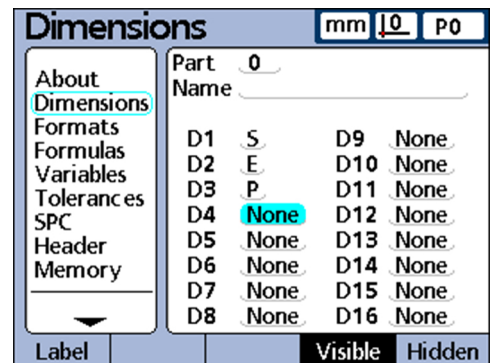
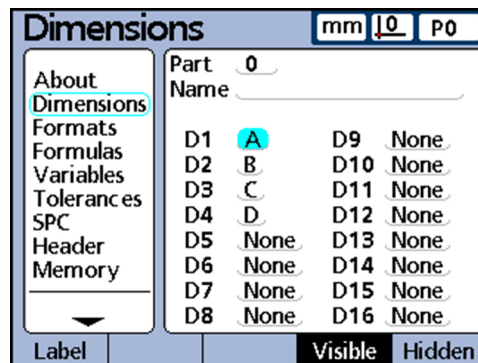
A name can also be assigned to the part, if desired. Part names can contain up to 8 alphanumeric characters.

In this example, dimensions are labeled as follows:

- S = side height, E = base length and P = perimeter

#### Labeling dimensions

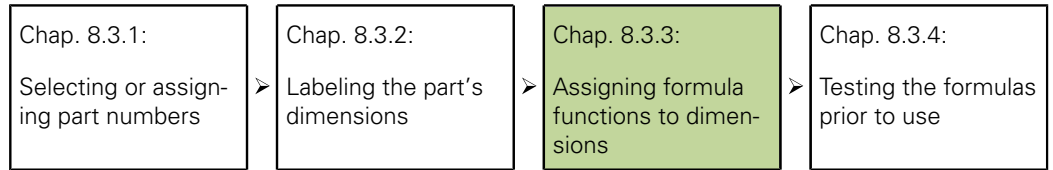
- ▶ While in the «Dimensions» setup screen, press the «down» arrow key to highlight the first dimension field.
- ▶ Press the «Label» soft key to display the Alpha Entry screen.
- ▶ Replace each default dimension label by pressing «cancel» to erase the label and entering the desired alphabetic characters for the dimension's new label.
- ▶ Press «finish» to return to the «Dimensions» setup screen.



**i** Since only three dimensions are used in this example, the fourth dimension is deleted. For more information on deleting dimensions, see "Deleting individual elements from a formula", page 147.

### 8.3.3 Assigning formula functions to dimensions

Now that the correct part is selected, and the dimensions are labeled to reflect the measurement application, the dimension formulas must be constructed.



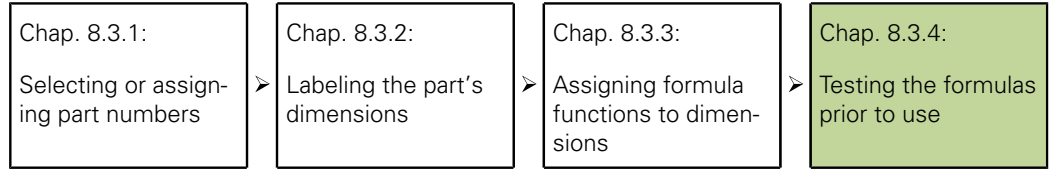
*Assigning formula functions*

- ▶ Navigate to the «Formulas» setup screen.
- ▶ Press the «right» arrow key to highlight the **Dimension** field.  
The default formula for dimension **S (C1)** is displayed. This formula already meets the requirement of the measurement application by displaying the side measurement as dimension **S**. It will thus remain unchanged.
- ▶ Press the «Inc» soft key to display the formula for dimension **E**.  
This formula also meets the application requirement by defining dimension **E** as the value of channel 2 (**C2**), so it will also remain unchanged.
- ▶ Press the «Inc» soft key to display the formula for dimension **P**.  
This formula will be changed to calculate the perimeter measurement.
- ▶ Use the «down» arrow key to position the cursor in the formula line.
- ▶ Press the «right» arrow key to position the cursor on the right side of the **C3** channel function.
- ▶ Press «cancel» to delete the **C3** channel function.  
Now that the formula line for **P** is empty, the following new formula can be entered:
  - $2*(C1+C2)$
- ▶ Press «2» on the numeric keypad.
- ▶ Press the «None» soft key to define **2** as a unitless constant.
- ▶ Press the «+\*/» soft key.
- ▶ Press the «\*» dimension key to insert the multiplication symbol into the formula.
- ▶ Press the «+\*/» soft key to display parentheses.
- ▶ Press the «(» dimension key to insert the open parenthesis into the formula.
- ▶ Press the «Chan...» soft key to display the channel functions.
- ▶ Press the «C1» dimension key to insert the «Channel 1» function.
- ▶ Press the «+\*/» soft key repeatedly until the «+» arithmetic function is displayed.
- ▶ Press the «+» dimension key to insert the plus sign.
- ▶ Press the «Chan...» soft key to display the channel functions.
- ▶ Press the «C2» dimension key to insert the «Channel 2» function.
- ▶ Press the «+\*/» soft key repeatedly until parentheses are displayed.
- ▶ Press the «)» dimension key to insert the closed parenthesis.
- ▶ Press «finish» twice to display the home screen.

The formulas are now ready to test.

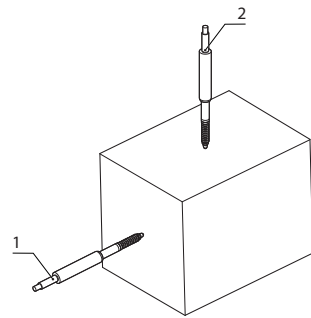
### 8.3.4 Testing the formulas prior to use

Always test formulas thoroughly to confirm their correct operation before using them for inspection.



In this example, the touch probes of the unit are positioned against the side and end of a rectangular block.

The **DRO** screen displays the value 1.759 mm for dimension **S** (side) and the value 1.255 mm for dimension **E** (end). The resulting perimeter **P** is calculated to be 6.028 mm, which is correct and confirms that the formula is ready to use.



- 1 S, channel 1
- 2 E, channel 2

$$P=2*(C1+C2)$$

$$6.028=2*(1.759+1.255)$$

Formulas are correct

Current Value		mm	in	PO
S	1.759			
E	1.255			
P	6.028			
View...		in/mm	Master	Menu...

## 8.4 Basic formula functions

Basic formula functions calculate and display dimensions based on channel inputs, other dimensions, arithmetic operators, mathematical functions and constants. Visible dimensions are typically used with basic functions to display values. Hidden dimensions are used with a combination of basic and advanced functions to perform operations.

*Example*

$$A = 2*pi*sqrt(B)$$

This formula uses basic functions to assign a numeric value to visible dimension **A**. This value is stored in the database when «enter» is pressed or when a **trip** function is executed.

*Basic functions*

Basic functions include:

- Channel functions (**C1...**) include channel inputs in formulas. For more information see "Channel functions", page 153
- Dimension functions (**D1,D2...H1,H2...S1,S2...**) include other dimensions in formulas. For more information see "Dimension functions", page 154
- Arithmetic operators ( **+ - \* /** ) add, subtract, multiply or divide. For more information see "Arithmetic operators", page 155
- Parentheses ( **)** group terms within a formula
- Square roots (**sqrt**) find the square roots
- Exponents (**exp**) raise to a power
- Trig functions (**sin, cos, tan**) find trigonometric values
- Inverse trig functions (**asin, acos, atan**) find inverse trigonometric values

- Absolute value (**abs**) removes the algebraic sign (polarity)
- Integer (**int**) converts real numbers to whole numbers
- Constants (numbers and **Pi**) include values that do not change in formulas

Basic mathematical functions

Basic mathematical functions include:

Function	Description
sqrt	Square root
exp	Exponentiation
Trig functions	sin, cos, tan, asin, acos, atan
abs	Absolute value
int	Integer
pi	Circle constant pi

### 8.4.1 Channel functions

Channel function values are determined by the outputs of measuring devices attached to channel input connectors on the rear panel of the unit. These values can be offset, scaled or calibrated using the «Master» menu or the «SLEC/LEC» setup screen.

The «Master» menu can be accessed by pressing the «Master» soft key on the front panel. It can be used in formulas and to offset or calibrate channel inputs. Error correction functions can only be accessed after entering the supervisor password in the «SLEC» setup screen. These functions are used to compensate for transducer or encoder nonlinearities.



For more information see "Setting a conditional calibration for input channel groups: Master", page 213 as well as "Master function", page 44.

For more information on error correction see "Compensating measurement errors: SLEC", page 103.

Channel functions can be assigned units of measure for linear, angular or temperature values, or can be without a unit of measure. Units of measure can be assigned using the «Channels» setup screen after the supervisor password has been entered.

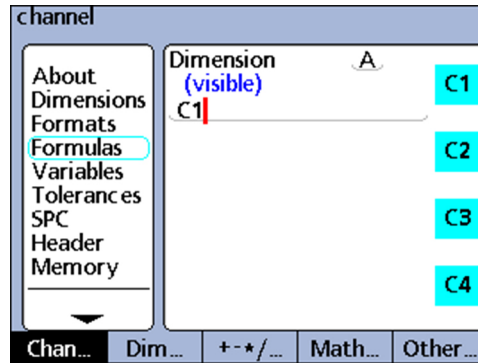
Channel functions used as variables in formulas can be:

- Directly from the channel inputs
- Level adjusted and calibrated by the «Master» function or error correction
- Given linear, angular or temperature units of measure

Channel functions can be inserted into formulas to include channel input values in dimensions.

*Inserting channel functions into a formula*

- ▶ Press the «Chan...» soft key.
- ▶ Press the dimension key for the channel you would like to insert.



The following two examples illustrate how to assign channel input values directly by making a dimension equal to a channel parameter and how to use these values in calculations:

*Example 1*

Assigning a value directly:  $A = C1$

*Example 2*

Using a value in calculations:  $A = (\text{Pi} * (C1 \text{exp} 2)) / 4$ , where

A = Area

C1 = Diameter of a circle

## 8.4.2 Dimension functions

Dimension functions are determined by formulas applied to channel functions, constants or other dimension functions.

Dimensions can be visible in the views and stored in the database, or can be hidden and used to perform actions or define custom functions.

Dimension values can be offset using the «Preset» function. The «Preset» function is available to operators using the front panel «Preset» soft key, and can also be used in formulas.

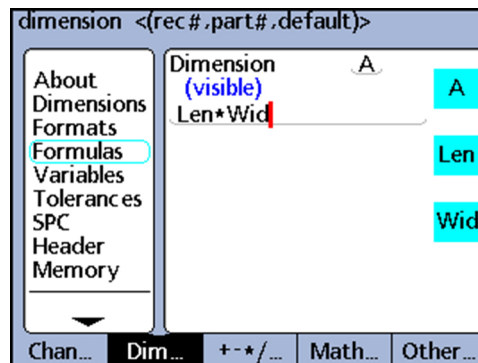


For more information see "Presetting dimension values: Preset", page 216 and "Configuring measuring devices: Channels", page 89.

Dimension functions are inserted into formulas to include values of existing dimensions in new dimensions.

*Inserting a dimension into a formula*

- ▶ Press the «Dim...» soft key.
- ▶ Press the dimension key for the dimension you would like to insert.



The following two examples illustrate how dimension values can be assigned to other dimensions or used in calculations.

## Custom programming

### Basic formula functions

*Example 1* Assigning a value to other dimensions:  
 $A = B$

*Example 2* Using a value in calculations:  
 $A = \text{Len} * \text{Wid}$ , where  
 $A$  = Area of a rectangle  
 $\text{Len}$  = Length of a rectangle  
 $\text{Wid}$  = Width of a rectangle



Channel functions, dimensions and constants are processed before becoming new dimension values that are used in formulas.

### 8.4.3 Arithmetic operators

Arithmetic operators are used to add, subtract, multiply and divide. The use of arithmetic operators in the unit's formulas is consistent with the use of arithmetic operators in general.

*Order of arithmetic evaluation*

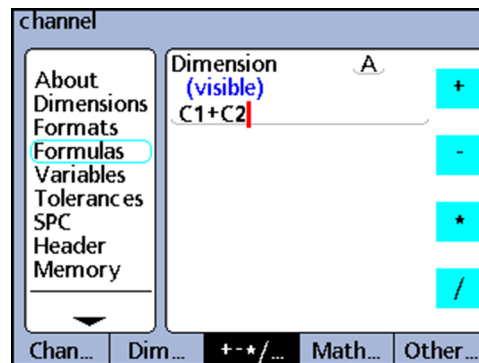
The order of evaluation of a collection of terms follows generally accepted practice.

Priority of evaluation	Arithmetic operator
First	Terms in parentheses, innermost first
Second	Exponentiation
Third	Multiplication and division
Fourth	Addition and subtraction

Arithmetic operators can be inserted into formulas as required by the application.

*Inserting arithmetic operators*

- ▶ Press the «+\*/... » soft key.
- ▶ Press the dimension key for the arithmetic operator you would like to insert.



Arithmetic operators are combined with constants and variables to define dimensions.

Operator	Example
Addition	$A = C1 + C2$
Subtraction	$B = 10 - C1$
Division	$C = C1 / 1.5$
Multiplication	$D = 2 * Pi * C1$

### 8.4.4 Parentheses

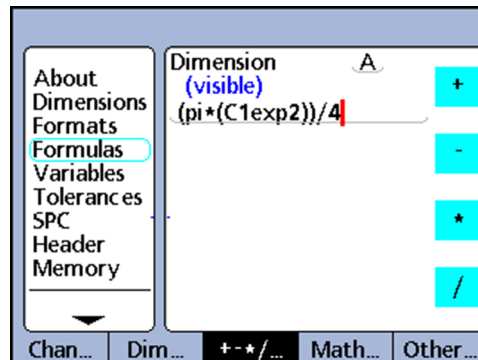
Parentheses are used to group terms within a formula for convenience and to improve readability. Grouped terms enclosed by parentheses are evaluated first and treated as a single term by the formula. Parentheses control the order of evaluation and make complex formulas easier to construct and read.

**i** Parentheses must be used in opposing pairs. Unmatched parentheses will generate an error message.

Parentheses can be inserted into formulas as required by the application.

*Inserting the function*

- ▶ Press the «+\*/... » soft key repeatedly until parenthesis ( ) are shown on the right of the screen.
- ▶ Press the dimension key for the open (or closed) parenthesis.



Parentheses are combined with arithmetic operators, mathematical functions, constants and variables to define dimensions.

*Example*

$A = (Pi * (C1exp2)) / 4$ , where  
 $(C1exp2)$  = value of C1 raised to the second power  
 $(Pi * (C1exp2))$  = entire numerator, combined into a single variable for division

### 8.4.5 Units of measure

Dimensions acquire units of measure from channel functions, dimension functions and constants used in the formulas for dimension definition. For example, formulas containing numeric channel functions and numeric constants will produce numeric dimensions without units of measure.

**i** If combining and mixing units of measure in formulas violates standard math or physics conventions, type or mismatch errors will be generated.



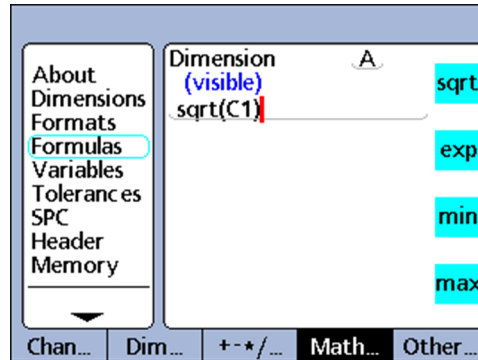
## 8.4.6 Square root function (sqrt)

*Application*

The square root function **sqrt** is used to calculate the square root of a term. Square roots can be calculated for terms with or without units of measure or for terms that have square units of measure such as square inches.

*Inserting the function*

- ▶ Press the «Math...» soft key.
- ▶ Press the «sqrt» dimension key.



### Syntax

A = **sqrt**(term)

*Example*

A = **sqrt**(B)

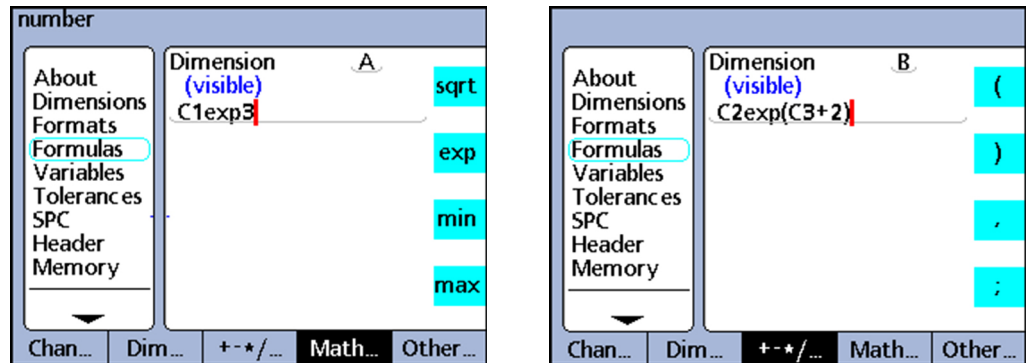
A = 4 mm when B = 16 mm<sup>2</sup>

## 8.4.7 Exponent function (exp)

*Application* The **exp** function is used to raise a term or collection of terms to a power. An exponent can be a value or collection of values with or without units of measure.

- Inserting the function*
- ▶ Press the «Math...» soft key.
  - ▶ Press the «exp» dimension key.

Parentheses must be applied where a collection of terms or values is used in an exponent function.



### Syntax

A = TermexpValue  
 B = Termexp(Collection of values)

*Example 1* A = C1exp3  
 A = 8 mm<sup>3</sup> when C1 = 2 mm

*Example 2* B = C2exp(C3+2)  
 B = 81 mm<sup>4</sup>  
 when C3 = 2 and C2 = 3 mm

## 8.4.8 Trigonometric and inverse trigonometric functions (sin to atan)

*Application*

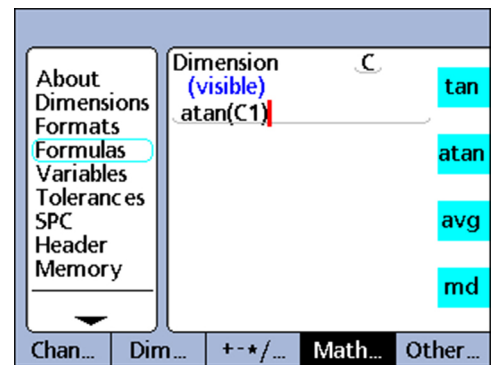
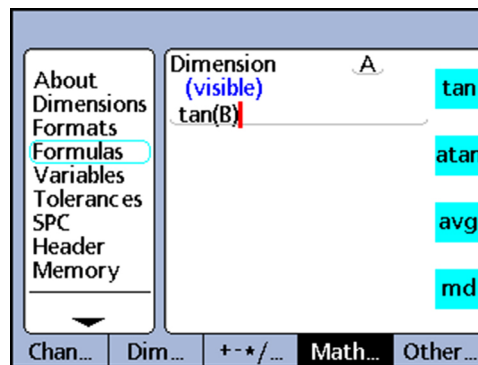
Trigonometric functions are used to calculate the sine, cosine or tangent of a term. Trigonometric functions can be applied to an angular or numeric term or collection of terms, and will return values without units of measure.

Inverse trigonometric functions are used to calculate the arcsine, arccosine, or arctangent of a term. Inverse trigonometric functions can be applied to a term or collection of terms, and will return angular values.

*Inserting the function*

- ▶ Press the «Math...» soft key.
- ▶ Press the dimension key for the trig or inverse trig function you would like to insert.

Parentheses for the term are provided. Terms can include channel inputs, dimensions and constants.



**tan function syntax**

$$A = \tan(\text{term})$$

*Example*

A = tan(B)  
 A = 1 when B = 45 degrees

**atan function syntax**

$$A = \text{atan}(\text{term})$$

*Example*

C = atan(C1)  
 C = 45 degrees when C1 = 1

### 8.4.9 Absolute value function (abs)

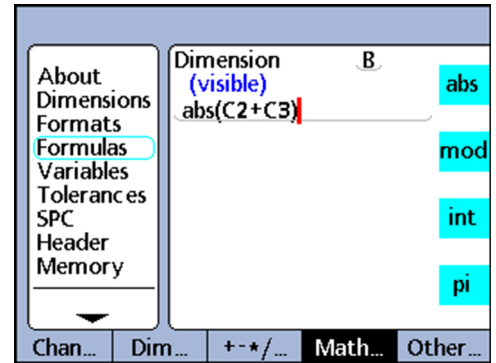
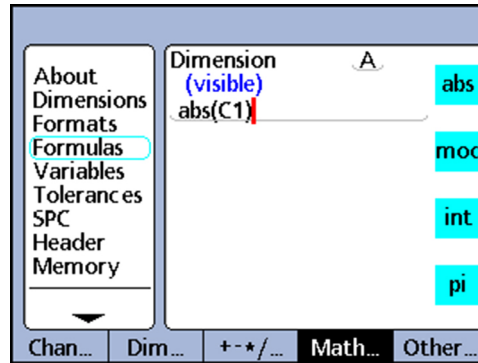
*Application*

The absolute value function **abs** removes the algebraic sign from a negative term. The absolute value function is inserted into formulas to include the absolute value of a channel input, dimension or collection of terms.

*Inserting the function*

- ▶ Press the «Math...» soft key.
- ▶ Press the «abs» dimension key.

Parentheses for the term are provided.



#### Syntax

$$A = \text{abs}(\text{term})$$

*Example 1*

$$A = \text{abs}(C1)$$

A = 3 when C1 = -3 or +3

*Example 2*

$$B = \text{abs}(C2+C3)$$

B = 17 when C2 = -19 and C3 = +2

## 8.4.10 Integer function (int)

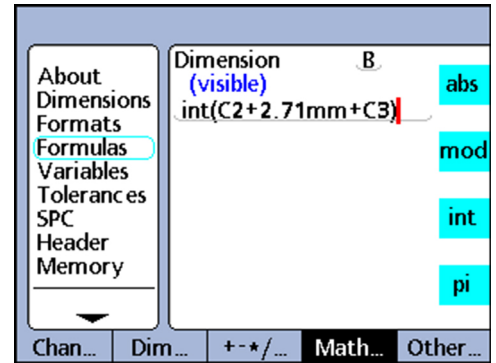
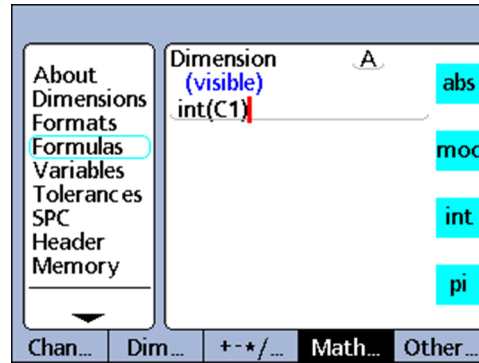
*Application*

The integer function **int** is used to remove the fractional portion from a term, leaving only the integer portion. The integer function does not round mixed numbers, but removes the fractional portion. The integer function includes the integer value of a channel input, dimension or collection of terms in a formula.

*Inserting the function*

- ▶ Press the «Math...» soft key.
- ▶ Press the «int» dimension key.

Parentheses for the term are provided.



### Syntax

$$A = \text{int}(\text{term})$$

*Example 1*

A = **int**(C1)  
 A = 2.000 mm when C1 = 2.9732 mm

*Example 2*

B = **int**(C2+2.71mm+C3)  
 B = 6.0000 mm when C2 = 2.21 mm and C3 = 1.789 mm

### 8.4.11 Pi and other constants

Constants are numeric values that do not change. The constant **Pi** or numbers entered from the numeric keypad are examples.

*Application*

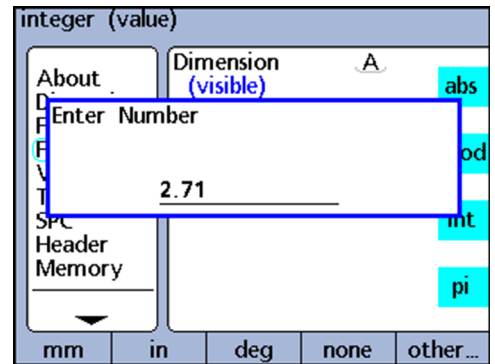
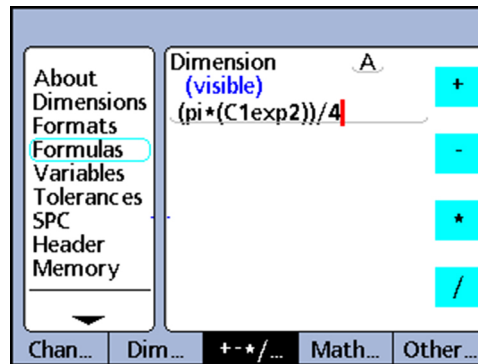
Constants are inserted into formulas to add, subtract, multiply, divide or raise a value to a power. Numeric constants are also used as arguments in logical, data evaluation and measurement control functions. For more information see "Advanced formula functions", page 163.

*Inserting the Pi constant*

- ▶ Press the «Math...» soft key.
- ▶ Press the «pi» dimension key.

*Inserting any constant*

- ▶ Use the numeric keypad to enter the desired number.  
The number is displayed in the «Enter Number» pop-up window.
- ▶ Press the soft key for the desired unit of measure or the «None» soft key if no unit of measure is required.



**Pi function syntax**

A = (Pi)\*(C1exp2)/4,  
 where  
 A = Area in units<sup>2</sup>  
 pi = Circle constant 3.14...  
 2 = unitless constant used as a power of C1  
 4 = unitless constant used for division

**Constant function syntax**

A = 2.71

## 8.5 Advanced formula functions

Advanced functions are used in visible and hidden dimension formulas to assign values, perform conditional tests and perform actions.

*Example 1*

A = if(C1>1.5mm,dmn(C2),dmn(C3))

The formula assigns a value to visible dimension A that depends on the input value of C1. If C1 is greater than 1.5 mm, the dynamic minimum value of C2 is assigned to A; otherwise, the dynamic minimum value of C3 is assigned.

*Example 2*

H1 = if(fail(),Relay(1,1),Relay(1,0))

A hidden dimension is used. Output relay 1 is set to its energized state (closed) if any tolerance test fails; otherwise, the relay is set to its de-energized state (open). Since a hidden dimension is used, no data is recorded in the database.

*Using soft keys and dimension keys to call advanced functions*

Advanced functions include the following operators, formulas and functions, which are accessed by pressing the «+/\*», «Math ...» or «Other ...» soft key for the respective group and then pressing the dimension key for the desired function:

- , (comma): Separates arguments within a formula
- ; (semicolon): Separates formulas within a dimension
- > (greater than): Logical test criterion
- >= (greater than or equal to): Logical test criterion
- < (less than): Logical test criterion
- <= (less than or equal to): Logical test criterion
- == (equal to): Logical test criterion
- != (not equal to): Logical test criterion
- **and** (&&): Logical test condition
- **or** (||): Logical test condition
- -- (range): Inclusive range of values between two specified points
- **min** (minimum value): Returns the minimum value from a list
- **max** (maximum value): Returns the maximum value from a list
- **mod** (modulo): Returns the remainder value from a division operation
- **if**: Logical true/false test that controls decisions and process flow
- **case**: Logical range test that controls decisions and process flow
- **seq** (sequence): Controls the process to follow a predetermined sequence of steps
- **trip**: Automates the entry of process or SPC data based on channel input or dimension values
- **dmn** (dynamic minimum): Returns the minimum sampled input value
- **dmx** (dynamic maximum): Returns the maximum sampled input value
- **davg** (dynamic average): Returns the average sampled input value
- **dmd** (dynamic median): Returns the median sampled input value
- **fail**: Returns logic levels for dimension tolerance pass/fail

### 8.5.1 Listing arguments: Comma (,)

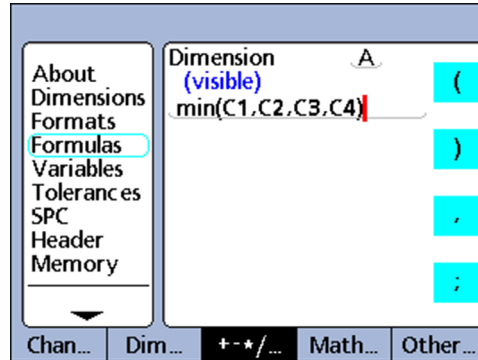
*Application*

Most advanced functions require or permit the use of multiple arguments to support function calculations. When multiple arguments are used in a function, the comma is used to separate the arguments.

Many advanced functions provide parentheses that include commas. In other cases, parentheses and commas must be added by the user. Commas can be inserted into formulas as required by the function.

*Inserting the function*

- ▶ Press the «+\*/» soft key.
- ▶ Press the «,» dimension key.



#### Syntax

A = Function (arg1, arg2, ... argn)

*Example*

A = min(C1,C2,C3,C4)

A = the minimum of channel inputs C1, C2, C3 and C4



## 8.5.2 Separating formulas: Semicolon (;)

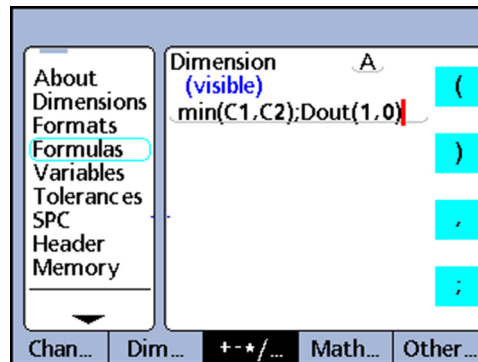
*Application*

Multiple formulas for a dimension can be used on a single formula screen. In this case, the semicolon is used to separate the formulas. When multiple formulas are included on one formula screen, the leading formula defines the value of a dimension, while subsequent formulas perform the required operations. The dimension value is stored in the database.

The actions performed by subsequent formulas can change relay states and set output data or variables. Semicolons are inserted between formulas on the formula screen for a dimension.

*Inserting the function*

- ▶ Press the «+\*/» soft key.
- ▶ Press the «;» dimension key.



### Syntax

A = Function 1(arg1, arg2, ... argn); Function 2(arg1, arg2, ... argn)

*Example*

A = min(C1,C2);Dout(1,0)

A = the minimum of channel inputs C1 and C2

and output pin 1 of the I/O interface is set to a logic 0

### 8.5.3 Logical and control functions

Logical functions assign values to dimensions or perform operations based on true/false and sorting tests of specified terms.

Each test type uses the same set of test criteria and conditions.

*Sorting tests*

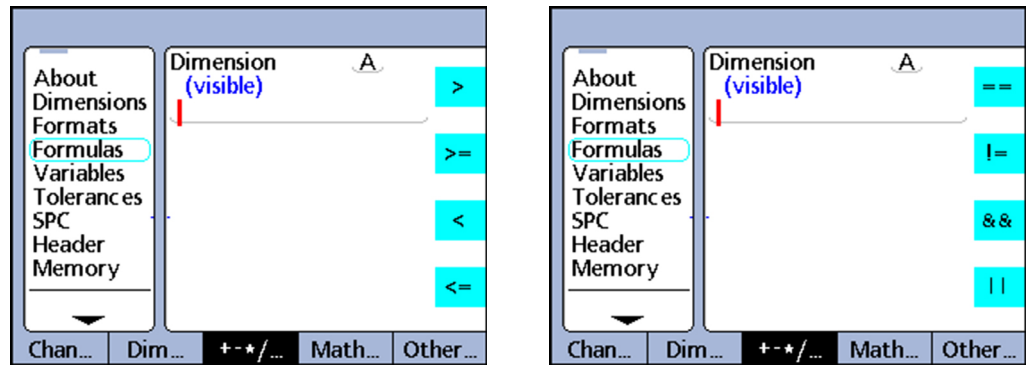
Sorting tests are performed by the **case** function.

*True/false tests*

True/false tests are performed by the **if** function.

#### Test criteria

Test criteria include:



#### Greater than (>)

5 > 3 is true                      5 > 5 is false                      5 > 6 is also false

#### Less than (<)

3 < 5 is true                      3 < 3 is false                      3 < 2 is also false

#### Greater than or equal to (>=)

5 >= 3 is true                      3 >= 3 is also true                      3 >= 4 is false

#### Less than or equal to (<=)

3 <= 5 is true                      3 <= 3 is also true                      3 <= 2 is false

#### Equal to (==)

5 == 5 is true                      5 == 4 is false

#### Not equal to (!=)

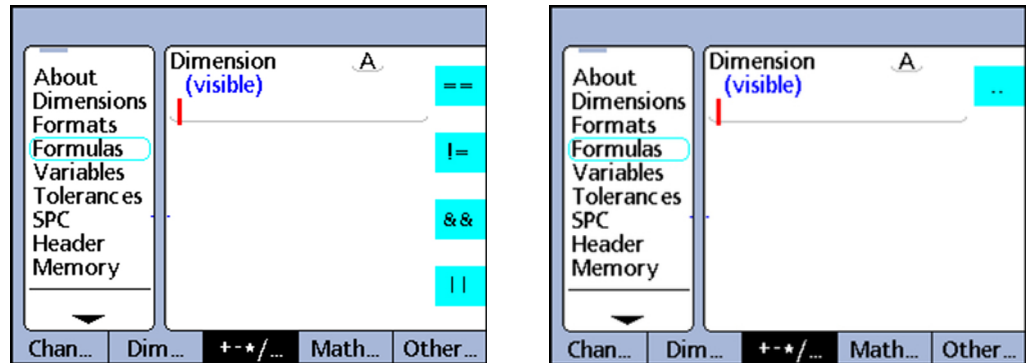
5 != 4 is true                      5 != 5 is false

*Inserting a test criterion function*

- ▶ Press the «+\*/» soft key.
- ▶ Press the dimension key for the test criterion you would like to insert.

## Test conditions

Test conditions include:



### Logical AND (and)

True only when all values tested fit the criterion

Example of logical AND

Condition  $(C1==2)\text{and}(C2>1)$

- $(C1==2)\text{and}(C2>1)$  is false when  $C1 = 1.9$  and  $C2 = 2.0$
- $(C1==2)\text{and}(C2>1)$  is false when  $C1 = 1.9$  and  $C2 = 2.5$
- $(C1==2)\text{and}(C2>1)$  is true when  $C1 = 2.0$  and  $C2 = 2.0$
- $(C1==2)\text{and}(C2>1)$  is true when  $C1 = 2.0$  and  $C2 = 2.1$

### Logical OR (or)

True when any value tested fits the criterion

Example of logical OR

Condition  $(C1==2)\text{or}(C2>1)$

- $(C1==2)\text{or}(C2>1)$  is false when  $C1 = 1.9$  and  $C2 = 1.0$
- $(C1==2)\text{or}(C2>1)$  is true when  $C1 = 1.9$  and  $C2 = 2.5$
- $(C1==2)\text{or}(C2>1)$  is true when  $C1 = 2.0$  and  $C2 = 1.9$
- $(C1==2)\text{or}(C2>1)$  is true when  $C1 = 2.0$  and  $C2 = 2.1$

### Range (--)

The evaluation of the range depends on the formula that includes it.

Ranges can be included in the following formula functions:

- **Din** (for more information see "Assigning / reading the logic levels of input pins: Din / DinBin", page 194)
- **Dout** (for more information see "Assigning / reading the logic levels of output pins: Dout / DoutBin", page 196)
- **MinIndex** (for more information see "Reading the positions of minimum and maximum values: MinIndex and MaxIndex", page 214)
- **MaxIndex** (for more information see "Reading the positions of minimum and maximum values: MinIndex and MaxIndex", page 214)
- **RsetDyn** (for more information see "Clearing minimum and maximum values: RsetDyn", page 208)

*Inserting a test condition function*

- ▶ Press the «+\*/» soft key.
- ▶ Press the dimension key for the test condition you would like to insert.

## 8.5.4 Specifying data input and data output pins: Din and Dout

### Din

*Application*

**Din** ranges can only be specified for the data input pins of the I/O connector.

#### Syntax

##### Din (1--n)

**Din** specifies the range Din (1) through Din (n).

---

*Example*

If(**Din**(1–4)>0,SendRec,0)

If any Din in the range Din (1) through Din (4) is greater than 0, send the record, otherwise do nothing.

### Dout

*Application*

**Dout** ranges can only be specified for the data output pins of the I/O connector.

#### Syntax

##### Dout (1--n)

**Dout** specifies the range Dout (1) through Dout (n).

---

*Example*

**Dout**(1–4,1)

Sets all data output pins in the range Dout(1) through Dout(4) to a logic 1.



For more information on **Din** and **Dout** ranges, see "Assigning / reading the logic levels of input pins: Din / DinBin", page 194 and "Assigning / reading the logic levels of output pins: Dout / DoutBin", page 196.

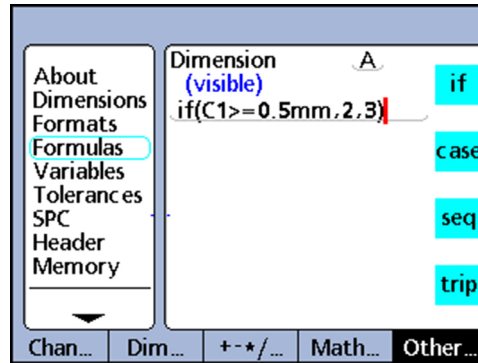
## 8.5.5 Performing true/false tests: if

*Application*

The **if** function evaluates a Boolean expression and assigns a value to a dimension or performs an operation based on the evaluation result. The logical true/false test uses the test criteria and conditions described earlier. Tests can be performed on channels, dimensions, system dimensions, custom functions, input pins of the I/O interface, database contents, time, output relay states, and variables.

*Inserting the function*

- ▶ Press the «Other ...» soft key.
- ▶ Press the «if» dimension key.



### Syntax

A = «if» (logical test condition, result when true, result when false)

*Example 1*

A value is assigned to a visible dimension

A = **if**(C1>=0.5mm,2.0,3.0)

A = 2.0 when C1 is greater than or equal to 0.5 mm

A = 3.0 when C1 is less than 0.5 mm

*Example 2*

This **if** function is appended to a dimension formula by using the **semicolon** function. The **if** function performs an operation; it activates relay contact 1 depending on the value of C4.

A = C4;**if**(C4>5mm,Relay(1,1),Relay(1,0))

A = C4 and relay contact 1 is activated when C4 is greater than 5 mm

A = C4 and relay contact 1 is not activated when C4 is less than or equal to 5 mm

The **if** function could also be assigned to a hidden dimension:

H1 = **if**(C4>=5mm,Relay(1,1),Relay(1,0))

*Suppressing the result*

When the **if** function is used to perform operations, the "true" or "false" result can be suppressed by inserting a numeric zero constant in either the "true" or "false" result position.

*Example*

In this example, no operation is performed when the logical test result is false.

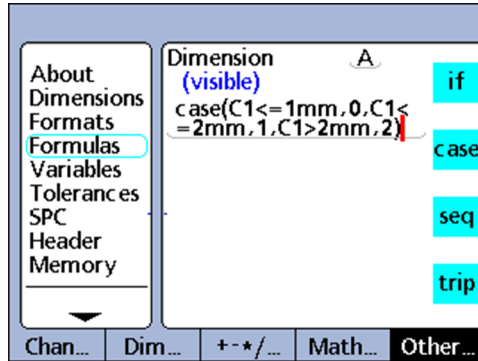
H1 = **if**(Fail(),Beep,0)

## 8.5.6 Performing logical sorting tests: case

*Application*

The **case** function performs logical sorting tests to assign values to dimensions or perform operations based on the test result case or classification. The logical tests use test criteria and test conditions. They can be performed on channels, dimensions, system dimensions, custom functions, input pins of the I/O interface, database contents, time, output relay states, and variables. For more information see "Logical and control functions", page 166.

- Inserting the function*
- ▶ Press the «Other ...» soft key.
  - ▶ Press the «case» dimension key.



### Syntax

A = **case**(test 1, result 1, test 2, result 2, ... test n, result n)

*Example 1*

A value is assigned to a visible dimension

A = **case**(C1<=1mm,0,C1<=2mm,1,C1>2mm,2)

- A = 0 when C1<=1 mm
- A = 1 when C1<=2 mm
- A = 2 when C1>2 mm

*Example 2*

This **case** function is appended to a dimension formula by using the **semicolon** function described earlier. The **case** function performs an operation: It sends one of three messages depending on the value of C1.

A = C4;**case**(C1<=1mm,SendMsg"Case 1",  
C1<=2mm,SendMsg"Case 2",C1>2mm,SendMsg"Case 3")

- A = C4 and when C1<=1 mm the message "Case 1" is sent to the RS-232/V.24 port
- A = C4 and when C1<=2 mm the message "Case 2" is sent to the RS-232/V.24 port
- A = C4 and when C1>2 mm the message "Case 3" is sent to the RS-232/V.24 port

The **case** function could also be assigned to a hidden dimension:

H1 = **case**(C1<=1mm,SendMsg"Case 1",C1<=2mm,SendMsg"Case 2",C1>2mm,SendMsg"Case 3")

*Suppressing results*

When the **case** function is used to perform operations, specific sort result can be suppressed by inserting a numeric zero constant in the respective sort result position. In the following example, no operation is performed for the second sort result.

H1 = **case**(C1<=1mm,SendMsg"Case 1",C1<=2mm,0"Case 2",C1>2mm,SendMsg"Case 3")



**Case** function tests are performed from left to right and only one result will be generated. This precludes the possibility of more than one result being generated for a single **case** function. For example, while a value of 0.75 for C1 in the example above would match the first two cases, only the first case will generate a result.

## Incomplete case statements

**Case** functions use logical test criteria and conditions to sort a large set of inputs into a relatively small collection of well-defined output categories. This logical sorting works well unless the inputs include a case that is not defined as an output category. For this reason, each **case** function must include a complete set of cases. A **case** function with an incomplete case set cannot be executed and will generate an error message.

*Example*

A = **case**(C1<1,0,C1>1,1)

- A = 0 when C1<1
- A = 1 when C1>1
- A is undefined when C1=1

The case C1=1 must be included to provide a complete **case** set.

## Category for undefined cases: Default case

*Application*

A default **case** provides an output category for all inputs that do not match any of the defined cases.

### Syntax

A = **case**(test 1, result 1, test 2, result 2, test n, result n...empty test, default result)

*Example*

Extending the above example by a default case will result in the following:

A = **Case**(C1 < 1,0,C1 > 1,1, ,2)

- A = 0 when C1 < 1
- A = 1 when C1 > 1
- A = 2 when C1 = 1



While it is easy to define complete sets of cases for simple applications, it is good practice to include default cases in all **case** function formulas, thereby eliminating the possibility of undefined results.

## 8.5.7 Determining minimum and maximum values: min and max

*Application*

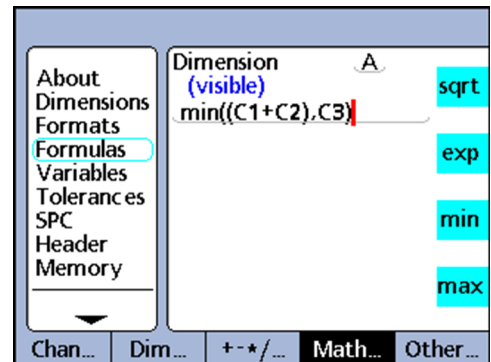
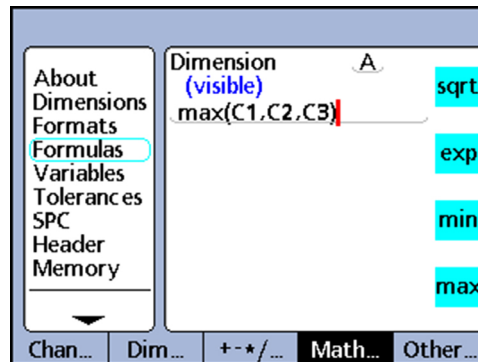
The **min** and **max** functions are used to find the minimum or maximum value in a list. The value list can include channels, dimensions and database content. The **min** and **max** functions can be used to assign values to dimensions, system dimensions, custom functions or to specify criteria for a comparison test.



**min** and **max** functions will not accept mixed units of measure.

*Inserting the function*

- ▶ Press the «Math...» soft key.
- ▶ Press the «min» or «max» dimension key.



### min function syntax

$A = \text{min}(\text{value1}, \text{value2}, \dots \text{value } n)$

Assigns the minimum list value to A.

*Example*

Multiple terms are grouped by parentheses and treated as a single term.

$A = \text{min}((C1+C2),C3)$

A = 3 mm when C1 = 1 mm, C2 = 2 mm, and C3 = 4 mm

### max function syntax

$A = \text{max}(\text{value1}, \text{value2}, \dots \text{value } n)$

Assigns the maximum list value to A.

*Example*

$A = \text{max}(C1,C2,C3)$

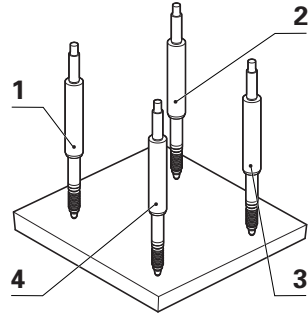
A = 6 mm when C1 = 6 mm, C2 = 3 mm and C3 = 2 mm

## Application example: Flatness measurement

The **min** and **max** functions can be used to evaluate many inputs simultaneously to produce a single result. The flatness measurement in this example illustrates this (many channels to one dimension) capability. Here, multiple measuring devices are distributed across a surface. Flatness is evaluated by simultaneously calculating the difference between the highest and lowest points on the surface.



$$F = \max(C1,C2,C3,C4) - \min(C1,C2,C3,C4)$$



- 1 C1
- 2 C2
- 3 C3
- 4 C4

### 8.5.8 Average (avg) and median (md) functions

*Application*

The **avg** and **md** functions are used to determine the average or median value in a list. The value list can include channels, dimensions and database content.

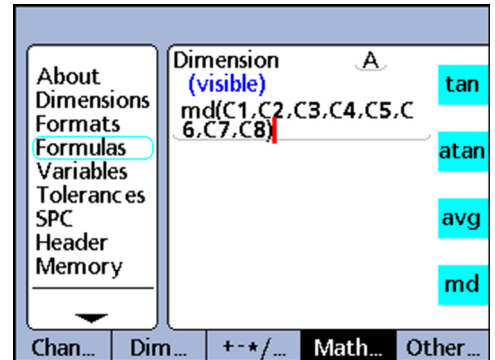
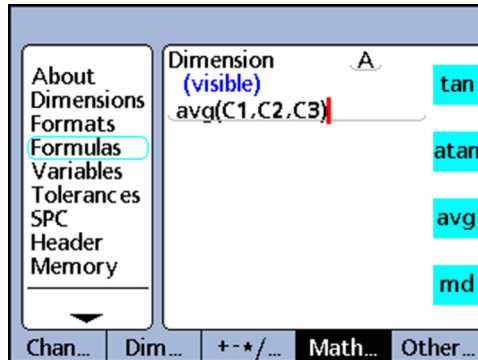
The **avg** and **md** functions can be used to assign values to dimensions, system dimensions, custom functions or to specify criteria for a comparison test.



**avg** and **md** functions will not accept mixed units of measure.

*Inserting the function*

- ▶ Press the «Math...» soft key.
- ▶ Press the «avg» or «md» dimension key.



### Average function (avg)

**avg function syntax**

A = **avg**(value1, value2, ... value n)  
 Assigns the average list value to A.

*Example*

A = **avg**(C1,C2,C3)  
 A = 3.67 mm when C1 = 6 mm, C2 = 3 mm and C3 = 2 mm

## Median function (md)

### md function syntax

A = **md**(value1,value2, ... value n)  
 Assigns the median list value to A.

*Example*

A = **md**(C1,C2,C3,C4,C5,C6,C7,C8)

A = 3.5 mm when C1 = 2 mm, C2 = 2 mm, C3 = 2 mm, C4 = 3 mm, C5 = 4 mm, C6 = 5 mm, C7 = 6 mm, C8 = 6 mm

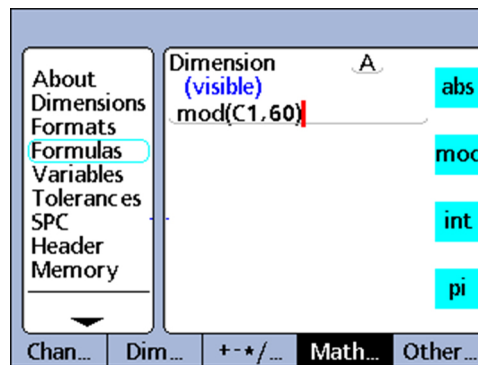
## 8.5.9 Determining the remainder of a division: Modulo (mod)

*Application*

The **Modulo** function is used to return the remainder of a division operation. Modulo values can be calculated for any term or collection of terms. The dividend and divisor are specified by the user as arguments of the **Modulo** function. When the division is performed, the remainder is assigned to a dimension.

*Inserting the function*

- ▶ Press the «Math...» soft key.
- ▶ Press the «mod» dimension key.



### Syntax

A = **mod**(dividend, divisor)

Results of the formula in the example below are shown in the accompanying table for some values of C1 from 0 to 120 in regular increments of 12.

*Example*

A = **mod**(C1,60)

C1	mod(C1,60)
0	0
12	12
24	24
36	36
48	48
60	0
72	12
84	24
96	36
108	48
120	0

## 8.5.10 Controlling the sequence of measurement steps: Sequence (seq)

*Application*

The **Sequence (seq)** function is used to control the order of measurement steps. Normally, dimension formulas are continuously evaluated and the results entered into the database simultaneously when «enter» is pressed or a **trip** function is executed. However, the **seq** function allows database record entries to be made individually in a user-defined sequence. The user defines the sequence by numbering the steps. The steps are then executed one at a time in ascending order each time «enter» is pressed or a **trip** function is executed.

Dimensions calculated from sequence steps are stored in sequence as «enter» is pressed. During operation, a blue line appears under the dimension label of the current sequence step. Each time «enter» is pressed or a **trip** function is executed, the current step function is stored, and the blue line advances to the next step.

This separation of steps makes it possible to conduct a series of different measurements using the same channel input, and is necessary for the development of applications requiring sequential logic.

*Inserting the function*

- ▶ Press the «Other...» soft key.
- ▶ Press the «seq» dimension key.

**Syntax**

A = **seq**(step number, function)

### Application example: Volume measurement

The volume of a rectangular solid is calculated from a sequence of 3 measurements using a single channel. The following equation is used:

$$\text{Volume} = \text{height} * \text{width} * \text{length}$$

where	Dimension formulas
H = height	H = seq(1,C1)
W = width	W = seq(2,C1)
L = length	L = seq(3,C1)
Vol = volume	Vol = H*W*L

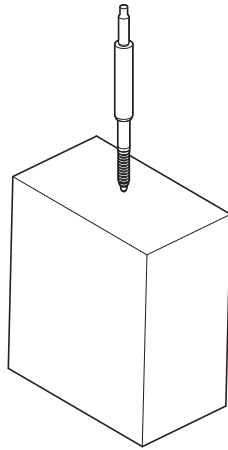
*Executing the measurement sequence*

To accomplish this sequence of measurements using only one channel, the user performs the following steps from the beginning of the sequence:

- ▶ Position the block and measuring device to measure height (H).
- ▶ Press «enter» to store the channel value.

The unit advances to the next step in the sequence.

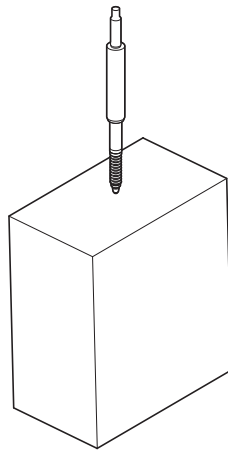
$$H = \text{seq}(1, C1)$$



Current Value		mm	0	P1
<u>H</u>	1.5003			
W				
L				
V <sub>ol</sub>				
View...	in/mm		Master	Menu...

- ▶ Position the block and measuring device to measure width (W).
- ▶ Press «enter» to store the new channel value.  
The unit advances to the next step in the sequence.

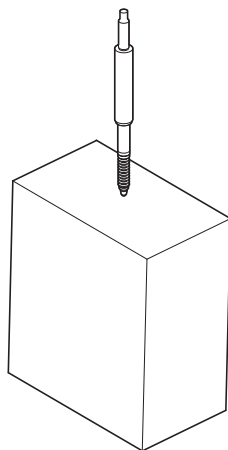
$$W = \text{seq}(2, C1)$$



Current Value		mm	0	P1
H	1.5003			
<u>W</u>	2.0013			
L				
V <sub>ol</sub>				
View...	in/mm		Master	Menu...

- ▶ Position the block and measuring device to measure length (L).
- ▶ Press «enter» to store the final channel value.

$$L = \text{seq}(3, C1)$$



Current Value		mm	0	P1
H	1.5003			
W	2.0013			
<u>L</u>	2.7263			
V <sub>ol</sub>	8.1859			
View...	in/mm		Master	Menu...

The last step in the sequence also stores the calculation of volume based on the values of H, W and L.

Upon completion of the last step, the unit returns to the first step in the sequence to begin a new series of measurements.

$$\text{Vol} = H * W * L$$

This example of volume measurement illustrates that many dimensions can be calculated from a single channel input.

## Performing operations within a sequence

### Application

Operations such as sending data and activating relay contacts can be performed within a sequence by appending the operation using a semicolon.

#### Syntax

A = **seq**(step number,function);**seq**(step number, operation)

---

### Example

A = **seq**(3,C1);(3,ClrTrig4)

Clears event trigger 4 when step 3 of the sequence is executed.

## Reinitialiating a sequence

### Application

Sequences can be ended prior to their completion and a new sequence initiated.

#### Syntax

**seq**(reinitialization step number)

---

### Example

Hidden dimension 1 is used to continually evaluate C2, and the sequence is reinitiated at step 1 if the value of C2 exceeds 1.

A = **seq**(1,C1)

B = **seq**(2,C2)

C = **seq**(3,C1+C2)

H1 = if(C2>1mm,**seq**(2),0)



The reinitializing step cannot be embedded in another sequence step.

## 8.5.11 Measurement automation: trip function

### Application

The **trip** function automates the data entry (storage) process. Normally, dimension formula calculations are stored in the database only when «enter» is pressed. However, the same effect can be achieved using the **trip** function. The **trip** function automatically stores formula calculations when a changing value passes through user-defined thresholds.

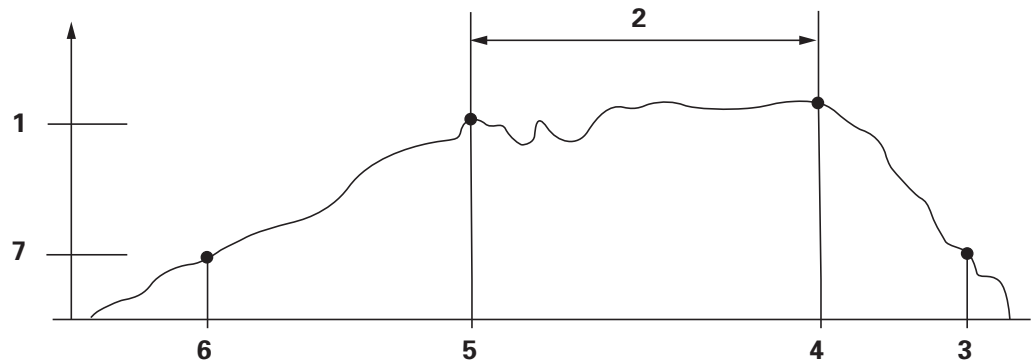
The **trip** function allows the user to conduct a series of identical measurements by loading and unloading parts into and out of a gage.



Measurement automation using the **trip** function can be toggled on and off from the front panel using the «Auto» hot key function. For more information on hot keys see "Configuring hot keys: Hot Keys", page 127.

The **trip** function is set and triggered by a value passing through predefined threshold levels. A delay can be included in the **trip** function to eliminate the effects of hardware noise and settling times.

The **trip** function thresholds and delay are diagrammed here for a positive-going value. **trip** functions can accommodate positive-going and negative-going values. Positive-going and negative-going values are conceptually identical except for direction and polarity of the input.



- 1 Trigger threshold
- 2 Delay
- 3 Trip reset
- 4 Measurement entered
- 5 Trip triggered
- 6 Set ready
- 7 Set threshold



The **trip** function delay can be set to 0 if hardware settling is not a problem.

Once the **trip** function has entered a value, it must be reset before it can be used again. The trip function is reset when the monitored value reverses direction and passes back through the set threshold as shown in the figure.

The **trip** function can be used by itself, included in **if** or **case** functions as the logical result of either passing or failing a conditional test, or included in a **sequence** function step.

- Inserting the function*
- ▶ Press the «Other...» soft key.
  - ▶ Press the «trip» dimension key.

#### Syntax

A = **trip**(value, set threshold, trigger threshold, delay)

Value can be a term or collection of terms.

---

#### Example

A = trip(C1,0.1mm,0.5mm,1.0sec)

A = C1 will be stored in the database after the value of C1 has passed through 0.1 mm, then 0.5 mm and then 1 second has passed.



The examples shown for the **trip** function use channel functions. However, any term or collection of terms that have numeric values could as easily have been used.

## Continuous sampling using the trip function

#### Application

Typical applications using the **trip** function include the use of set and trigger thresholds as discussed. However, some applications are configured with the input channel devices in constant contact with the surfaces to be measured, and require continuous input sampling.

Continuous input sampling can be achieved by omitting the set and trigger thresholds from the standard **trip** function syntax.

#### Syntax

A = **trip**(value, , , delay)

---

The rate of continuous sampling is determined by the entered delay and by the system refresh time. System refresh time typically varies between 0.03 and 0.10 seconds depending on the number and type of channels used and the complexity of formulas.

The resulting sample rate becomes:

Sample rate = 1/(total trip function time) ~ 1/(system refresh time + delay)

Assuming the maximum system refresh time, and no sample delay, the maximum sample rate is approximately:

Max sample rate = 1/(0.10 + 0) = 10 samples/second

Generally applications that require continuous sampling employ slower rates, with seconds, minutes or even more time between samples. For these applications the sample rate can be expressed as the inverse of the user-defined delay as shown below.

Sample rate ~ 1/delay

Application developers generally know the sample rate requirement and need to find the delay parameter to enter into the **trip** function. Since sample rate and delay are inversely related, for sample rates less than 10 samples/second, delay can be expressed as:

Delay ~ 1/sample rate

For example, a sample rate of 1 sample per minute requires a delay of 60 seconds, resulting in the following formula parameters:

A = **trip**(C1, , , 60sec)

Continuous samples can be accumulated in the unit's database, transmitted over the RS-232/V.24 port or sent to a USB drive.

A = **trip**(C1, , , 60sec);Send



The **Auto** hot key function toggles the **trip** function on and off. It should be assigned to the desired front panel key prior to configuring the **trip** function for continuous sampling. For more information see "Configuring hot keys: Hot Keys", page 127.

## 8.5.12 Determining the minimum and maximum of dynamically sampled values: dmn and dmX

*Application*

The **dmn** (dynamic minimum) and **dmX** (dynamic maximum) functions assign values to dimensions based on the minimum or maximum values of dynamically sampled channels or dimensions. The sampled values can be assigned directly, or can be used as triggers to assign a value from a second source.

The channel inputs are sampled many times per second. The system updates and retains the minimum and maximum values encountered in the sampling process. Both values are evaluated simultaneously during sampling. Dynamic minimum and maximum values can be calculated for any term or collection of terms. The minimum and maximum values are saved by pressing «enter» or using the **trip** function.

*Inserting the function*

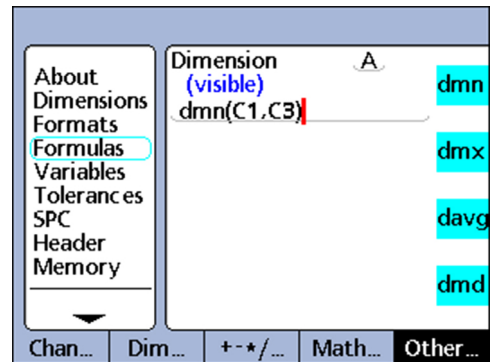
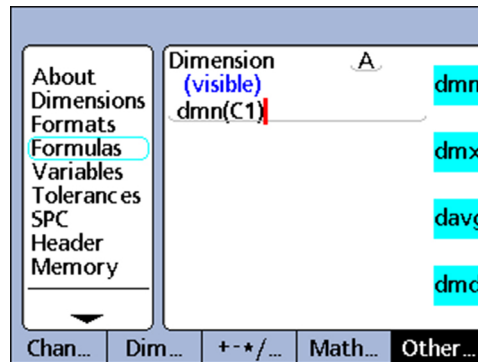
- ▶ Press the «Other ...» soft key.
- ▶ Press the «dmn» or «dmX» dimension key.

**Left:**

*Assigning a sampled value*

**Right:**

*Assigning a second value*



### dmn function syntax

A = **dmn**(sampled value)

Assigns the sampled minimum value.

A = **dmn**(sampled value, second source)

Assigns the value from the second source when the sampled value is at the minimum.



**dmx function syntax**

A = **dmx**(sampled value)

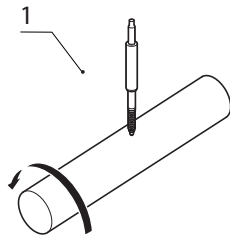
Assigns the sampled maximum value.

A = **dmx**(sampled value, second source)

Assigns the value from the second source when the sampled value is at the maximum.

*Example 1*

In the following example, the runout of a shaft is determined by spinning the shaft, dynamically measuring the shaft's minimum and maximum diameters and then subtracting the minimum diameter from the maximum diameter.

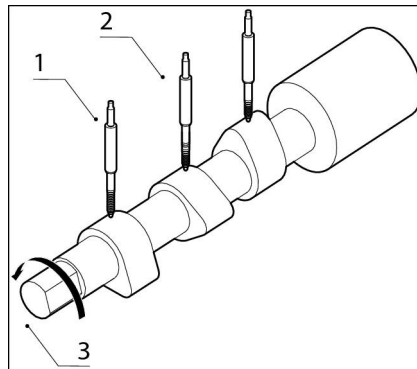


**1** E1

$$R = \mathbf{dmx}(C1) - \mathbf{dmn}(C1)$$

*Example 2*

In the following example, the angle between high points of two cams is determined by spinning the camshaft, dynamically measuring the rotational angle at each cam minimum, and subtracting the smaller angle from the larger angle.



**1** C1

**2** C2

**3** C3

$$A = \mathbf{dmx}(C2, C3) - \mathbf{dmx}(C1, C3)$$

Encoder C1 measures cam **1**, encoder C2 measures cam **2**, and the rotary encoder C3 measures the rotational angle of the camshaft as it spins.

### 8.5.13 Determining the average and median of dynamically sampled values: davg and dmd

*Application*

The dynamic average (**davg**) and dynamic median (**dmd**) functions assign values to dimensions based on the average or median values of dynamically sampled channels or dimensions. The sampled values are assigned directly.

Dynamic averages are useful when measuring rough surfaces. Dynamic medians are useful when measuring in the presence of noise.

The channel inputs are sampled many times per second. The system updates and retains the average and median values encountered in the sampling process. Average and median values are evaluated simultaneously during sampling. The number of samples used to calculate the average or median is specified as an argument by the user. Smaller numbers of samples have little impact on system performance but result in rapidly changing averages and medians. Larger numbers of samples result in more stable averages and medians but slow system performance.

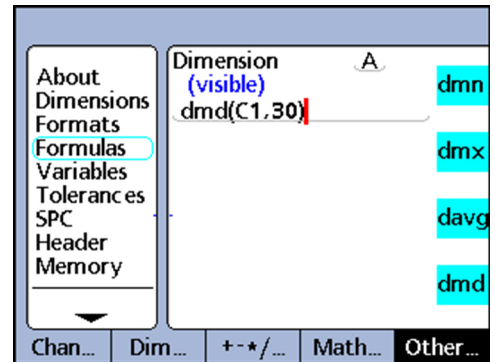
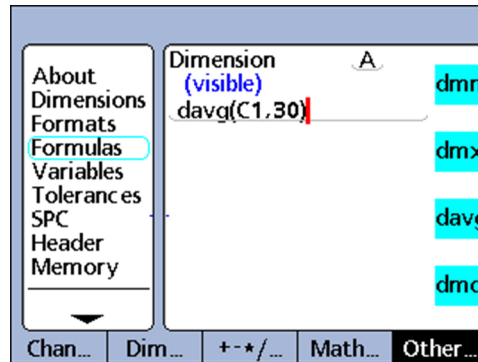
Dynamic average and median values can be calculated for any term or collection of terms. Pressing «enter» stores the average and median values.



Due to the relatively low sample rates of the **davg** and **dmd** functions, surfaces must be moved slowly during the sampling process to insure that all points are evaluated.

*Inserting the function*

- ▶ Press the «Other...» soft key.
- ▶ Press the «davg» or «dmd» dimension key.



#### davg function syntax

A = **davg**(sampled value, sample size)

Assigns the average value of the samples. The minimum sample size for averages is 2.

#### dmd function syntax

A = **dmd**(sampled value, sample size)

Assigns the median value of the samples. The minimum sample size for medians is 3.



The sample size must be specified using a constant without a unit of measure. Before using the **davg** and **dmd** functions, the **RsetDyn** function must be used to clear existing samples from previous measurements. For more information see "Clearing minimum and maximum values: RsetDyn", page 208.

## 8.5.14 Evaluating the pass/fail status: fail

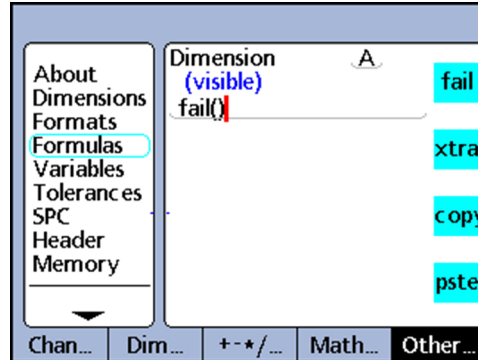
*Application*

The **fail** function tests the current pass/fail tolerance status of any dimension, list of dimensions provided as the **fail** argument or of all dimensions.

The **fail** function returns a logic level 0 or 1, indicating the pass or fail status of specified dimensions. The value of 0 or 1 can be assigned to a dimension or can be included in a dimension formula as a logic or dimensionless variable.

*Inserting the function*

- ▶ Press the «Other...» soft key.
- ▶ Press the «fail» dimension key.



**Syntax**

A = **fail**()

Assigns a logic 1 to A if any dimension fails a tolerance test.  
 Assigns a logic 0 to A if all dimensions pass a tolerance test.

A = **fail**(DimX)

Assigns a logic 1 to A if the specified dimension (X) fails a tolerance test.  
 Assigns a logic 0 to A if the specified dimension (X) passes a tolerance test.

A = **fail**(Dim1, Dim2,...DimN)

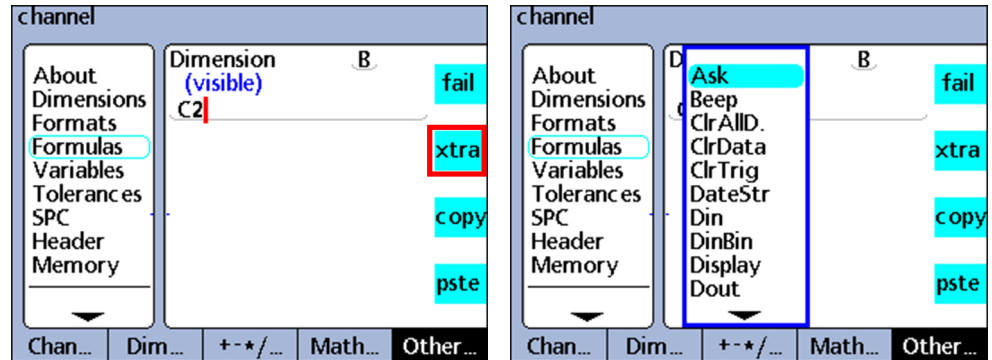
Assigns a logic 1 to A if any of the specified dimensions fail a tolerance test.  
 Assigns a logic 0 to A if all of the specified dimensions pass a tolerance test.

## 8.6 «xtra» menu functions

*Navigating to the «xtra» menu*

- ▶ In the «Formulas» setup screen, press the «Dec» or «Inc» soft key to highlight the desired dimension for the formula.
- ▶ Press «enter».
- ▶ Repeatedly press the «Other...» soft key until «xtra» is displayed next to the second dimension key.
- ▶ Press the «xtra» dimension key.

The «xtra» menu is displayed:



*Overview*

The following functions are available in the «xtra» menu:

- **Ask**: Displays a message or prompts the user for keyboard entry, then returns the entered value
- **Beep**: Makes a beep sound
- **ClrAllD** (Clear all data): Clears data across all parts
- **ClrData** (Clear data): Clears data for the current part
- **ClrTrig** (Clear trigger): Part of the **OnEvent** function. Clears the specified event trigger
- **DateStr** (Date string): Returns the current system date
- **Din** (Data in): Returns logic levels from the input pins of the I/O interface
- **DinBin** (Data in binary): Returns a base 10 number equivalent to the logic levels from the input pins of the I/O interface
- **Display**: Sets the current graph display to a specific dimension and a specific number of axes
- **Dout** (Data out): Applies individually defined logic levels to the output pins of the I/O interface
- **DoutBin** (Data out binary): Applies binary logic levels equivalent to a base 10 number to the output pins of the I/O interface
- **FnCall** (Function call): Calls a user-defined custom function that returns a value based on arguments passed in the calling statement
- **FnDefine** (Function define): Defines a function and includes parameter placeholders for arguments
- **FnParam** (Function parameters): Defines up to 12 parameters to be passed to a custom function
- **FnReturn** (Function return): Returns immediately from a custom function without returning a value
- **GetMult** (Multiturn information): Reads the current position regarding the revolution information from an EnDat multiturn rotary encoder

Note:

This function is only available when an EnDat multiturn rotary encoder is connected.

- **Global**: Returns the value of a global variable that is available across all parts
- **HwDmn** (Hardware dynamic minimum): Returns the minimum channel input value sampled at high speed by dedicated hardware

Note:

This function is only available on versions with 1 Vpp, TTL or Solartron Orbit measuring device interfaces.

- **HwDmx** (Hardware dynamic maximum): Returns the maximum channel input value sampled at high speed by dedicated hardware

Note:

This function is only available on versions with 1 Vpp, TTL or Solartron Orbit measuring device interfaces.

- **HwLx** (Hardware latch): Returns the value of one channel based on the incremental values of another channel

Note:

This function is only available on versions with 1 Vpp or TTL measuring device interfaces.

- **Lookup**: Returns one of a selection of several dimensions, part values or database values
- **Loop**: Loop control used to repeat a series of steps or functions
- **Master**: Presets input channels to numeric values specified in the «Master» setup screen
- **OnEvent**: Evaluates a formula term and returns the value or performs a task when a specified event occurs
- **PartNo** (Part number): Changes the part number, usually in conjunction with an **OnEvent** function
- **Preset**: Presets a dimension to a numeric value
- **Recall**: Recalls dimension values that were specified the last time the **Preset** function was used
- **Relay**: Operates dry-contact relay outputs
- **Remark**: Adds a comment to a formula, but has no effect on values or operation
- **Report**: Prints a report on the I/O or serial interface
- **RsetDyn** (Reset dynamic): Clears **dmn**, **dmx**, **HwDmn** and **HwDmx** sampled channel input values in preparation for new samples
- **Scan**: Collects all channel input data at the maximum rate

Note:

This function is only available on versions with 1 Vpp, TTL or EnDat measuring device interfaces.

- **Send**: Transmits one or more specified dimensions to an output port
- **SendMsg** (Send message): Transmits text or ASCII code to the RS-232/V.24 port
- **SendRec** (Send record): Transmits one or more specified dimension records to an output port
- **SetColor**: Sets the color of a specified dimension displayed on the **DRO** screen
- **SetTrig** (Set trigger): Part of the **OnEvent** function. Sets a user-defined event trigger.
- **Setup**: Performs a variety of setup functions for the specified dimension
- **Time**: Returns elapsed time since startup or the amount a formula term has changed over an elapsed time
- **TimeStr** (Time string): Returns the current system time

- **Var** (Variable): Returns or initializes the value of a local variable available for individual parts
- **XLatch** (optional): Returns a channel input value when an external edge is detected

### 8.6.1 Creating user prompts: Ask

*Application*

The **Ask** function is used to display messages that prompt the user for data or display instructions on the LCD:

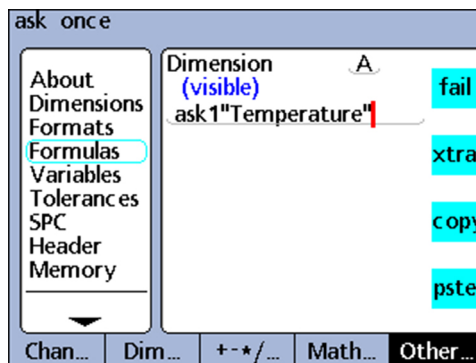
- Messages can contain up to 80 upper or lower case alphanumeric characters
- Messages can be displayed once when the part is loaded, always when a data record is entered, immediately (**Now**) upon formula execution or for a **timed** interval specified by the user
- Messages can be displayed once when the part is loaded, always when a data record is entered, immediately (**Now**) upon formula execution or for a **timed** interval specified by the user
- The **Now** selection should only be used as the result of an **OnEvent** function to prevent continuous prompting
- Numeric data entered by the user in response to a prompt can be interpreted as linear (**lin**), angular (**ang**), dimensionless (**none**) or a yes or no answer (**no/yes**)

*Inserting the function*

**NOTICE**

This function should only be used for the result of an **OnEvent** function to avoid continuous prompting, which in the worst case can prevent subsequent use of the unit!

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Ask** function.
- ▶ Press «enter».
- ▶ Press the «Once», «Always», «Now» or «Timed» soft key.  
(Not available if «Timed» is selected)
- ▶ Use the Alpha Entry screen to create the prompt message.
- ▶ Only if «Timed» is selected:  
Enter the time interval (in seconds) for repeating the prompt.
- ▶ Press «enter».



**Syntax**

A = **ask**When(user prompt)

Using the function to prompt the user for data.

A = Formula;**ask**DisplayTime(user prompt)

Using the function to display a message without data entry by the user.

Examples

A = **ask1**"Temperature"

A = C3;**askT5**"Part 11"

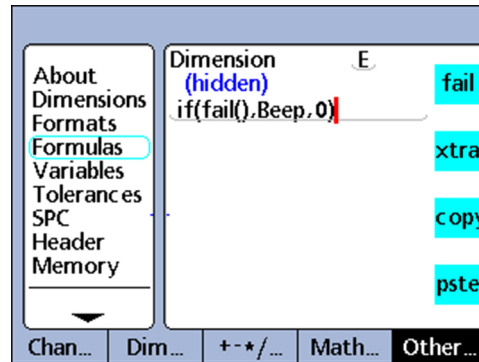
### 8.6.2 Generating audio alert: Beep

Application

The **Beep** function generates a beep sound. The volume of beep is determined by the **Volume** parameter specified in the «Misc» setup screen.

Setting the function

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Beep** function.
- ▶ Press «enter».



**Syntax**

Hn = function (**Beep**)

Example

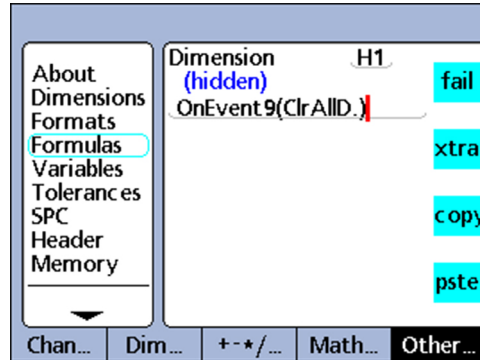
E = if(fail(),**Beep**,0)

A beep sound is generated if any measurement fails a tolerance test.

### 8.6.3 Clearing data for all parts: ClrAllID

*Application* The **ClrAllID**(Clear All Data) function clears all data stored in the unit's database for all parts.

- Inserting the function*
- ▶ Press the «xtra» dimension key.
  - ▶ Highlight the **ClrAllID** function.
  - ▶ Press «enter».



#### Syntax

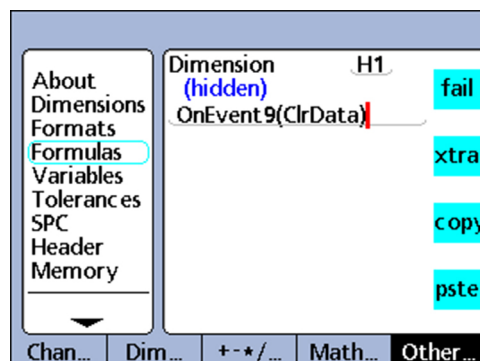
Hn = **ClrAllID**  
 Hidden dimension displayed

*Example* H1 = OnEvent9(**ClrAllID**)  
 All database data is cleared when no numeric data is required and the «9» number key is pressed.

### 8.6.4 Clearing data for the current part: ClrData

*Application* The **ClrData** function clears all data stored in the unit's database for the current part.

- Inserting the function*
- ▶ Press the «xtra» dimension key.
  - ▶ Highlight the **ClrData** function.
  - ▶ Press «enter».



#### Syntax

Hn = **ClrData**  
 Hidden dimension displayed



Example

H1 = OnEvent9(ClrData)

All data for the current part is cleared when no numeric data is required and the «9» number key is pressed.

### 8.6.5 Setting and clearing triggering events: SetTrig and ClrTrig

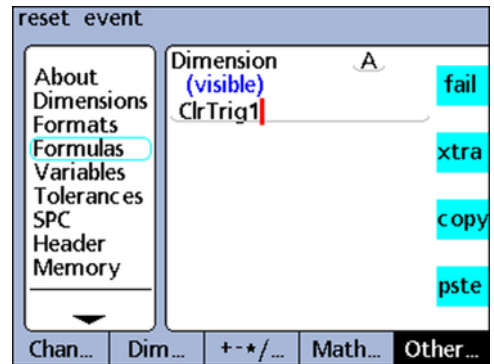
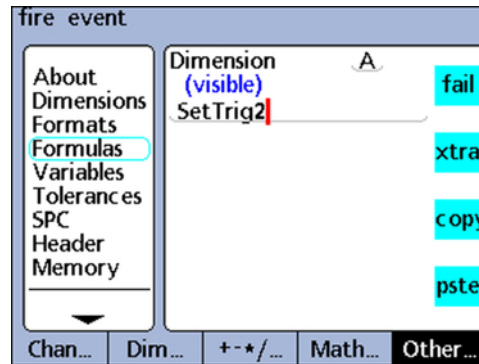
Application

A user-defined triggering event causes an **OnEvent** function to be executed once each time the triggering event happens.

First, the triggering event must be set using the **SetTrig** function. After execution of the **OnEvent** function, the triggering event must be cleared with the **ClrTrig** function before it can be used again.

Inserting the function

- ▶ Press the «extra» dimension key.
- ▶ Highlight the **ClrTrig** or **SetTrig** function.
- ▶ Press «enter».
- ▶ Enter the event number for the triggering event.
- ▶ Press «enter».



#### Syntax

ClrTrigTrigNo.

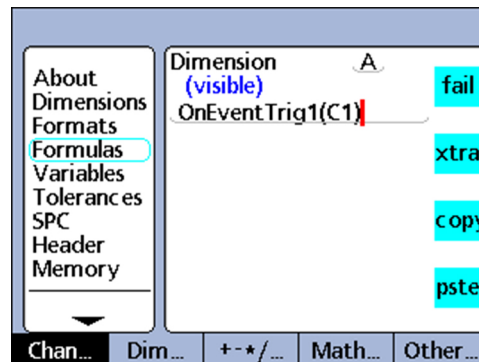
SetTrigTrigNo.

TrigNo. = Event number of triggering event

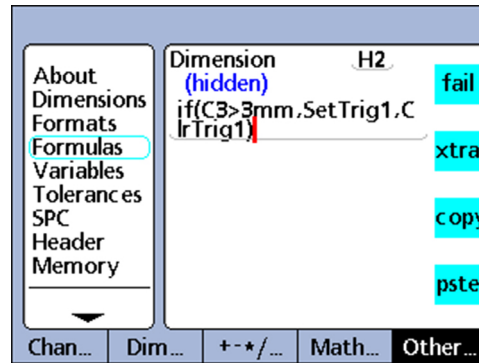
Example

The value of channel input C1 is assigned to visible dimension A once when the value of C3 exceeds 3 mm.

A = **OnEvent**Trig1(C1) Defines the triggering event Trig1:



An **if** function is used to set and clear the triggering event using the **SetTrig** and **ClrTrig** functions; H2 = If(C3>3mm,SetTrig1,ClrTrig1):



When **C3 > 3 mm**, triggering event **1** is set and causes the **OnEvent** function shown above to be executed once.

When **C3 <= 3 mm**, triggering event **1** is cleared so that the next time **C3 > 3 mm**, the **OnEvent** function can be executed again.

### 8.6.6 Triggering a conditional event: OnEvent

*Application*

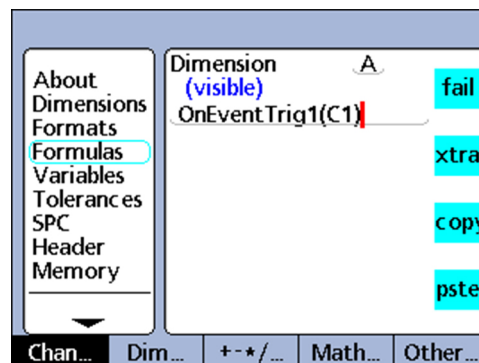
The **OnEvent** function is used to assign values to dimensions or to perform operations when triggered by a specified event. When the triggering event occurs, the value is assigned to the dimension and latched, or the specified operation is performed.

*Inserting the function*

- ▶ Press the «extra» dimension key.
- ▶ Highlight the **OnEvent** function.
- ▶ Press «enter».

When the function is inserted, a menu of triggering events is displayed; for more information see "Triggering events", page 191.

- ▶ Select the triggering event and press «enter».
- ▶ Follow screen prompts if any additional steps are required for inserting the triggering event.
- ▶ Press «enter».



#### Syntax

A = **OnEvent**Event(value or operation)  
 Event, operation: Triggering event

### Example

A = **OnEventDataEntr**(C1)

The value of channel input C1 is assigned to dimension A each time a record is entered into the database.

## Triggering events

Triggering events include a collection of system-specific triggering events provided by the menu, and one triggering event that is user-defined. System-specific triggering events cause **OnEvent** functions to be executed each time predetermined system events happen.

Event	Description
<b>DataEntr</b>	Occurs after a data record is entered into the database.
<b>DispOff</b>	Occurs after the display is turned off using the «LCD on/off» button.
<b>DispOn</b>	Occurs after the display is turned on using the «LCD on/off» button.
<b>Edge&lt;n&gt;</b>	Occurs after an (optional) external edge event has occurred on channel input <n>.
<b>HwLx</b>	Occurs after the <b>HwLx</b> function has latched a new value.
<b>Key</b>	Occurs after the specified front panel key has been pressed.
<b>PartClr</b>	Occurs after the part database has been cleared.
<b>PartLoad</b>	Occurs after a new part has been loaded.
<b>PartUnld</b>	Occurs after a part has been unloaded.
<b>Playback</b>	Occurs after execution of the <b>scan</b> function, when scanned results are played back.
<b>PowerOn</b>	Occurs when the unit is switched on.
<b>Trig</b>	User-defined triggering event. The user-defined triggering event causes <b>OnEvent</b> functions to be executed each time a user-defined event happens.

## 8.6.7 Displaying date and time: DateStr and TimeStr

*Application*

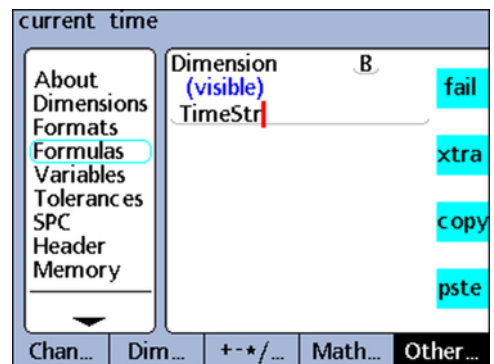
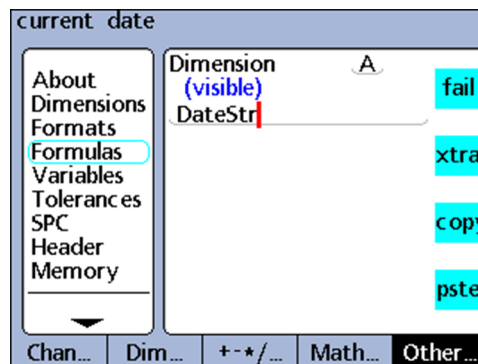
The **DateStr** and **TimeStr** functions display the current system date and time on the LCD screen in the formats specified in the «Clock» setup screen.

Since the current date and time values will typically exceed tolerance limits, they are often displayed in the color specified for the fail state of tolerance tests.

The date and time values are updated during each formula evaluation cycle.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **DateStr** or **TimeStr** function.
- ▶ Press «enter».



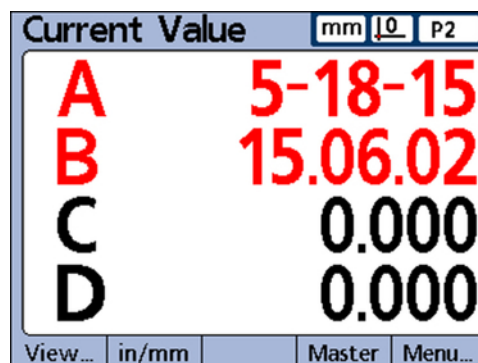
### Syntax

A = **DateStr**  
Display of system date

A = **TimeStr**  
Display of system time

*Example*

Date and time in the **DRO** screen. The display depends on the formats specified in the «Clock» setup screen. For more information see "Setting date and time: Clock", page 134.



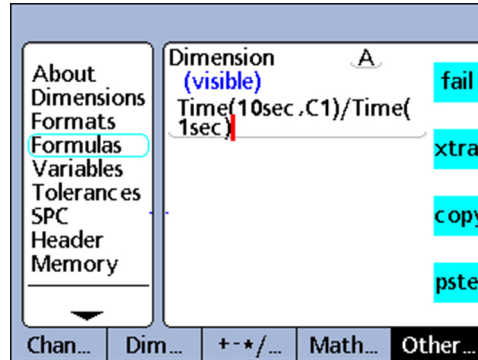
## 8.6.8 Assigning elapsed time and intervals of functions: Time

*Application*

The **Time** function is used to assign the elapsed time in seconds since system startup or assign the elapsed time in seconds equal to, or closest to (but exceeding) a specified time interval.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Time** function.
- ▶ Press «enter».
- ▶ Enter time parameter values.
- ▶ Press «enter».



### Syntax

A = **Time**()

Assigns the elapsed time in seconds since system startup.

A = **Time**(Interval)

Assigns the elapsed time in seconds that is closest to a specified time interval.

A = **Time**(Interval,value)

Assigns value changes over a specified time interval.

*Example*

H = **Time**(10sec,C1)/**Time**(1sec)

Uses an elapsed time interval and a value change captured at channel input C1 to calculate the exact velocity of the motion of C1.



The approximation of specific time intervals is necessary for the exact calculation of velocity and other time-related quantities because the system clock is not a precise timekeeping device.

By returning a time interval that is known precisely, exact calculations of time-related quantities are possible.

## 8.6.9 Assigning / reading the logic levels of input pins: Din / DinBin

The I/O interface is configured as a GPIO (General Purpose Input/Output) port and does not support parallel printers.



For more information on the pin layout of the I/O interface, see "Wiring of switching inputs and outputs", page 26.

For more information on the electrical specifications of the I/O interface, see "Specifications", page 261.

### Din function

*Application*

The **Din** function is used to read the logic level of a single input pin or range of input pins on the I/O interface. The logic level from a single pin can be inserted in a dimension formula, or the decimal equivalent of the binary values from a range of pins can be used.

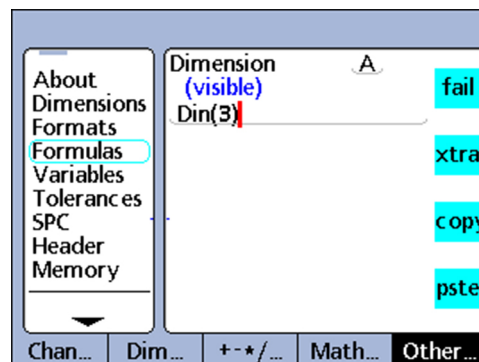
The I/O interface pins used for the **Din** function are numbered 1 through 5.

Din	Pins of the I/O interface
1	15
2	13
3	12
4	11
5	10

Logic levels are referred to ground on pins 18 through 25.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Din** function.
- ▶ Press «enter».
- ▶ Enter a pin number or range of pins.
- ▶ Press «enter».



### Syntax

A = **Din**(pin number)

The logic level at a single Din pin is assigned to a dimension as a numeric value **1** or **0**.

A = **Din**(range of pins)

The decimal equivalent of the binary values from a range of pins are assigned to a dimension as a numeric value.

## Custom programming

«xtra» menu functions

*Example 1*      A = **Din**(3)  
 A = 1  
 When **Din**(3) = logic level 1

*Example 2*      A = **Din**(3-5)  
 A = 20  
 When:  
**Din**(3) = logic level 1  
**Din**(4) = logic level 0  
**Din**(5) = logic level 1

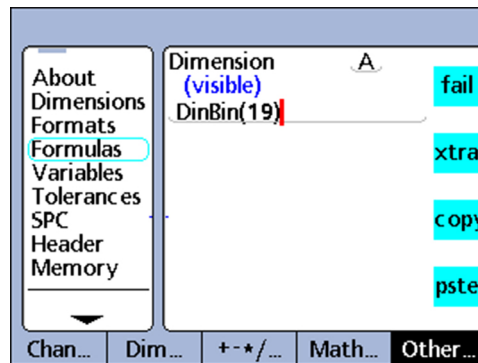
Din	Din(5)	Din(4)	Din(3)	Din(2)	Din(1)
Din logic level	1	0	1	0	1
Decimal equivalent	16	0	4	0	1

◀ Specified range ▶

## DinBin function

*Application*      Using the **DinBin** function, the logic levels of multiple input pins of the I/O interface can be read simultaneously as a decimal equivalent. The decimal value can be included directly in a dimension formula as a variable, or can be evaluated in conditional **if** and **case** statements.

- Inserting the function*
- ▶ Press the «xtra» dimension key.
  - ▶ Highlight the **DinBin** function.
  - ▶ Press «enter».
  - ▶ Enter the lines number.
  - ▶ Press «enter».



### Syntax

A = **DinBin**(lines)  
 The logic levels at the Din pins are assigned to a dimension as a decimal value.  
 Lines: Decimal value of the binary mask that specifies which input pins to read

*Example*      A = **DinBin**(19)  
 Includes a lines value of 19, which when converted to a binary mask of 10011, reads the pins Din(1), Din(2) and Din(5). All unread pins are given a logical value of 0. The binary value of the input pins read at the I/O interface is then returned as a decimal equivalent.

A = **DinBin**(19)

A = 17, when

- the input pin logic levels are 10101
- the lines mask value is decimal 19 = 10011
- the masked result is 10001 = decimal 17

Din	5	4	3	2	1
Din logic level	1	0	1	0	1
Lines mask (dec 19)	1	0	0	1	1
Masked value (dec 17)	1	0	0	0	1

### 8.6.10 Assigning / reading the logic levels of output pins: Dout / DoutBin

The I/O interface is configured as a GPIO (General Purpose Input/Output) port and does not support parallel printers.



For more information on the pin layout of the I/O interface, see "Wiring of switching inputs and outputs", page 26.

For more information on the electrical specifications of the I/O interface, see "Specifications", page 261.

### Dout function

*Application*

The **Dout** function is used to output a TTL logic level of 0 or 1 to a specific output pin or range of pins of the I/O interface. Logic levels are referred to ground on pins 18 through 25. The logic level is presented to the pins specified, no other pins are affected.

If a delay is also specified, the logic level will be presented for the delay period, and then the affected output pins will be changed to the opposite logic state.

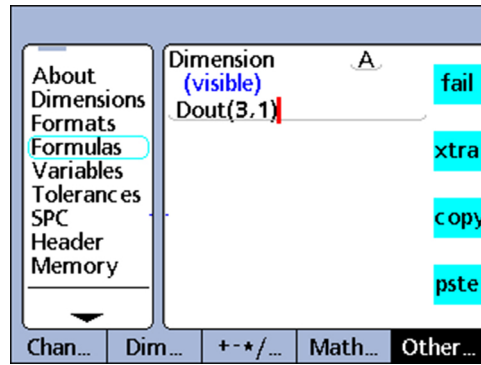
The I/O interface pins used for the **Dout** function are numbered 1 through 12.

Dout	Pin of the I/O interface	Dout	Pin of the I/O interface
1	2	7	8
2	3	8	9
2	4	9	1
4	5	10	14
5	6	11	16
6	7	12	17

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Dout** function.
- ▶ Press «enter».
- ▶ Enter the pin number/range of pins, state and delay.
- ▶ Press «enter».





### Syntax

Hn = **Dout**(pin number/range of pins, state, delay)

Pin number/range of pins: Specifies which output pin or pins are used

State: Logic level to be presented to the specified pins

Delay: Time in seconds that the logic level will be present – if no delay is specified, the logic level will be continuously present

Example 1

H1 = **Dout**(3,1)

H1 = sets Dout pin 3 to a logical 1 continuously

Example 2

H1 = **Dout**(3-5,1,5sec)

H1 = sets Dout pins 3 through 5 to a logical 1 for 5 seconds, then to 0

### DoutBin function

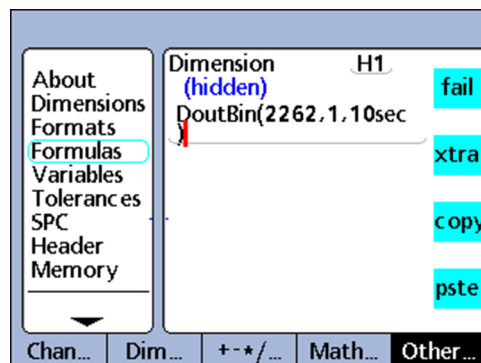
Application

The **DoutBin** function is used to output a specified logic level simultaneously to multiple output pins of the I/O interface. The new logic level can be presented continuously or for a specified period.

The logic level is presented to the pins specified by the lines mask; no other pins are affected. If a delay is also specified, the logic level will be presented for the delay period, and then the affected output pins will be changed to the opposite logic state.

Inserting the function

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **DoutBin** function.
- ▶ Press «enter».
- ▶ Enter values for lines, state and delay.
- ▶ Press «enter».



**Syntax**

Hn = **DoutBin**(lines,state,delay)

Lines: Decimal value of the binary mask that specifies which output pins are used

State: Logic level to be presented to the specified pins

Delay: Time in seconds that the logic level will be present – if no delay is specified, the logic level will be continuously present

*Example*

H1 = **DoutBin**(2262,1,10sec)

Includes a lines value of 2262, which when converted to a binary mask of 100011010110, outputs a logic level of 1 for 10 seconds to lines Dout(2), Dout(3), Dout(5), Dout(7), Dout(8) and Dout(12). All pins not included in the mask are unaffected. After the 10 second delay period, the affected output pins are changed to a logical 0.

H1 = **DoutBin**(2262,1,10sec)

When

- the lines mask is decimal 2262 = 100011010110
- the state is logical 1
- the delay is 10 seconds

a logical 1 is output for 10 seconds as shown in the following table:

Dout	12	11	10	9	8	7	6	5
State	1	1	1	1	1	1	1	1
Lines mask (dec 2262)	1	0	0	0	1	1	0	1
Resulting output	1	ua*	ua	ua	1	1	ua	1

\*: ua = unaffected

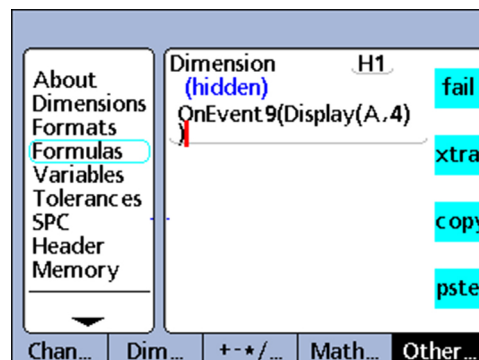
### 8.6.11 Setting the graph display: Display

*Application*

The **Display** function sets the current graph display to a specified dimension and a specified number of axes. The display function should be used in other functions that are evaluated once, such as the **OnEvent** function.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Display** function.
- ▶ Press «enter».
- ▶ Enter the dimension and the number of graph axes.
- ▶ Press «enter».



**Syntax**

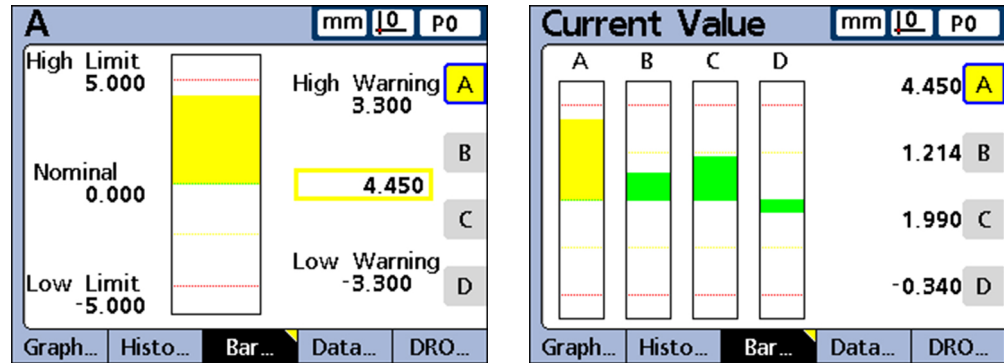
Hn = **Display**(dim,axes)

Dim: Dimension to display

Axes: The number of graph axes to display

Example

H1 = OnEvent9(**Display**(A,4))



The display of graphs will change to show dimension A and a total of 4 axes when no numeric data is required and the «9» number key is pressed.

### 8.6.12 Creating custom functions: FnDefine, FnParam and FnCall

Application

A custom function is a collection of formula operations that perform a specific task. Custom functions are relatively independent of other formula operations. Calling a custom function in a formula returns a value calculated by the function.

Advantages to creating custom functions include:

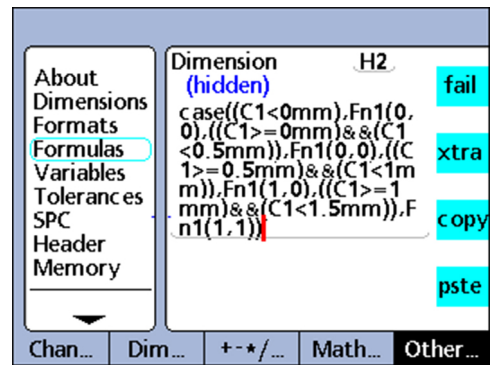
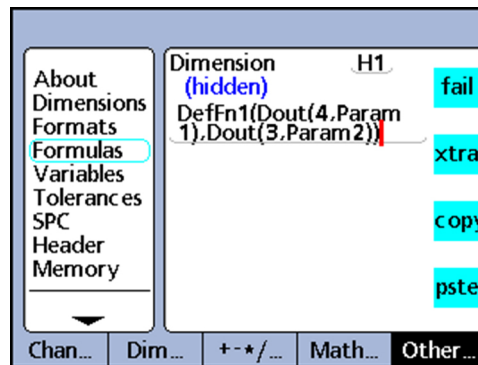
- Reducing the duplication of formula operations in a part program
- Reuse of formula operations in multiple part program locations
- Compressing complex operations into short, simple statements that improve readability

Characteristics of custom functions:

- They always include a collection of formula operations to be executed when the function is called
- They can contain parameters that are passed to the function and will be used in the calculation of the returned value
- They are created using the **FnDefine** function
- They are executed when the **FnCall** function is included in a formula
- They can be defined with or without input parameters and return the result of the included formula operations
- They must be defined on hidden dimension formula lines, but can be called from hidden or visible dimension formulas
- Functions that are passed parameters use the **FnParam** function

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **FnCall**, **FnDefine** or **FnParam** function.
- ▶ Press «enter».
- ▶ Enter the function number.
- ▶ Press «enter».



**Syntax**

<b>FnDefine</b>	Hn = <b>DefFn#</b> (action 1, action 2, ...action<n>) Action: Combinations of formula operations
<b>FnParam</b>	<b>Param#</b> Parameters passed to <b>FnCall</b> (i.e. <b>Fn#</b> )
<b>FnCall</b>	A = <b>Fn#</b> (param1, param2, ...param<n>) Param: Parameters. They are passed to the function and used to calculate the result.

*Example*

A custom function is defined to change the logic state of output pins Dout(3) and Dout(4) of the I/O interface to indicate four ranges of displacement of the probe connected to input channel 1.

The value ranges of C1 and the corresponding logic states of Dout(3) and Dout(4) are shown in the following truth table.

C1 value range	Dout(4)	Dout(3)
<0 mm	0	0
>=0 mm AND <0.5 mm	0	1
>=0.5 mm AND <1.0 mm	1	0
>=1.0 mm AND <1.5 mm	1	1

This custom function is defined in a hidden dimension and uses 2 parameters to set the logic states of Dout(3) and Dout(4).

H1 = **DefFn1**(Dout(4,**Param1**),Dout(3,**Param2**))

The function is then called in a case operation, and in the calling statement the 2 parameters are passed that correspond to the logic states of Dout(3) and Dout(4) shown in the truth table above.

H2 = Case((C1<0mm),**Fn1(0,0)**,  
 ((C1>=0mm)&&(C1<0.5mm)),**Fn1(0,1)**,  
 ((C1>=0.5mm)&&(C1<1.0mm)),**Fn1(1,0)**,  
 ((C1>=1.0mm)&&(C1<1.5mm)),**Fn1(1,1)**)

### 8.6.13 Defining variables: Var

*Application*

The **Var** function is used to:

- Read the variable value to assign values to dimensions
- Increment or decrement a variable value for loop or event counters

Up to 20 variables can be defined for each part. Variables can be assigned in different ways, depending on the application.

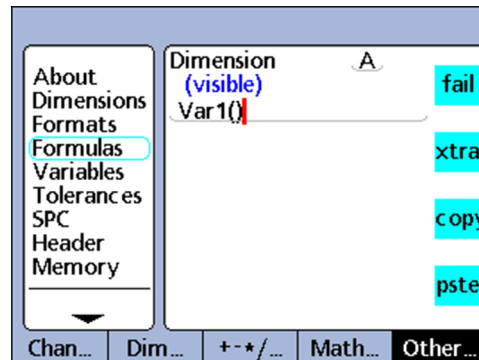
Variables created using the **Var** function are effective locally for a specific part. For example, a variable used in part 0 is not available in part 1.



Variables that are available to all parts in the system are created using the **Global** function, see "Defining global variables: Global", page 204.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Var** function.
- ▶ Press «enter».
- ▶ Enter the variable number.
- ▶ Enter the variable value.
- ▶ Press «enter».



**Syntax**

**Var#**(Value)

Examples

**Var1**(ask!"Number")

The variable value is set based on the user's response to a prompt (ask!).

**Var1**(C1+sqrt(C2+C3))

The variable value is calculated from the expression in parentheses.

**Var1**(27)

The variable value is set directly to the constant 27.

### Reading the variable value to assign values to dimensions

Application

Variables can be evaluated by **if** and **case** functions to count loop executions, indicate states and assign values to dimensions.

**Syntax**

**Var#( )**

Example

A = **Var1**()

Assigns the value of Var1 to dimension A.

### Incrementing or decrementing a variable value for loop or event counters

Application

Variables can be incremented or decremented to serve as loop or event counters for controlling the logic sequence.

Incrementing a variable increases its value by a specified amount at each increment.

Decrementing a variable decreases its value by a specified amount at each increment.

A variable is typically incremented or decremented each time a loop is executed or an event occurs. The value is evaluated to determine whether the required number of loops or events have taken place.

**Syntax**

Incrementing the variable value: **Var#(Var#() + increment value)**

Decrementing the variable value: **Var#(Var#() - increment value)**

Example

Incrementing:

**Var1(Var1()+1)**

Increments the value of variable Var1 by 1.

Decrementing:

**Var1(Var1()-1)**

Decrements the value of variable Var1 by 1.

## 8.6.14 Reading the position of a multiturn rotary encoder: GetMult

*Application*

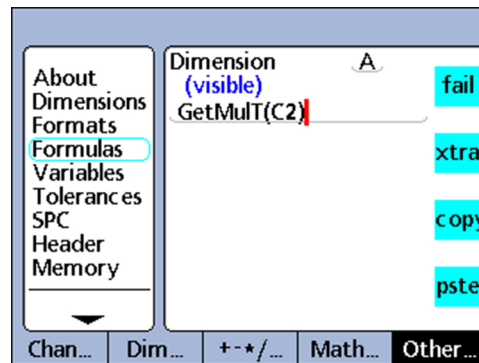
The **GetMult** function is used to read the current position regarding the revolution information of an EnDat multiturn rotary encoder. This position is determined directly from the rotary encoder and can be used to calculate an overall position value (consisting of singleturn and multiturn positions).



The **GetMult** function is only available when an EnDat multiturn rotary encoder is connected.

*Inserting the function*

- ▶ Press the «extra» dimension key.
- ▶ Highlight the **GetMult** function.
- ▶ Press «enter».
- ▶ Use the arrow keys to move the cursor between the parentheses.
- ▶ Press the «Chan...» soft key.
- ▶ Press the dimension key for the input channel of the multiturn rotary encoder.
- ▶ Press «enter».



### Syntax

**GetMult** (channel of multiturn rotary encoder)

*Example*

A = GetMult(C2)

Reads the current position regarding the revolution information from the EnDat multiturn rotary encoder at channel 2.

## 8.6.15 Defining global variables: Global

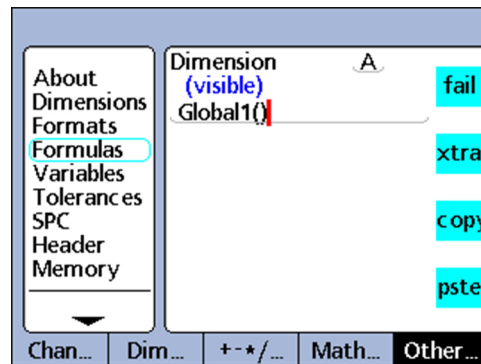
*Application*

The **Global** function is used to create and address global variables. Globals are variables that are available to all parts in the system. For example, a global variable used in part 0 can also be used in part 1, or in any other part.

The **Global** function is identical in use to the **Var** function; for more information see "Defining variables: Var", page 201.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Global** function.
- ▶ Press «enter».
- ▶ Enter the number of the global variable.
- ▶ Enter the value of the global variable.
- ▶ Press «enter».



### Syntax

**Global#(value)**

*Example*

The examples illustrating the use of variables apply accordingly to global variables, see "Defining variables: Var", page 201.



## 8.6.16 Creating function loops: Loop



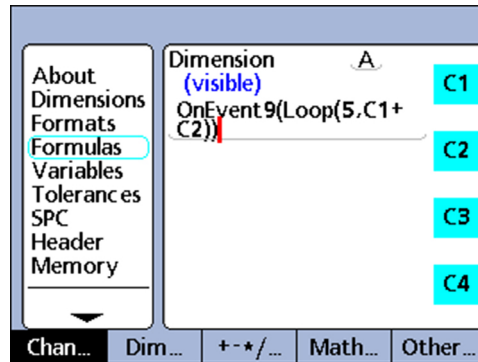
The **Loop** function must be defined within an **OnEvent**, **seq** or other function to prevent the loop from being executed continually at the dimension evaluation rate.

*Application*

The **Loop** function performs an evaluation or operation repeatedly through a specified number of execution loops.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Loop** function.
- ▶ Press «enter».
- ▶ Enter the number of loops, evaluation or operation.
- ▶ Press «enter».



### Syntax

**Loop**(number of loops, evaluation or operation)

*Example*

A = **Loop**(5,C1+C2)

Gets the sum of C1 and C2 five times for every dimension evaluation.

A = OnEvent9(**Loop**(5,C1+C2)

Here, the loop execution is constrained by the **OnEvent** function and will be executed only once when the 9 number key is pressed.

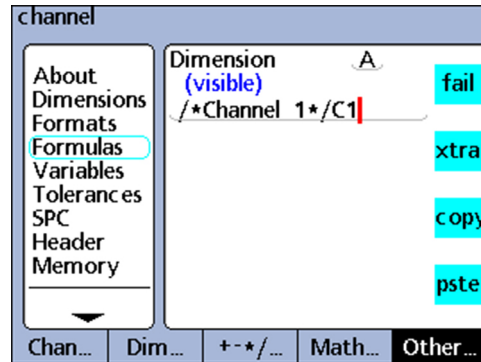
### 8.6.17 Creating comments: Remark

*Application*

The **Remark** function adds a comment to a formula, but does not affect values or operations. The comment can be included before or after the formula operations in visible dimensions, hidden dimensions and custom functions.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Remark** function.
- ▶ Press «enter».
- ▶ Use the Alpha Entry screen to create a comment.
- ▶ Press «finish».



#### Syntax

A = /\***Remark text**\*/formula or formulas/\***Remark text**\*/

## 8.6.18 Sampling minimum and maximum values: HwDmn and HwDmx

*Application*

The **HwDmn** and **HwDmx** functions are largely identical to the **dmn** and **dmx** functions. For more information see "Determining the minimum and maximum of dynamically sampled values: dmn and dmx", page 180.

The only difference from **dmn** and **dmx** is that

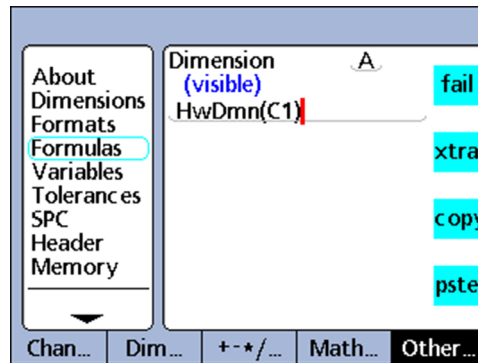
- only channel inputs are sampled and
- the sample rates are very high



The **HwDmn** and **HwDmx** functions can only be used for measuring device input channels and are only available on versions with 1 Vpp, TTL or Solartron Orbit measuring device interfaces.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **HwDmn** or **HwDmx** function.
- ▶ Press «enter».
- ▶ Press the «Chan...» soft key.
- ▶ Press the dimension key for the desired input channel.
- ▶ Press «enter».



### Syntax

A = **HwDmn**(sampled value)

A = **HwDmx**(sampled value)

Assigns the sampled minimum or maximum value to **HwDmn** or **HwDmx**.

A = **HwDmn**(sampled value, second source)

A = **HwDmx**(sampled value, second source)

Assigns the value from the second source when the sampled value is at the minimum or maximum.

## 8.6.19 Clearing minimum and maximum values: RsetDyn

*Application*

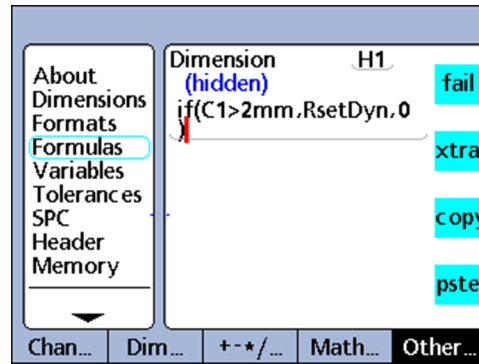
The **RsetDyn** (Reset Dynamic) function clears any existing **dmn** and **dmx** values. This function must be used before assigning values using the **drmn** and **drmx** functions. The left fast track key is the default hot key for the **RsetDyn** function. Pressing this hot key prior to a dynamic measurement will clear all previous minimum and maximum values.

The **RsetDyn** function is also available in the «xtra» menu for manual operation and for inclusion in formulas.

Use of the **RsetDyn** function in formulas must be controlled by **if**, **case** or **OnEvent** functions so that the reset only occurs when desired, and not repeatedly in every evaluation cycle.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **RsetDyn** function.
- ▶ Press «enter».



### Syntax

RsetDyn

## 8.6.20 Assigning a conditional input value: HwLx

*Application*

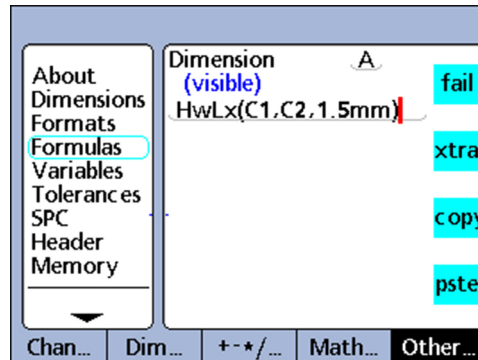
The **HwLx** (Hardware Latch) function is used to assign the value of one channel when a second reference channel reaches a specified value.



This function is only available on versions with 1 Vpp or TTL measuring device interfaces.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **HwLx** function.
- ▶ Press «enter».
- ▶ Enter the target channel, reference channel and value.
- ▶ Press «enter».



### Syntax

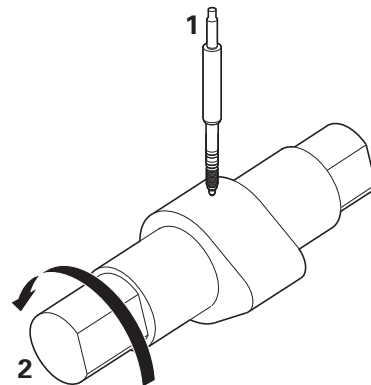
A = **HwLx**(Chan #1, Chan #2, value)

Assigns the value of channel #2 when channel #1 reaches the specified value.

*Example*

A = **HwLx**(C1,C2,1.5mm)

The rotational angle of the cam (C2) will be latched and the value assigned to dimension A when the cam lift (C1) is 1.5 mm.



- 1 C1
- 2 C2

## 8.6.21 Including information in formulas: Lookup and data lookup

### Lookup function

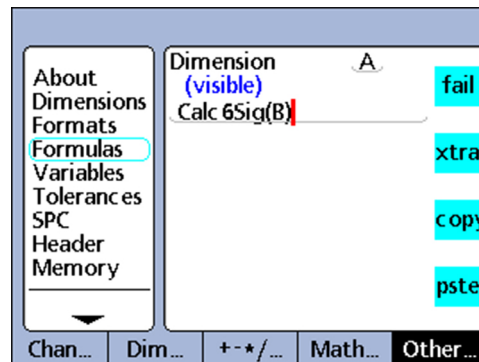
*Application*

The **Lookup** function is used to include SPC data, tolerances, database records and other information in formulas.

The **Lookup** function is combined with **if** and **case** functions to extend the system's tolerance capabilities.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Lookup** function.
- ▶ Press «enter».  
A list of available information options is displayed.
- ▶ Highlight the desired information.
- ▶ Press «enter».
- ▶ Enter parameters.
- ▶ Press «enter».



### Syntax

The syntax of the **Lookup** function depends on the type of information to be included in the formula; see list below.

The following information can be included in formulas using the **Lookup** function:

- **BarMax**: The **Nom + Max** value from the «Tolerances» setup screen
- **BarMin**: The **Nom - Min** value from the «Tolerances» setup screen
- **Calc6Sig**: The **6 Sigma** value from the **Data** view
- **CalcCp**: The **Cp** value from the **Data** view
- **CalcCpk**: The **Cpk** value from the **Data** view
- **CalcMax**: The **Max** value from the **Data** view
- **CalcMean**: The **Mean** value from the **Data** view
- **CalcMin**: The **Min** value from the **Data** view
- **CalcPp**: The **Pp** value from the **Data** view
- **CalcPpk**: The **Ppk** value from the **Data** view
- **CalcR**: The **r** value from the **Data** view
- **CalcRBar**: The **rbar** value from the **Data** view
- **CalcSig**: The sigma value from the **Data** view
- **Datum**: The current datum status 0/1; absolute/incremental

- **HiLimit**: The **Nom + Limit** value from the «Tolerances» setup screen
- **HiWarn**: The **Nom + Warn** value from the «Tolerances» setup screen
- **IsDD, IsDMS**: The current angular unit of measure of the system
- **IsInch, IsMM**: The current linear unit of measure of the system
- **MaxSGrp**: The **Max Subgroups** value from the «SPC» setup screen
- **NextId**: The **Next Record Id** value from the «SPC» setup screen
- **Nominal**: The nominal value from the «Tolerances» setup screen
- **NumRecs**: The number of records stored in the database for the current part
- **LCL**: The **LCL** value from the «SPC» setup screen
- **LoLimit**: The **Nom - Limit** value from the «Tolerances» setup screen
- **LoWarn**: The **Nom - Warn** value from the «Tolerances» setup screen
- **RecDate, RecTime**: The date and time that a specified record was stored in the database
- **RLCL**: The **r Lcl** value from the «SPC» setup screen
- **RUCL**: The **r Ucl** value from the «SPC» setup screen
- **SGrpSize**: The **Subgroup size** value from the «SPC» setup screen
- **UCL**: The **UCL** value from the «SPC» setup screen
- **XBarLCL**: The  $\bar{x}$  **Lcl** value from the «SPC» setup screen
- **XBarUCL**: The  $\bar{x}$  **Ucl** value from the «SPC» setup screen

### Example

A = Calc6Sig(B)

A = 0.0345 when the **6 Sigma** value for dimension B is 0.0345 in the **Data** view.

## Data lookup

### Application

The data lookup function is used to query a value from the database of stored dimension values, and assign it to a dimension or include it as the criterion of a comparison test.



The data lookup function does not appear in any menu and must be constructed of a dimension label and parentheses containing record index and part index. The syntax is shown in the example below.

When no part index is specified, the records of the current part are used. The record elements are numbered in ascending order, starting with element 0 at the top of the list for each dimension.

The most recently stored value is at the top. Value A(2) is the third element from the top of the dimension A list (not the second), as shown below.

List indexes must be positive integers. An index that exceeds the range of a specified list results in an error message.

### Syntax

C = A(record index, part index)

---

## Custom programming

«xtra» menu functions

Example 1

$C = A(2)$   
 $C = 2.314$

10:35.34 AM 12-11-12		mm   0   P0	
#63 2.314			
A	B	C	D
1.822	0.000	0.838	0.052
1.870	0.071	1.207	0.105
2.314	0.071	1.207	0.105
0.798	0.981	0.276	0.996
0.576	0.735	0.106	0.785
0.132	0.366	-0.121	-0.481
0.243	0.489	-0.007	-0.059
0.465	0.735	0.163	0.574
0.576	0.858	0.163	0.785
0.465	0.981	0.106	0.363

Example 2

$C = B(2,3)$   
 $C = 0.858$

10:29.49 AM 12-11-12		mm   0   P3	
#15 1.353			
A	B	C	D
0.798	1.350	0.900	1.207
1.020	1.227	0.616	1.418
1.353	0.858	0.673	0.785
0.873	0.652	0.773	0.840
0.651	0.775	0.659	1.262
0.651	0.283	0.432	0.840
0.651	0.283	0.432	0.840
1.095	0.160	0.206	-0.004
1.095	0.160	0.206	-0.004
0.984	0.283	0.319	0.418

Shows the syntax of a data lookup function that uses record and part indexes. In the formula, the value of the third element of the data stored for dimension B of part 3 is assigned to dimension C.



## 8.6.22 Setting a conditional calibration for input channel groups: Master

### Application

The **Master** function is used to perform a master calibration of input channel groups in response to remote I/O signals on the I/O interface, key presses or, more rarely, evaluations performed in formulas. For remote I/O signals and key presses, the function is implemented using the **OnEvent** function.

The input channel mastering uses values previously entered into master groups.

The **Mean** or **Min-Max** setting specified for the **Master Type** parameter in the «Master» setup screen is also applied automatically. For more information see "Calibrating encoders and transducers: Master", page 100.

If **Mean** is selected, either a Min or a Max channel preset is performed at the current position of the probe. **Min-Max** mastering performs a channel preset followed by a resolution calibration.

Min-Max mastering can be performed in the following order:

- 1 Min preset followed by
- 2 Max to calibrate the resolution

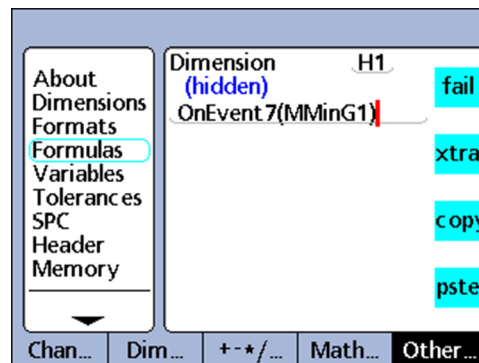
or

- 1 Max preset followed by
- 2 Min to calibrate the resolution

In either case, the **Master Type** parameter should be changed to **Mean** in the «Master» setup screen once the resolution is calibrated to prevent accidental recalibration when a new preset is performed.

### Inserting the function

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Master** function.
- ▶ Press «enter».
- ▶ Press the «Min» or «Max» soft key to set the preset type.
- ▶ Enter the group number.
- ▶ Press the «OK» soft key.



### Syntax

**Master**<preset type><group number>

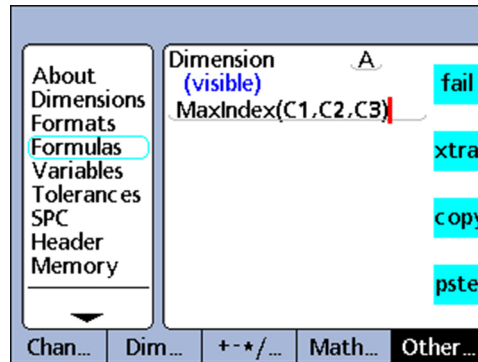
### 8.6.23 Reading the positions of minimum and maximum values: MinIndex and MaxIndex

*Application*

The **MaxIndex** and **MinIndex** functions return the position of either the minimum or maximum value in a list. The list can contain individual values, ranges of values or a mixture of both.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Press «enter».
- ▶ Highlight the **MaxIndex** or **MinIndex** function.
- ▶ Enter values or ranges of values.
- ▶ Press «enter».



#### Syntax

A = **MinIndex**(list of values or ranges)  
 A = **MaxIndex**(list of values or ranges)

*Examples*

Function	Result
A = <b>MaxIndex</b> (12,34,23, <b>67</b> ,13)	A = 4
A = <b>MinIndex</b> (2,45,27,41,56)	A = 1
A = <b>MaxIndex</b> (C1--C4,7,A,6,4)	A = 1 when C1 = 2.0, C2 = 5., C3 = 2.1 C4 = <b>8.2</b> , A = 3.8
A = <b>MinIndex</b> (C1,C2,C3)	A = 2 when C1 = 2.5, C2 = <b>1.5</b> , C3 = 3.7
A = <b>MaxIndex</b> (C1,C2,C3)	A = 3 when C1 = 2.5, C2 = 1.5, C3 = <b>3.7</b>

## 8.6.24 Changing part numbers by using formulas: PartNo

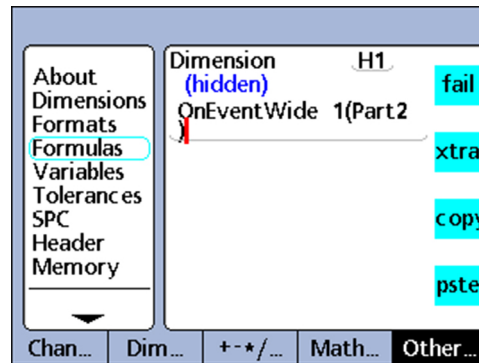
*Application*

The **PartNo** function is used to change part numbers from within a formula.

The database can store up to 16 dimensions for each part. Applications involving more than one physical part or requiring greater than 16 dimensions can use multiple parts to provide additional database capacity.

*Inserting the function*

- ▶ Press the «extra» dimension key.
- ▶ Highlight the **PartNo** function.
- ▶ Press «enter».
- ▶ Enter the part number.
- ▶ Confirm with «OK».
- ▶ Press «enter».



### Syntax

A = Formula;**PartNo**

Assigns the function to a visible dimension.

H1 = **PartNo**

Assigns the function to a hidden dimension.

H1 = Function(**PartNo**)

Assigns the function to a hidden dimension within another function.

*Example 1*

A = C4;**Part2**

A = C4 and changes the current part to part number 2.

*Example 2*

H1 = OnEventWide 1(**Part2**)

Changes the current part to part number 2 when the left fast track key is pressed.

*Example 3*

Users are given access to parts by password:

H2 = ask1"Pass"

The user is prompted for a password:

H3 = Case(H2==1234,**Part1**,H2==5678,**Part2**,**Part3**)

Entering the password **1234** activates part 1.

Entering the password **5678** activates part 2.

Any other password activates part 3.

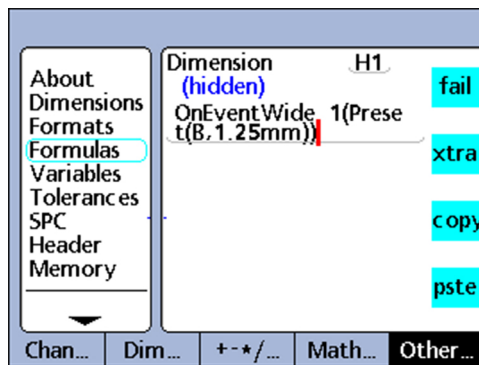
## 8.6.25 Presetting dimension values: Preset

*Application* The **Preset** function presets a dimension to a specified value.  
The dimension may be

- Visible
- Hidden
- Hidden within another function

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Preset** function.
- ▶ Press «enter».
- ▶ If required, enter first the function and then the dimension and value.
- ▶ Press «enter».



### Syntax

A = Formula;**Preset**(dimension,value)

Assigns the function to a visible dimension.

H1 = **Preset**(dimension,value)

Assigns the function to a hidden dimension.

H1 = Function(**Preset**(dimension,value)

Assigns the function to a hidden dimension within another function.

*Example 1* A = C1;**Preset**(B,1.25mm)

A = C1 and dimension B are preset to 1.25 mm

*Example 2* H1 = OnEventWide 1(**Preset**(B,1.25mm))

Presets dimension B to 1.25 mm when the left fast track key is pressed.

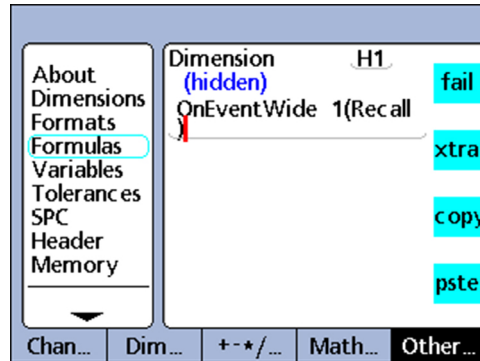
## 8.6.26 Recalling dimension preset values: Recall

*Application*

The **Recall** function is used to recall the last dimension preset value or values specified using the **Preset** function. All dimension presets last applied will be recalled. The **Recall** function is generally included in an **OnEvent**, **if** or **case** function.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Recall** function.
- ▶ Confirm with «enter».
- ▶ Press «enter».



### Syntax

A = Formula;**Recall**

Assigns the function to a visible dimension.

H1 = **Recall**

Assigns the function to a hidden dimension.

H1 = Function(**Recall**)

Assigns the function to a hidden dimension within another function.

*Example 1*

A = C1;**Recall**

A = C1 and all the dimension presets last applied are recalled as current presets.

*Example 2*

H1 = OnEventWide 1(**Recall**)

Recalls the last applied dimension presets when the left fast track key is pressed.

## 8.6.27 Controlling relays by using formulas: Relay

*Application*

The **Relay** function is used to control electrical relays by using formulas.

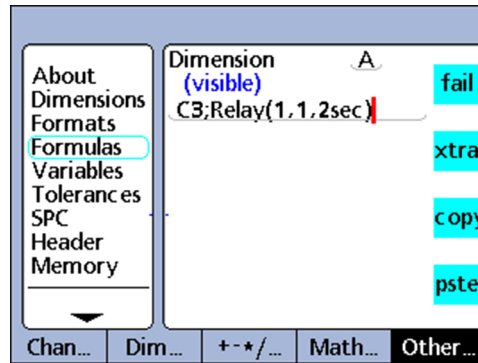
The contacts of two single-pole, double-throw dry-contact relays are accessible on the rear of the unit for special applications requiring low-power electrical switching.

The normally open and normally closed contacts of both relays are available for use in low-current, low-voltage applications; for more information see "Wiring of switching inputs and outputs", page 26.

The **Relay** function can be used by itself or included in **if** or **case** statements as the logical result of either passing or failing a comparison test.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Relay** function.
- ▶ Confirm with «enter».
- ▶ Enter relay number, state and delay.
- ▶ Press «enter».



**Syntax**

**Relay**(relay number, state, delay)

When used within a formula:

A = Formula;**Relay**(relay number, state, delay)

Relay number: 1 or 2

State: 0 (off/low/de-energized) or 1 (on/high/energized).

Delay: The time in seconds that the relay will be in the new state before returning to the previous state.

*Example*

A = C3;**Relay**(1,1,2sec)

A = C3 and relay number 1 will be energized for 2 seconds.

1	2	3	4	5	6	7	8
R-1 COM	R-1 NC	R-1 NO	R-2 NO	R-2 NC	R-2 COM	/	/

For more information on the relay connector, see "Wiring of switching inputs and outputs", page 26.

## 8.6.28 Specifying report contents: Report

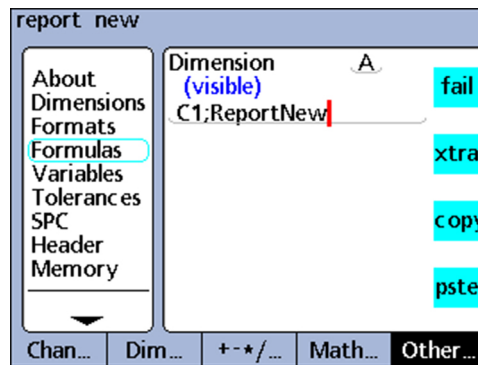
*Application*

The **Report** function is used to print reports on the USB port.

Report contents can include a user-defined range, all new records (never before reported), all records or a record selected in the **Data** view.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Report** function.
- ▶ Press «enter».
- ▶ Press the «Range», «New», «All» or «Selected» soft key to select the desired contents for the report.
- ▶ Only when «Range» is selected:  
Enter the range of records.



**Syntax**

- A = Formula;**Report**  
Assigns the function to a visible dimension.
- H1 = **Report**  
Assigns the function to a hidden dimension.
- H1 = Function(**Report**)  
Assigns the function to a hidden dimension within another function.

*Example 1*

A = C1;**Report**New  
A = C1 and a report of new records is printed.

*Example 2*

H1 = OnEventWide 1(**Report**New)  
Prints a report of new records when the left fast track key is pressed.

## 8.6.29 Setting simultaneous data acquisition from all input channels: Scan

### Application

The **Scan** function rapidly collects potentially large quantities of measurement data from all input channels simultaneously. The function is generally included in another function as an operation to be performed in response to a condition or an event.

When the scanning process is initiated, the data from all input channels is collected and buffered in a series of records. No data is displayed on the **DRO** screen and no formulas are evaluated during the scanning process.

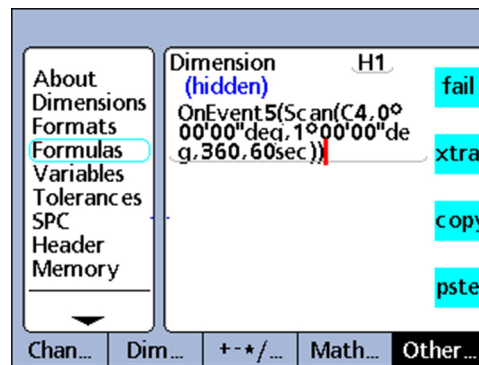


This function is only available on versions with 1 Vpp, TTL or EnDat measuring device interfaces.

The scanning sequence is explained in detail and illustrated in a flowchart in the following section.

### Inserting the function

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Scan** function.
- ▶ Press «enter».
- ▶ Enter the reference channel, starting value, scanning increment, depth of scans and timeout interval.
- ▶ Press «enter».



### Syntax

**Scan** (ch, st, inc, dp, to)

ch (reference channel):

Scans of all channels are collected at predetermined intervals that are measured by the reference channel.

st (starting value):

Scans begin when the reference channel measurement reaches this value.

inc (scanning increment):

A new scan is performed each time the reference channel value increases (or decreases) by this increment value. The scans continue only when the increments progress in the same direction (+ or -) over the scanning cycle.

dp (depth of scans):

Scans are accumulated in a temporary buffer memory until the specified depth (number) of scans has been collected, or until the timeout interval has elapsed.

to (timeout interval):

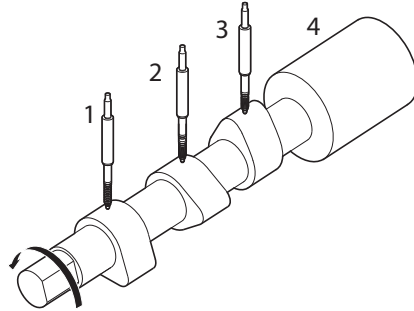
Scanning is aborted if the timeout interval expires before the specified depth of scans has been collected. A **RsetDyn** function must be performed before the **Scan** function can be used again.



### Examples

In the following two examples, camshaft lift profiles are measured at 1 degree intervals over 360 degrees of rotation using a rotary encoder for the reference channel and three touch probes for the cams.

In these examples, the «5» number key is pressed to generate an event that initiates scanning.



- 1 E1
- 2 E2
- 3 E3
- 4 E4

The two examples show different ways to play back the scanned data; however, they both use the **OnEvent** function to route the data.

### Example 1

Scanning and entering data into the database:

```
H1 = OnEvent5(Scan(C4,0Deg,1Deg,360,60sec))
```

```
A = C1
```

```
B = C2
```

```
C = C3
```

```
D = C4
```

```
H2 = OnEventPlayback(Trip(,,))
```

The input channels are scanned and the data is then entered into the database using the **trip** function and a playback event. Scanning is initiated by pressing the «5» number key. 360 scans are then collected at 1 degree increments.

If all the specified scans are not complete within the specified period of 60 seconds, the **Scan** function is aborted by the **60sec** timeout.

During playback, each time a playback event occurs, a record of dimension values is entered into the database.

Example 2

Scanning and transmitting data to the RS-232/V.24 serial port:

H1 = OnEvent5(**Scan**(C4,0Deg,1Deg,360,60sec))

A = C1

B = C2

D = C4

H2 = OnEventPlayback(SendNewRec)

The input channels are scanned and the data is then transmitted to the RS-232/V.24 serial port using the **SendRec** function and a playback event.

Scanning is initiated by pressing the «5» number key. 360 scans are then collected at 1 degree increments.

If all the specified scans are not complete within the specified period of 60 seconds, the **Scan** function is aborted by the **60sec** timeout.

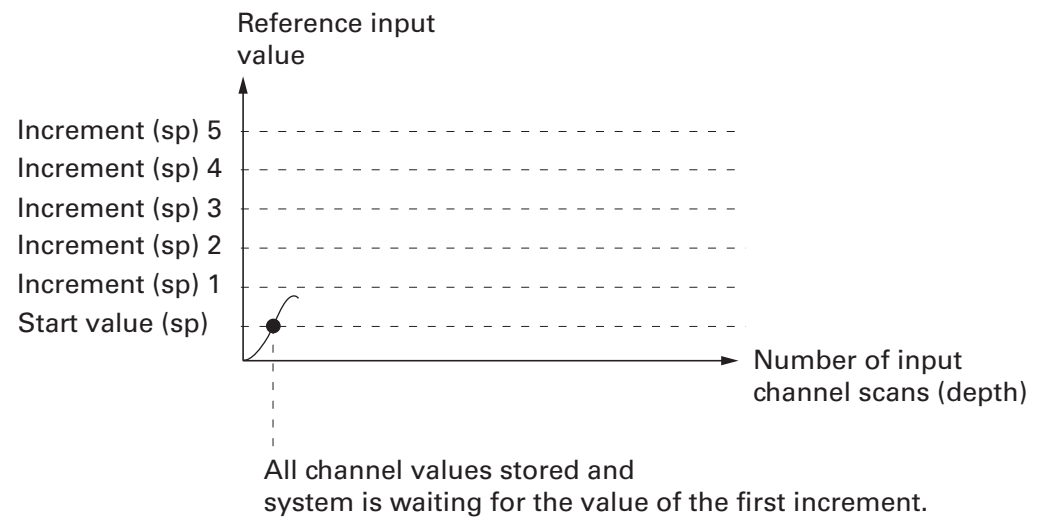
During playback, each time a playback event occurs, a record of dimension values is transmitted to the RS-232/V.24 serial port.

### Scanning sequence

When scanning begins, the reference channel value (ch) is compared to the starting value (st) parameter.

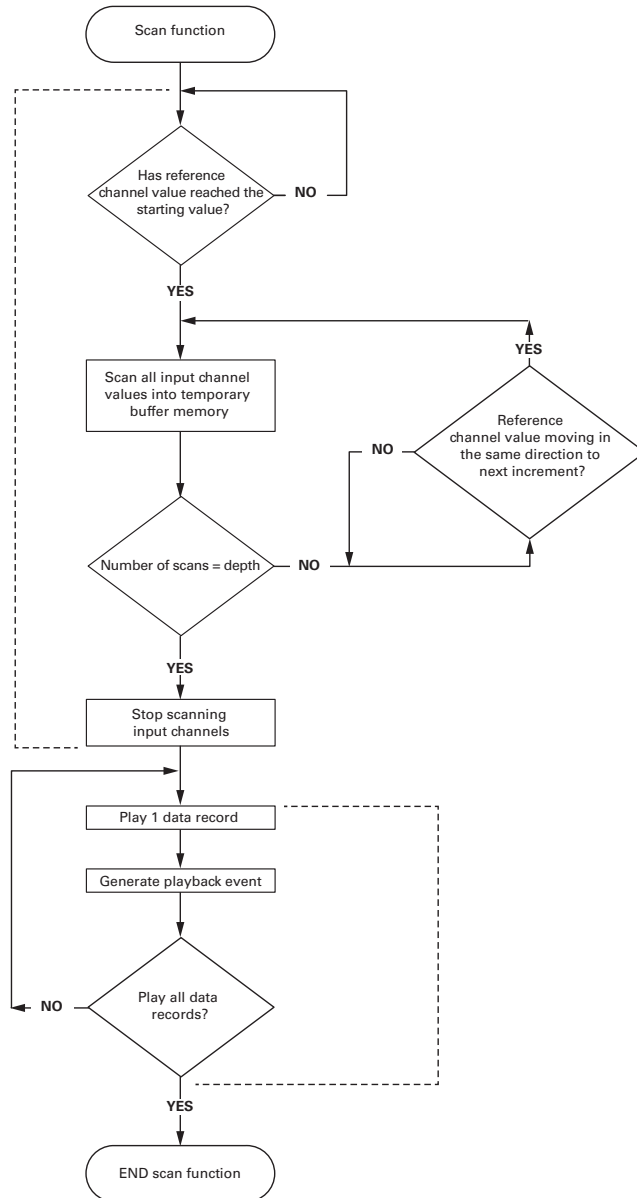
When the reference channel value reaches the starting value, all input channels are scanned once and stored in a temporary memory buffer.

The system then waits for the reference channel value to cross the first increment above (or below) the starting value.



**Scanning**

All input channel values are scanned and buffered. The scanning process is aborted if a timeout occurs before the specified depth of scans has been collected. A **Rset-Dyn** function must be performed before using the **Scan** function.



**Playback**

Records of scanned channel data are played back to the **DRO** screen. A playback event is generated with each record.

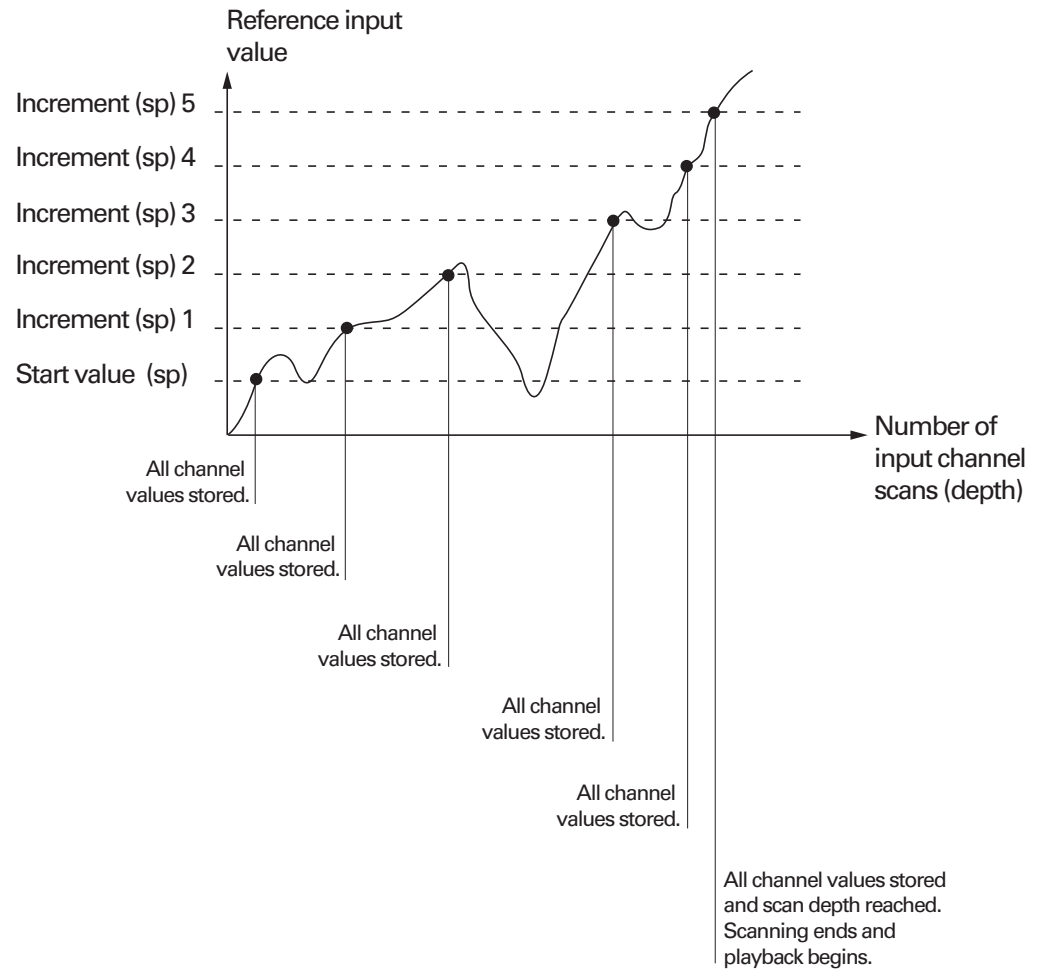
Each time the value of the reference channel increases or decreases by the specified increment (inc), another scan of all input channels is collected and buffered. Input channel scanning continues in this manner at each new increment until the specified depth of scans (dp) is collected.

Reference channel values between increments are irrelevant to the process as long as the values pass through increments in one direction.

The scan function is aborted if the timeout interval (to) elapses before the specified depth of scans is collected.

When the specified depth of scans has been collected, the channel data are immediately played back and displayed on the **DRO** screen in the order they were scanned.

A playback event is generated each time a record is played back. This playback event is used in conjunction with the **OnEvent** function to enter the scanned data into the database, include the data in the formulas or send the data to a computer.



A **RsetDyn** function must be performed to clear the buffer before the **Scan** function can be used again.

## 8.6.30 Transmitting numeric data over the USB or RS-232/V.24 port: Send

*Application*

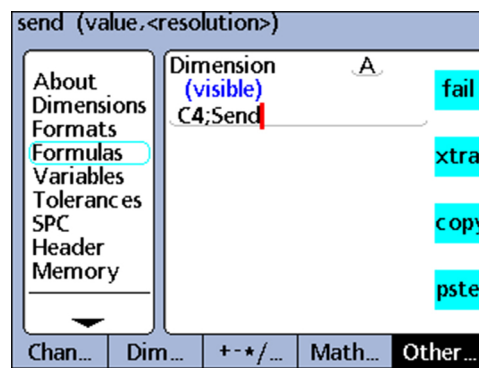
The **Send** function transmits the current value of the formula's dimension or other numeric data over the USB or RS-232/V.24 serial port. Which of the two ports is used depends on the configuration of the respective port.

For more information on configuring the USB port for data transmission, see "Setting the USB port: USB", page 125.

For more information on configuring the serial ports, see "Setting the RS-232 interface: RS232", page 123.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Send** function.
- ▶ Press «enter».



### Syntax

A = Formula;**Send**

Appends the function to a visible dimension formula.

A = Formula;**Send**(number,display resolution)

Extends the syntax of the function to transmit the value of a number (constant) that can be evaluated as a number, and can also include display resolution formatting.

A = Formula;**Send**(expression,display resolution)

Extends the syntax of the function to transmit the value of an expression that can be evaluated as a number, and can also include display resolution formatting.

H1 = **Send**

Assigns the function to a hidden dimension.

H1 = Function(**Send**)

Assigns the function to a hidden dimension within another function.

*Example 1*

A = C4;**Send**

A = C4 and the data of dimension A is transmitted to a port.

*Example 2*

A = C1;**Send**((B+D),0.001)

A = C1 and the value of the expression (B+D) is transmitted to a port with 3 decimal places.

*Example 3*

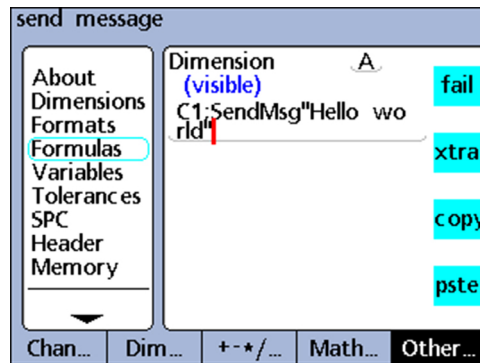
H1 = OnEventWide 1(**Send**)

Transmits data to a port when the left fast track key is pressed.

## 8.6.31 Transmitting text or ASCII code over the RS-232/V.24 port: SendMsg

*Application* The **SendMsg** function transmits text or ASCII code over the RS-232/V.24 port. Text messages and ASCII codes are entered into the Alpha Entry screen.

- Inserting the function*
- ▶ Press the «xtra» dimension key.
  - ▶ Highlight the **SendMsg** function.
  - ▶ Press «enter».
  - ▶ Enter message text.
  - ▶ Press «enter».



### Syntax

A = Formula;**SendMsg**

Appends the function to a visible dimension formula.

H1= **SendMsg**

Assigns the function to a hidden dimension.

H1 = Function(**SendMsg**)

Assigns the function to a hidden dimension within another function.

*Example 1* A = C1;**SendMsg**"Hello world"  
 A = C1 and the message "Hello world" is transmitted to the RS-232/V.24 port.

*Example 2* H1 = OnEventWide 1(**SendMsg**)  
 Transmits a message when the left fast track key is pressed.

### 8.6.32 Transmitting records over the USB or RS-232/V.24 port: SendRec

*Application*

The **SendRec** function is used to send records over the USB or RS-232/V.24 (serial) ports.

The following records can be selected for transmission:

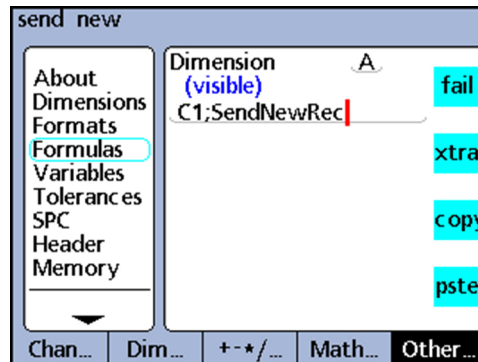
- A user-defined range
- All new records (never before reported)
- All records
- A specified record

For more information on configuring the USB port for data transmission, see "Setting the USB port: USB", page 125.

For more information on configuring the serial ports, see "Setting the RS-232 interface: RS232", page 123.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **SendRec** function.
- ▶ Press «enter».
- ▶ Press the «Range», «New», «All» or «Selected» soft key to select the desired contents for the report.
- ▶ Only when «Range» is selected:  
Enter the range of records.



#### Syntax

A = Formula;**SendRec**

Appends the function to a visible dimension formula.

H1 = **SendRec**

Assigns the function to a hidden dimension.

H1 = Function(**SendRec**)

Assigns the function to a hidden dimension within another function.

*Example 1*

A = C4;**SendRec**

A = C4 and record data is transmitted.

*Example 2*

H1 = OnEventWide 1(**SendRec**)

Transmits record data when the left fast track key is pressed.

### 8.6.33 Setting dimension colors for the DRO screen: SetColor

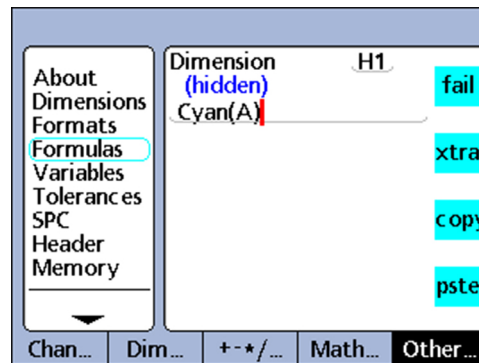
*Application*

The **SetColor** function is used to set the color in which a dimension is displayed on the **DRO** screen. The **SetColor** function only changes colors in the **DRO** screen and has no effect on other screens.

Using this function, the color of a dimension can be changed to highlight the result of an **if** or **case** statement or to emphasize some other state or condition.

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **SetColor** function.
- ▶ Select a color.
- ▶ Press «enter».



#### Syntax

Hn = **SetColor**(dimension)

*Example*

H1 = **SetColor**(A)  
 Select **Cyan** in response to the prompt.  
 H1 = Cyan(A)  
 Dimension A is displayed in cyan on the **DRO** screen.



## 8.6.34 Specifying display parameters for the bar graph: Setup

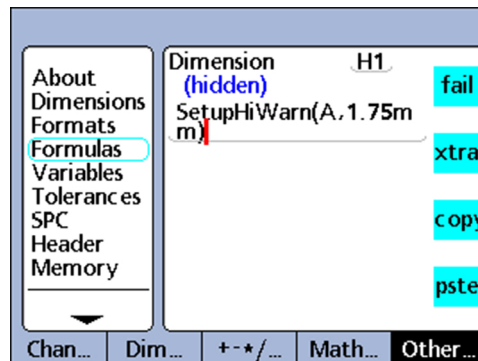
*Application*

The **Setup** function is used to specify bar graph parameters for the current part. The following display parameters are available:

- Maximum value (**BarMax**)
- Minimum value (**BarMin**)
- High limit (**HiLimit**)
- High warning (**HiWarn**)
- Low limit (**LoLimit**)
- Low warning (**LoWarn**)
- Nominal value (**Nominal**)

*Inserting the function*

- ▶ Press the «xtra» dimension key.
- ▶ Highlight the **Setup** function.
- ▶ Press «enter».  
The list of parameters is displayed.
- ▶ Highlight the desired parameter.
- ▶ Press «enter».
- ▶ Enter the dimension and value.
- ▶ Press «enter».



### Syntax

Hn = **Setup**Parameter(dimension,value)

*Example*

H1 = **Setup**HiWarn(A,1.75mm)  
 H1 = **Setup**HiWarn(B,2.00mm)  
 H1 = **Setup**HiWarn(C,2.25mm)  
 H1 = **Setup**HiWarn(D,2.50mm)

Sets the high warning parameters for the bar graph to different values for dimensions A to D.

# 9 Measurement, review, output of results

## Personnel requirement



The following steps can be performed by a user!  
For more information see "Personnel qualification", page 10.

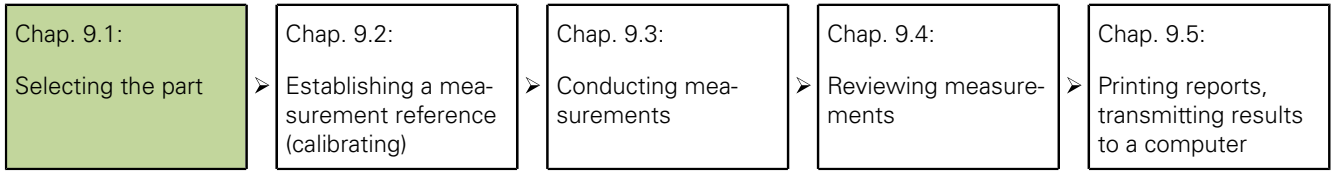
This chapter describes the basic operation of the unit for conducting and reviewing measurements and for the output of measurement results.



Measurement steps and the resulting data collected depend entirely on setup parameters and dimension formulas defined to satisfy a specific application.  
Examples used in this chapter use touch probes to emphasize concepts. However, the concepts apply accordingly to any other measuring devices.

Chap. 9.1: Selecting the part	Chap. 9.2: Establishing a measurement reference (calibrating)	Chap. 9.3: Conducting measurements	Chap. 9.4: Reviewing measurements	Chap. 9.5: Printing reports, transmitting results to a computer
Specifying the part number	Absolute datum (D0) <ul style="list-style-type: none"> <li>■ Hard stop zero</li> <li>■ Datum setting</li> <li>■ Datum and range calibration</li> </ul> Incremental datum (D1) <ul style="list-style-type: none"> <li>■ Zero datum</li> <li>■ Preset datum</li> </ul>	Manual: <ul style="list-style-type: none"> <li>■ Probe + «enter»</li> </ul> Sequence: <ul style="list-style-type: none"> <li>■ Series of probe + «enter»</li> </ul> Dynamic: <ul style="list-style-type: none"> <li>■ Probe samples + «enter»</li> </ul> Semi-automated: <ul style="list-style-type: none"> <li>■ Probe + auto-matic «enter»</li> </ul>	SPC subgroups = 1 <ul style="list-style-type: none"> <li>■ Dimension graphs</li> </ul> Histograms <ul style="list-style-type: none"> <li>■ Dimension data tables</li> <li>■ SPC data</li> </ul> SPC subgroups > 1 <ul style="list-style-type: none"> <li>■ x charts</li> <li>■ r charts</li> <li>■ Dimension data tables</li> <li>■ SPC data</li> </ul>	Printing reports Transmitting data to a computer Clearing measurement data and calibrations

### 9.1 Selecting the part

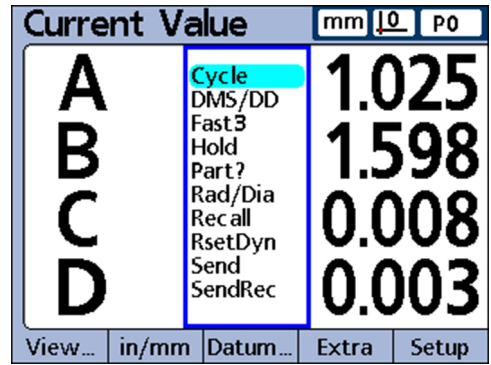
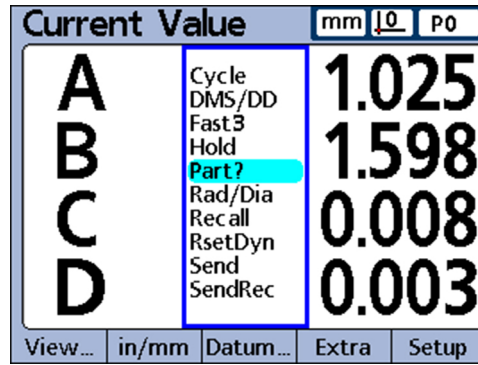


Prior to conducting measurements, the desired part must be selected by entering its part number.

100 part configurations can be stored in the unit. Each part configuration includes all the unit's settings and all dimension formulas required to conduct measurements and report results for the part.

Selecting the part

- ▶ Press the «Menu/Extra» soft keys.
- ▶ Use the arrow keys to highlight the **Part?** or **Cycle** function.
- ▶ Press «enter».



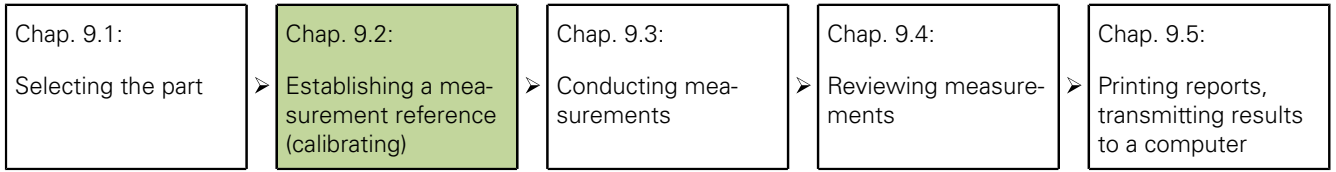
If **Part?** was highlighted, you will be prompted for a part number.

- ▶ Use the numeric keypad to enter the part number.
- ▶ Press «finish».

If **Cycle** was highlighted, the part number will be incremented.

- ▶ Continue incrementing to select the desired part number.

## 9.2 Establishing a measurement reference (calibrating)



A measurement reference point should be established prior to conducting measurements. Measurement references can be established by calibrating input channels or presetting dimensions.



An input channel calibration is applied to any parts that use that input channel in a formula. For example, a calibration performed for channel 1 and part number 0 will also apply to any other parts using channel 1.

### Input channel calibration using the Master function

Input channel calibrations are performed using the «Master» function.

- A single-point calibration defines the reference value of the absolute datum (D0) of an input channel
- A full calibration defines the reference value of the absolute datum and the resolution of the input channel

#### Single-point calibration

Encoders have fixed resolutions based on etched scales or other permanent device characteristics. Therefore, only a single point is usually calibrated to define a reference position.

#### Full calibration

Transducers such as LVDT and half-bridge devices (HBT) do not have fixed resolutions. The use of these devices requires calibrating both ends of the transducer range of measurement to derive transducer resolution. Once a full calibration has been performed, single-point calibrations can be performed as required to define new measurement reference positions.

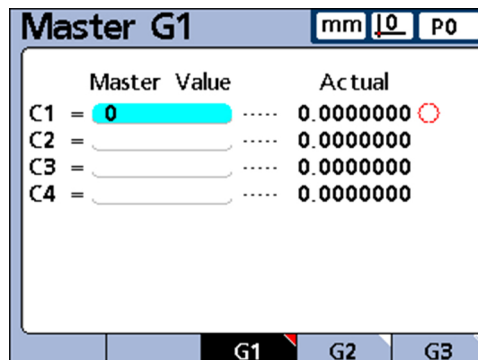
### Calibration of a single reference point

A single measurement reference point can be calibrated for encoders and fully calibrated transducers.



The **Master Type** parameter should be set to **Mean** in the «Master» setup screen to perform a calibration of a single point; see "Calibrating encoders and transducers: Master", page 100.

- ▶ Press the «Master» soft key.
- ▶ Use the arrow keys to select the desired input channel.

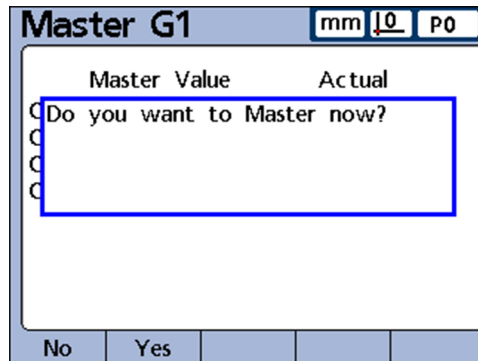


Channel 1 selected. Reference value of 0.

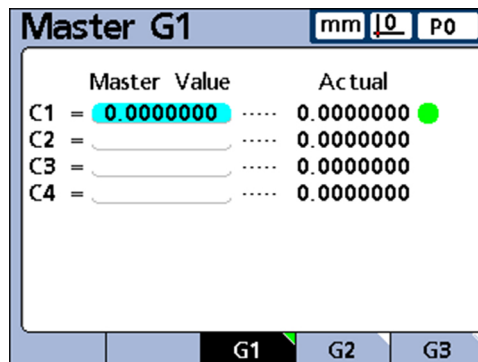
## Measurement, review, output of results

Establishing a measurement reference (calibrating)

- ▶ Position the probe against the reference surface.
- ▶ Use the numeric keypad to enter the reference value (zero or the desired offset) into the **Master Value** field.
- ▶ Press «enter».



- ▶ Press the «Yes» soft key to confirm the calibration of the measurement reference point.



Channel 1 is calibrated. A green dot appears next to the actual value, indicating that the reference point is calibrated.

All other reference points are set in the same way.

### 9.2.1 Calibration groups (G1, G2, G3...G18)

All calibration values shown on the screen are simultaneously applied when the reference points are confirmed.

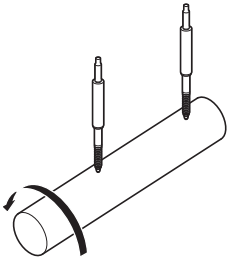
While this is acceptable in most cases, some applications require entering a series of calibrations at different times.

*Example: Calibrating 2 points on a rod (G1)*

When measuring runout at two points on a rod, both channels are measuring a common surface and can be calibrated simultaneously.

In this example, both channels are calibrated to zero on the rod surface in calibration group **G1**.

Completed calibrations are indicated by green dots at the right of the respective channel values:



Master G1		mm	10	P0
	Master Value		Actual	
C1 =	0.0000000	.....	0.0000000	●
C2 =	0.0000000	.....	0.0000000	●
C3 =		.....	0.0000000	
C4 =		.....	0.0000000	

G1   G2   G3

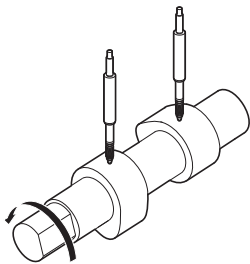
Example: Calibrating offset cams (G1, G2)

When measuring the low and high lifts of two offset cams, it is not possible to calibrate the two cams to zero in a single calibration group.

In this case, first one channel (C1) must be calibrated to zero on the low surface of the first cam. This calibration is performed in calibration group G1.

The camshaft is then rotated by 90° and the other channel (C2) is calibrated to zero on the low surface of the second cam. This calibration is performed in calibration group G2.

By performing the calibrations for the two cams in different groups, the calibrations are made independent. Completed calibrations are indicated by green dots at the right of the respective channel values:



Master G1		mm	10	P0
	Master Value		Actual	
C1 =	0.0000000	.....	0.0000000	●
C2 =		.....	0.0000000	
C3 =		.....	0.0000000	
C4 =		.....	0.0000000	

G1   G2   G3

Master G2		mm	10	P0
	Master Value		Actual	
C1 =		.....	0.0000000	●
C2 =	0.0000000	.....	0.0000000	●
C3 =		.....	0.0000000	
C4 =		.....	0.0000000	

G1   G2   G3

### 9.2.2 Calibration of transducer resolution (Min-Max calibration)

Transducers such as LVDT and HBT devices do not have fixed resolutions based on etched scales or other permanent device characteristics.

The use of these devices requires calibrating both ends of the transducer range of measurement to derive transducer resolution.

Full transducer calibrations are performed periodically using the «Master» function; the calibration schedule required depends on the application.

Full calibrations are performed only after performing the transducer **Gain** and **Zero** setup steps, see "Clearing input channel calibrations", page 238.



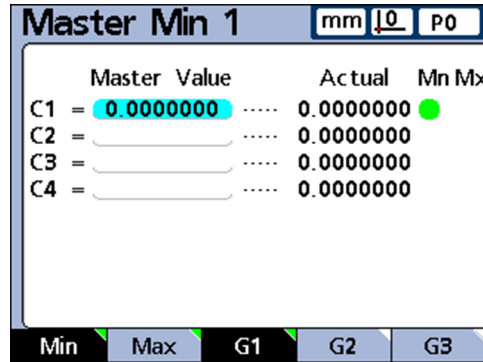
The **Master Type** parameter should be set to **Mean** in the «Master» setup screen to perform a calibration of a single point. For more information see "Calibrating encoders and transducers: Master", page 100.

## Performing a full transducer calibration

*Calibrating the low end of the range*

- ▶ Press the «Master» soft key.
- ▶ Press the «Min» soft key.  
The **Master Min** screen is displayed.
- ▶ Use the arrow keys to select the desired channel.
- ▶ Press the «G1, G2...G18» soft key to select a group to store the calibration data in, see "Calibration groups (G1, G2, G3...G18)", page 233.
- ▶ Position the transducer connected to that channel against the reference surface for the low end of the measurement range.
- ▶ Use the numeric keypad to enter the Min reference value into the **Master Value** column for the channel.
- ▶ Press «enter».
- ▶ Press the «Yes» soft key to set the **Min** value or offset the absolute datum (D0) for the channel.

This calibrates the low end of the channel measurement range. A green dot is displayed in the **Mn** column at the right of the actual channel value.



## Measurement, review, output of results

Establishing a measurement reference (calibrating)

*Calibrating the high end of the range*

- ▶ Press the «Max» soft key.
- ▶ Use the arrow keys to select the same channel as in the previous step if necessary.
- ▶ Position the transducer connected to that channel against the reference surface for the high end of the measurement range.
- ▶ Use the numeric keypad to enter the Max reference value into the **Master Value** column for the channel.
- ▶ Press «enter».
- ▶ Press the «Yes» soft key to confirm the calibration of the **Max** value for the channel.

This calibrates the high end of the channel measurement range. A green dot is displayed in the **Mx** column at the right of the actual channel value.

	Master Value	Actual	Mn	Mx
C1 =	2.0000000	2.0000000	●	●
C2 =		0.0000000		
C3 =		0.0000000		
C4 =		0.0000000		

Min Max G1 G2 G3

### 9.2.3 Establishing a temporary dimension reference (preset)

Establishing a temporary dimension reference is useful when quick point-to-point measurements are desired.

The temporary reference is only applied to the associated dimension, and only to the current part.

For example, a temporary reference established for dimension A and part number 0 will not apply to any dimensions or to any other parts that might include their own dimension A.

Temporary dimension references can be established for encoders and transducers. Since only one point is used as a reference, transducer resolution remains unchanged.

Dimension references can be zeroed or preset to specific values.

#### Zeroing a dimension reference

Dimensions can be zeroed at any time using the «Datum/Zero» function.

A zero reference set with this function acts as a temporary zero point because it uses the incremental datum D1, and has no effect on the absolute datum D0.

*Zeroing a dimension*

- ▶ Press the «Menu/Datum» soft keys.
- ▶ Press the «Zero...» soft key.
  - The soft-key row changes to display the functions for zeroing specific available dimensions or all dimensions.
  - If there are more dimensions defined than soft keys:
    - ▶ Use the «left» or «right» arrow keys to scroll through dimensions.
    - ▶ Press the desired soft key, e.g. «Zero A».



## Measurement, review, output of results

Establishing a measurement reference (calibrating)

Dimension A before zeroing (left) and after zeroing (right)

Current Value		mm	1.0	P0
A	1.993			
B	0.926			
C	-0.162			
D	0.421			
Zero All	Zero A	Zero B	Zero C	Zero D

Current Value		mm	1.1	P0
A	0.000			
B	0.926			
C	-0.162			
D	0.421			
Zero All	Zero A	Zero B	Zero C	Zero D

## Presetting a dimension reference to a specific value

Dimensions can be preset to a user-defined value as the reference point by using the «Datum/Preset» function.

The reference point is temporary in the sense that it uses the incremental datum D1, and has no effect on the absolute datum D0.

Defining a preset

- ▶ Press the «Menu/Datum» soft keys.
- ▶ Press the «Preset» soft key.

The **Preset dimension** screen is displayed.

Select dimensions	mm	1.1	P0
A			
B			
C			
D			
			w/Nom

- ▶ Press the dimension key for the desired input channel.  
A field for entering the reference value for the selected dimension is displayed.
- ▶ Use the numeric keypad to enter the reference value (preset) for the new reference point.

Preset dimension.	mm	1.1	P0
A			
B			
C			
D			
			w/Nom

Preset dimension.	mm	1.1	P0
A			
B			
C			
D	0.25		
			w/Nom



If desired, the new reference value preset here can be applied directly as the nominal value in the «Tolerances» setup screen (see "Defining tolerance values: Tolerances", page 74):

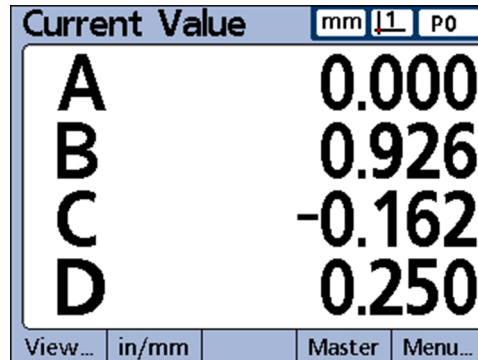
- ▶ Press the «w/Nom» soft key.

## Measurement, review, output of results

Establishing a measurement reference (calibrating)

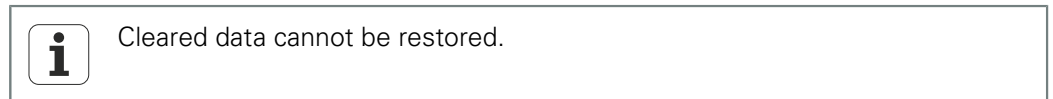
- ▶ Press the dimension key for the next input channel and enter a value.
- ▶ Press «enter» to confirm the preset values and exit the screen.

This sets the reference point to a user-defined value.



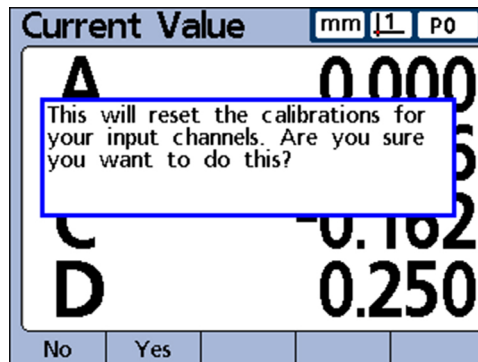
## Clearing input channel calibrations

The reference calibrations and full calibrations of all parts, which were set in the **Master** screen opened with the «Master» soft key, as well as all full calibrations can be cleared.



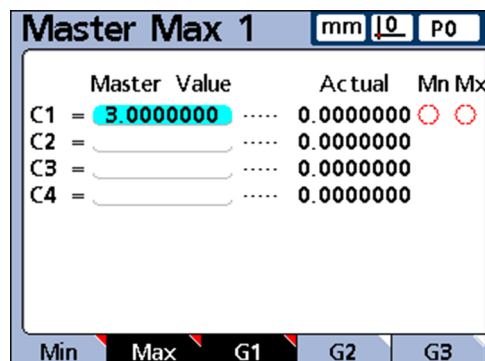
### Clearing calibrations

- ▶ Press the «LCD on/off» key.  
The soft-key row provides different deletion options:  
«Clr Part» - Clears all the records of the part  
«Clr All» - Clears all the records of all parts  
«Clr Cal» - Clears calibrations
- ▶ Press the «Clr Cal» soft key.



- ▶ Press the «Yes» soft key to confirm clearing the calibration of parts.

Cleared values are indicated by circles at the right of the screen.





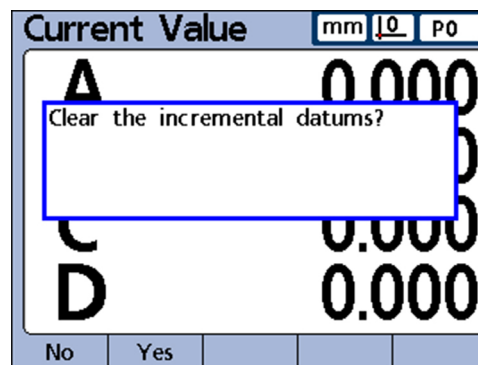
The values will be retained in the data fields of the **Master** screen and can be reactivated at any time.

### Clearing dimension references (presets)

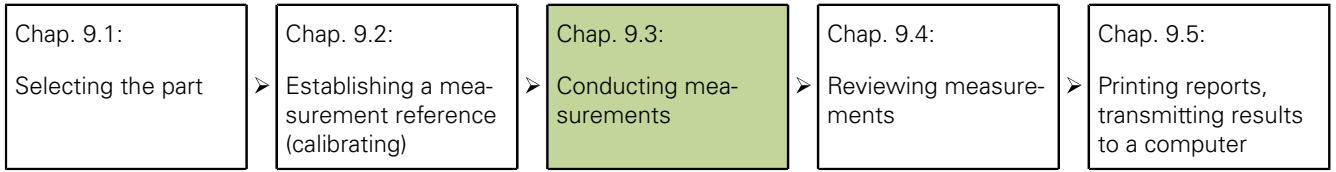
Dimension references (presets) can be cleared at any time. D0 becomes the new reference point after clearing.

- ▶ Press the «Menu/Datum» soft keys.
- ▶ Press the «Clear» soft key.
- ▶ Press the «Yes» soft key to confirm clearing.

D0 is the new reference point.



### 9.3 Conducting measurements



*Measurement types*

Once a part number is selected and a reference point is established, measurements can be conducted.

Measurements can:

- Be conducted manually, completely under the control of the user
- Follow a predetermined sequence of measurement steps shown on the screen
- Be based on dynamic samples of changing input data
- Be semi-automated to increase the throughput of repetitive measurements

*Requirements*

**i** The unit must be configured by a **setup specialist** (qualification: qualified personnel; see "Personnel qualification", page 10) using the «Master» setup screen.

The setup specialist then uses the «Formulas» setup screen to construct the required formulas for defining the dimensions. For more information see "Custom programming", page 142.

Once the unit is configured and the dimension formulas are constructed, measurement instructions are usually given to the **user** that reflect the specific measurement requirements and measuring device setup.

*Output of measurement data*

Measurement data can be:

- Displayed as current values, in graphs or in data tables using the screens described earlier in this manual.  
For more information see "View function", page 36
- Printed or transmitted to a computer. For more information see "Printing reports, transmitting results to a computer", page 244

### Conducting manual measurements

Manual measurements are performed completely under the control of a user.

- ▶ Probe a single point with one measuring device, or multiple points simultaneously with multiple measuring devices.
- ▶ When the measurement data is displayed on the LCD, press «enter» to store the data.

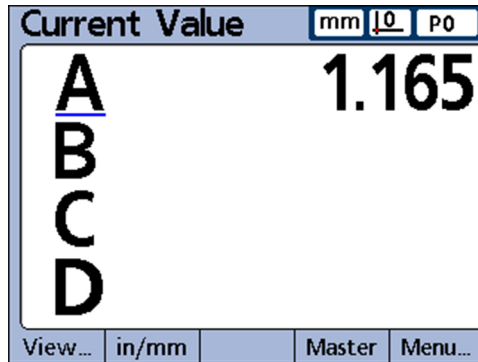
### Conducting measurement sequences

The unit can be configured in the «Formulas» setup screen to direct the user through a sequence of predetermined measurement steps.

Typically a setup specialist (qualification: qualified personnel) will provide instructions describing how to conduct the measurements. However, the operation of the unit is essentially the same for all measurement sequences.

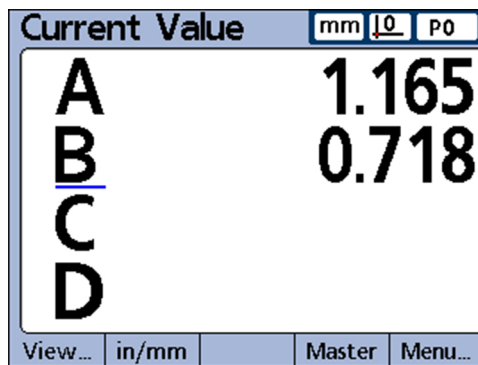
*Conducting a measurement sequence*

- ▶ Probe the dimension underlined on the **DRO** screen.



- ▶ Press «enter» to store the data.

The underline will advance to highlight the next dimension in the measurement sequence.



- ▶ Continue probing the dimensions in the sequence indicated by the underline on the LCD.
- ▶ Press «enter» each time a dimension was probed.

When all the measurements specified for the part have been completed, the underline will return to the first dimension in the measurement sequence to indicate the beginning of a new sequence.

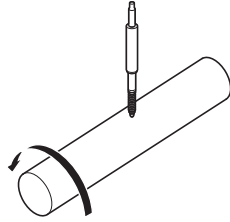
## Conducting dynamic measurements

The unit can be configured in the «Formulas» setup screen to sample input channels and retain the minimum and maximum values of all samples for each channel.

Typically a setup specialist (qualification: qualified personnel) specifies dynamic measurements to evaluate rotational or curved surfaces and will provide instructions describing how to conduct the measurements. However, the operation of the unit is essentially the same for all dynamic measurements.

*Example: Runout of a shaft*

In the example shown here, the runout of a shaft is measured. The minimum and maximum values are sampled as the shaft is turned.



*Conducting a dynamic measurement*

- ▶ Press the left fast track key (factory default),  
or
- ▶ Highlight the **RsetDyn** entry in the «Extra» menu.
- ▶ Press «enter» to clear the data from previous dynamic measurements before starting a new measurement.
- ▶ Position the probe(s) against the surface to be measured.
- ▶ Rotate or move the shaft slowly while observing the resulting dimension values on the LCD.



The sampling rate for LVDT, HBT (half-bridge) and serial transducers will be slower than for encoders. If these transducers are connected, the part must be rotated or moved slowly to ensure that all points on the surface are sampled.

- ▶ Repeat the rotation or movement until the dimension values that reflect minimum or maximum values no longer change.
- ▶ Press «enter» to store the measurement data.

## Conducting semi-automated measurements

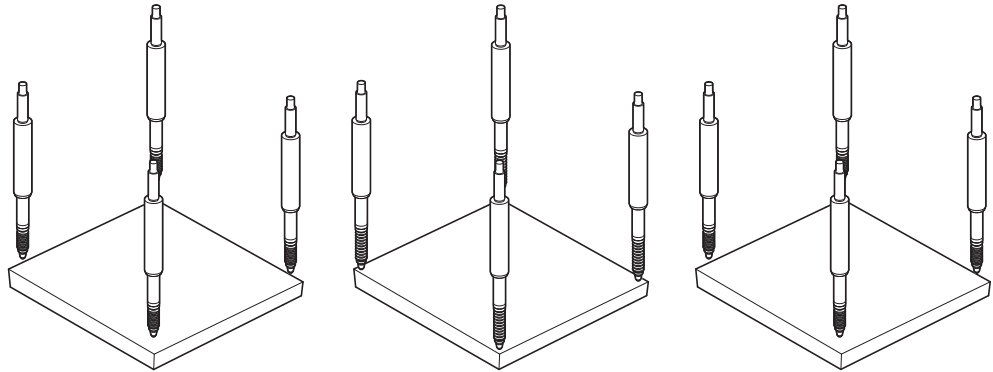


The instructions for performing semi-automated measurements depend entirely on the setup of the measurement application and equipment. Therefore, the instructions must be provided by the setup specialist (qualification: qualified personnel). For more information see "Measurement automation: trip function", page 178.

Normally, measurements shown on the **DRO** screen are not stored in the database until the user presses «enter». However, the unit can be configured in the «Formulas» setup screen to perform and store measurements automatically when the measuring device is loaded with a new part.

*Example:  
Measurement of the  
flatness of a sheet*

In the example shown here, the flatness of a sheet is measured:



Part is loaded:  
Input channels are ready

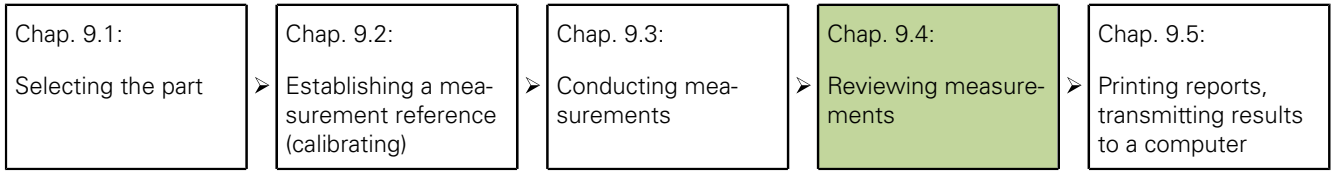
The probes of the input channels are lowered to touch the measured object. Measurement is performed

Part is unloaded: Input channels are reset

The measurement is performed and entered into the database a short time after the probes of the input channels have been lowered until touching the surface of the sheet.

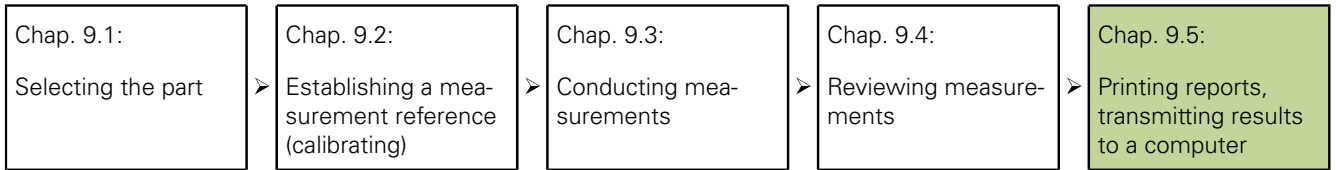
The channels are reset for a new measurement when the probes are retracted. Typically, a setup specialist (qualification: qualified personnel) specifies semi-automated measurements to increase the throughput of repetitive measurements, and will provide instructions describing how to conduct the measurements, and load and unload the measuring device.

## 9.4 Reviewing measurements



Measurement results can be reviewed in graphs or in data tables using the views described earlier in this manual. For more information see "View function", page 36.

## 9.5 Printing reports, transmitting results to a computer



Measurement data can be printed or transmitted to a computer.

The report and data transmission formats are described in the respective sections of the following setup screens:

- "Creating header labels and user prompts: Header", page 86
- "Setting the print format and report contents: Report", page 114
- "Selecting fields for record transmission: Send", page 119
- "Setting the I/O interface: Parallel", page 122
- "Setting the RS-232 interface: RS232", page 123

### Printing reports

Reports of current dimension values, stored measurement results or setup parameters can be printed.

- ▶ Display the desired view.
- ▶ Press «Send».

In some cases, a prompt to enter additional information will be displayed.



### Transmitting data to a computer

Current dimension values or a collection of stored dimension measurement results can be transmitted to a computer.

*Transmitting current dimension values*

- ▶ Display the desired view.
- ▶ Press the «Menu/Extra» soft keys.
- ▶ Use the «up/down» arrow keys to highlight the **Send** entry.

The screenshot shows a screen titled 'Current Value' with a unit of 'mm' and a decimal point set to '0'. The screen is divided into four columns: 'A', 'B', 'C', and 'D'. Each column contains a list of options and a numerical value. The 'Send' option in the 'D' column is highlighted in cyan. At the bottom, there are five soft keys: 'View...', 'in/mm', 'Datum...', 'Extra', and 'Setup'.

		mm	0	P0
A	Cycle	1.165		
	DMS/DD			
B	Fast3	0.718		
	Hold			
C	Part?	0.000		
	Rad/Dia			
	Recall			
	RsetDyn			
	Send			
D	SendRec	0.000		

- ▶ Press «enter».

*Transmitting stored measurement results*

- ▶ Display the desired view.
- ▶ Press the «Menu/Extra» soft keys.
- ▶ Use the «up/down» arrow keys to highlight the **SendRec** entry.

The screenshot shows the same 'Current Value' screen as above, but now the 'SendRec' option in the 'D' column is highlighted in cyan. The 'Send' option is no longer highlighted.

		mm	0	P0
A	Cycle	1.165		
	DMS/DD			
B	Fast3	0.718		
	Hold			
C	Part?	0.000		
	Rad/Dia			
	Recall			
	RsetDyn			
	Send			
	SendRec	0.000		

- ▶ Press «enter».

## Measurement, review, output of results

Printing reports, transmitting results to a computer

### Data reports

Report type	View	Press key / Action
Current dimension values (numeric display)	<b>DRO</b>	«Send»
Line graphs of dimension values (SPC subgroups = 1)	<b>Graph...</b>	«Send»
Histograms of dimension values (SPC subgroups = 1)	<b>Histo...</b>	«Send»
$\bar{x}$ chart of subgroup mean values (SPC subgroups > 1)	<b><math>\bar{x}</math>chart</b>	«Send»
r chart of subgroup range values (SPC subgroups > 1)	<b>r chart</b>	«Send»
Current dimension values (bar graph)	<b>Bar...</b>	«Send»
Current dimension values (dial graph)	<b>Dial...</b>	<ul style="list-style-type: none"> <li>■ «Send»</li> <li>■ Respond to prompt</li> </ul>
Table of data from multiple dimensions	<b>Data...</b>	<ul style="list-style-type: none"> <li>■ «Send»</li> <li>■ Respond to prompt</li> </ul>
Table of data from single dimension	<b>Data...</b>	<ul style="list-style-type: none"> <li>■ Press dimension key for desired dimension</li> <li>■ «Send»</li> <li>■ Respond to prompt</li> </ul>

# 10 Maintenance



This chapter contains a description of maintenance work for the product only. For a description of maintenance work for peripheral devices, please refer to the documentation of the peripheral concerned.

## 10.1 Cleaning

### NOTICE

- ▶ Never use abrasive cleaners, and never use strong detergents or solvents.
- ▶ Never use a cleaning cloth that is dripping wet.

- ▶ Use only a cloth dampened with water and a mild detergent for cleaning the exterior surfaces.

## 10.2 Maintenance schedule

The product is largely maintenance-free.

### NOTICE ANSI

Operating defective products  
 Operating defective products may result in serious consequential damage.

- ▶ Do not operate or repair the product if damaged
- ▶ Replace defective products immediately or contact a HEIDENHAIN service agency

### Personnel requirement



Die nachfolgenden Schritte dürfen nur durch eine Elektrofachkraft durchgeführt werden!

Weitere Informationen see "Personnel qualification", page 10.

Maintenance step	Interval	Corrective action
▶ Check all labels and symbols provided on the product for readability	Annually	▶ Contact HEIDENHAIN service agency
▶ Inspect electrical connections for damage and check their function	Annually	▶ Replace defective cables. Contact HEIDENHAIN service agency if required
▶ Check power cables for faulty insulation and weak points	Annually	▶ Replace power cables according to the specification

## 10.3 Replacing the fuse



The following steps are only to be performed by electrical specialists!  
For more information, see "Personnel qualification", page 10.



### WARNING

Risk of electric shock!

When replacing the fuse, there is a possibility of coming into contact with dangerous live components.

- ▶ Switch off the unit.
- ▶ Disconnect the power cable from the power supply.

### NOTICE

To prevent damage to the product, only the fuses given in the "Specifications", page 261 must be used!

#### *Replacing the fuse*

- ▶ Turn the power switch off.
- ▶ Disconnect the power cable from the power source.
- ▶ Push the locking tabs on the fuse holder until they disengage. For information on the location of the fuse holder on the rear panel, see "Product overview", page 19.
- ▶ Remove the fuse holder and replace the fuse.
- ▶ Re-insert the fuse holder and push in gently until the locking tabs re-engage.

# 11 What to do if ...

## 11.1 Malfunctions

### Personnel requirement



The following steps are only to be performed by the personnel indicated in the table below!

For more information see "Personnel qualification", page 10.

If faults or malfunctions that are not listed in the table below occur during operation, a HEIDENHAIN service agency must be contacted.

Examples:

- The unit has been dropped or the exterior has been damaged
- Liquid has got into the housing
- The power cable is damaged
- The connector is damaged
- The unit is not functioning properly for unknown reasons and needs to be repaired

Error	Error source	Error correction	Personnel for corrective action
Instead of numbers, bars are displayed across the screen	Malfunction or failure of the connected measuring device	▶ Inspect the measuring device and/or contact a service agency of the measuring device manufacturer.	Qualified personnel
	Electrical noise at the measuring device input	▶ Check the condition of the unit's connection to ground and ensure that it is connected to the central grounding point of the power supply system.	Electrical specialist
		▶ Ensure that the cable connecting the measuring device is shielded and connected to the ground connection of the unit. For information on the location of the ground connection, see "Rear panel", page 19.	Electrical specialist
	Specified traversing speed exceeded	▶ Check the «Slew Limit» setting and adjust it, if possible for the application.	Qualified personnel
Instead of numbers, blank spaces are displayed across the screen. <b>DRO</b> screen is empty	Measuring device incorrectly connected	▶ Correct the connection or contact a service agency of the measuring device manufacturer.	Qualified personnel
	Permissible measuring device input frequency exceeded	▶ Reduce the traversing speed, check the connected measuring devices.	Qualified personnel
The LCD remains dark after switch-on	No voltage supply	▶ Check line fuses and power cable.	Electrical specialist
	Unit is not functioning properly	▶ Return the unit to a HEIDENHAIN service agency for repair.	Qualified personnel

## What to do if ...

Malfunctions

Error	Error source	Error correction	Personnel for corrective action
Connected devices are not functioning	Faulty connection or defect in the connected device	► Check the wiring or the connected device.	Electrical specialist

## Resuming operation

When resuming operation, e.g. during reinstallation after repair or re-mounting, the same measures and personnel requirements apply as for mounting the unit (see "Assembly", page 15) and for installation (see "Installation", page 18).

When reconnecting peripherals it may be necessary to take special measures according to the manufacturer's documentation and to observe special safety precautions!

*Obligations of the operating company*

Taking into account the requirements for peripherals, the operating company must ensure safe resumption of operation of the devices to be connected and assign authorized and appropriately qualified personnel to the task. For more information on personnel qualification, see "Obligations of the operating company", page 11.

## 11.2 Error messages

### Personnel requirement



Corrective action is only to be performed by qualified personnel!  
For more information see "Personnel qualification", page 10.

### Error messages in alphabetical order

Error message	Explanation	Action
*****	Number cannot be displayed, e.g. due to overflow.	▶ Change display settings.
SLEC was enabled for a channel, but no machine zero was performed.	Machine zero point has not yet been set.	▶ Set zero point.
Graph Pts cannot be greater than Max Subgroups (or 200).	Self-explanatory	▶ Correct the number of points specified in Graph Pts.
Graph Pts must be from 2 to 200.	Self-explanatory	▶ Correct the number of points specified in Graph Pts.
Since no other parts have been defined Cycle will not do anything.	Self-explanatory	▶ Use the Cycle function correctly.
Sorry, but the system cannot have more than 100 parts.	Self-explanatory	▶ Reduce the number of parts.
The settings file was not successfully loaded.	The settings cannot be loaded from the USB flash drive.	▶ Check the USB drive. ▶ Check the file.
Sorry, but the Next Record Id must be greater than the largest one currently in the database.	Next Record ID in the SPC settings was set to an existing ID.	▶ Choose a new ID.
Cannot add a record to the database because a dimension has a "units" result which is different than a previously stored one.	The new record could not be added because it has different units of measure than the previous one.	▶ Adapt the units of measure. ▶ Check the program.
The printer cover is open.	Self-explanatory	▶ Close the printer cover.
The Orbit probe assigned to channel C%d has already been used. This channel will be disabled until a new probe is assigned to it.	Double assignment of the probe	▶ Change the probe assignment.
The battery which preserves your settings and data needs to be replaced. Please contact your dealer for a replacement.	Self-explanatory	▶ <b>Back up the settings</b> , then have the battery replaced.

Error message	Explanation	Action
The values for High and Low Warnings in the Master Screen are assumed to be in mm. If they were in inches, please re-enter them.	Self-explanatory	▶ Adjust the configuration.
These channels have unexpected calibration results:	Referencing (mastering) a channel failed.	▶ Repeat. ▶ Check the unit.
That label already exists for this part. Please choose another.	Self-explanatory	▶ Create another label.
This probe should not be used with the other probes that are currently selected in the system.	It is not possible to connect different types of probes.	▶ Check the configuration.
Sorry, but that part has not yet been defined.	Self-explanatory	▶ Define the part.
The printer job is incorrect.	Software error occurred	▶ Restart the unit. ▶ Contact HEIDENHAIN service agency if necessary.
Printing was canceled.	Self-explanatory	▶ Restart printing, if required.
The printer is busy.	Self-explanatory	▶ Wait for printing to finish.
The printer is offline.	Self-explanatory	▶ Switch on the printer. ▶ Check the connection to the printer.
The printer context is incorrect.	Software error occurred	▶ Restart the unit ▶ Contact HEIDENHAIN service agency if necessary.
The attached printer is not supported.	Print attempt, but the connected printer is not supported.	▶ Refer to the list of printers (at <a href="http://www.heidenhain.de">www.heidenhain.de</a> ).
A printer error has occurred. Please try again.	A generic printer error was reported.	▶ Check the printer.
A channel has been improperly calibrated.	Self-explanatory	▶ Calibrate the input channel.
Sorry, but you can't copy an empty part.	Self-explanatory	▶ Define the part before copying it.
A loop exceeding 500 iterations has been detected and disabled.	Self-explanatory	▶ Correct the formula.



Error message	Explanation	Action
An overtravel condition has occurred on a channel associated with this dimension.	The calibrated range of the probe was exceeded.	▶ Check the measuring device.
One or more of your channels has failed because the calibration points were out of tolerance.	The measured value of a channel has exceeded the warning limit for the calibration.	▶ Check the configuration
Could not calibrate one or more channels because their "Ref Marks" setting was set to C-Scale type.	Incorrect setting of the measuring device with regard to reference mark evaluation.	▶ Adjust the configuration.
One or more of your channels cal point is out of tolerance.	Measured value is out of tolerance.	▶ Check the configuration.
Input errors have occurred on the following Channel(s): %s. Data derived from these Channel(s) may now be incorrect.	Measuring device error or the configuration does not correspond with the program.	▶ Compare the actual configuration with the expected configuration. ▶ Check the measuring device.
That channel has already been assigned with another Master Link.	Self-explanatory	▶ Adjust the program.
Units are mismatched in the formula.	Self-explanatory	▶ Correct the formula.
EnDat timeouts have occurred on channel %s. This channel will be disabled until the network is restarted.	Communication with measuring device not possible.	▶ Check the measuring device.
While evaluating the formula, an expected value was missing.	Self-explanatory	▶ Check the program.
A communication error has occurred on a channel associated with this dimension.	Self-explanatory	▶ Check the program.
The wrong tray is selected for the printer.	Print attempt, but the selected tray does not contain the right paper size for the printer job.	▶ Choose another tray. ▶ Insert suitable paper.
A divide by zero error occurred in the formula.	Self-explanatory	▶ Correct the formula.
An error occurred in the format of the file.	There are errors in the format of the settings file to be loaded.	▶ Check the format.
Received Serial Device Error: %s. Disable Serial Device?	Error message received from the connected measuring device.	▶ Check or disable the measuring device.
An error has occurred while communicating with the printer.	Print attempt, but communication with the printer was interrupted or disturbed.	▶ Check the connection to the printer.

Error message	Explanation	Action
The formula could not be evaluated because of a cyclic dependency.	Circular reference	▶ Correct the formula.
The formula is not complete.	Self-explanatory	▶ Correct the formula.
Formulas were disabled at power up.	Self-explanatory	▶ Check the program.
An Ask question in a formula was not answered.	Self-explanatory	▶ Answer the question.
No formula is defined for this axis.	No formula has been assigned to the dimension.	▶ Assign a formula to the dimension.
Sorry, because of your channel types a Master cannot be performed.	Self-explanatory	▶ Adjust the configuration.
Master has been disabled in Supervisor Setup.	Self-explanatory	▶ Assign appropriate access permissions.
This function is not permitted due to a parameter conflict.	Self-explanatory	▶ Correct the formula.
This function is not supported in the hardware.	Self-explanatory	▶ Check the configuration.
You cannot copy the current part to a part number that doesn't exist unless it's the next available part number.	Self-explanatory	▶ A new part number needs to be created before copying a part.
Hardware Error: Unable to load Expansion FPGA.	Error loading the expansion FPGA on some daughterboards.	▶ Contact HEIDENHAIN service agency.
In part %d D%d named %s has a corrupted id of %d.	The internal memory is damaged and a visible dimension cannot be saved back.	▶ Contact HEIDENHAIN service agency.
In part %d H%d named %s has a corrupted id of %d.	The internal memory is damaged and a hidden dimension cannot be saved back.	▶ Contact HEIDENHAIN service agency.
A calibration could not be performed on one or more channels because SLEC has been enabled.	Self-explanatory; in most cases SLEC has been enabled.	▶ Disable SLEC, etc.
An undertravel condition has occurred on a channel associated with this dimension.	Traverse distance of probe is not large enough.	▶ Check the measuring device.
The settings file cannot be opened.	The settings cannot be opened on the USB flash drive.	▶ Check the USB drive. ▶ Check the file.
The part file cannot be written to.	The settings cannot be saved to the USB flash drive.	▶ Check the USB drive. ▶ Check the file.
External Edge Input #%d is not valid. Please try again.	External edge input is not configured.	▶ Configure the external edge input.

## What to do if ...

### Error messages

Error message	Explanation	Action
Unable to locate a valid printer.	Print attempt, but no connected printer was found.	▶ Check the printer connection.
The printer is out of paper. Please load and then press OK to continue.	Self-explanatory	▶ Load paper into the printer and continue printing.
Unable to find a usable printer pen.	Print attempt, but no suitable pen was found.	▶ Check the printer.
No counter values were captured.	Measuring device information not received.	▶ Adjust the measuring velocity. ▶ Check the measuring device.
A parenthesis is missing from the formula.	Self-explanatory	▶ Correct the formula.
Could not delete the data record because that capability is locked out in supervisor setup.	Self-explanatory	▶ Assign appropriate access permissions.
Unable to locate reference mark on Solartron probe. Please try again.	Self-explanatory	▶ Repeat. ▶ Check the unit.
Couldn't load the new startup screen.	The startup screen could not be loaded from the USB flash drive.	▶ Check the USB drive. ▶ Check the file.
Clr Part and Clr All have been disabled in Supervisor Setup.	Self-explanatory	▶ Assign appropriate access permissions.
The Calibration failed. Please try again.	Self-explanatory	▶ Correct the LVDT calibration.
Max Subgroups must be from 2 to 1000.	Self-explanatory	▶ Correct the number of subgroups.
A dimension specifier is missing.	Self-explanatory	▶ Correct the formula.
An error has occurred while reading a channel associated with this dimension.	Measuring device information could not be read.	▶ Correct the formula.
At least one dimension must have a label for a part to be left selected.	To get a display, at least one dimension must be labeled as a visible dimension.	▶ Define a dimension.
The balance function was NOT successful. Calculated scalars: %lf, %lf.	Error in calculation	▶ Check the calculation.
This version of the LVDT Board is no longer supported and requires an upgrade to your hardware.	Self-explanatory	▶ Contact HEIDENHAIN service agency.

## What to do if ...

### Error messages

Error message	Explanation	Action
There are not enough parameters for a function in the formula.	Self-explanatory	▶ Correct the formula.
Not enough memory!	Self-explanatory	▶ Delete unused data from memory.
There is not enough alpha-memory left for this Ask function.	Desired text is too long.	▶ Shorten the text.
There isn't enough free memory to allocate the desired amount for this part!	The selected part cannot be loaded into memory.	▶ Delete unused data from memory.
Data can't be added to this part: there isn't enough memory!	Self-explanatory	▶ Delete unused data from memory.
There is not enough free memory to make the requested changes.	Self-explanatory	▶ Delete unused data from memory.
There's not enough available memory to copy the part.	Self-explanatory	▶ Delete unused data from memory.
The channel number is out of range.	Self-explanatory	▶ Choose another number.
The printer is out of paper.	Self-explanatory	▶ Load paper into the printer.
The printer is jammed.	Self-explanatory	▶ Remove the paper jam.
Error. Passwords were different.	Self-explanatory	▶ Enter the password correctly.
A problem has occurred in trying to evaluate the formula.	A formula error has occurred.	▶ Correct the formula.
Serial Device Error: Failed to receive expected response before timeout was exceeded. Disable Serial Device?	The device connected to the serial port failed to respond.	▶ Check the transmission parameters. ▶ Check the device. ▶ Check the cables.
Serial Device Error: Failed to receive expected response before timeout was exceeded. Disable Serial Device?	Communication with measuring device not possible.	▶ Check the communication. ▶ Check or disable the measuring device.
Unable to print to the serial port.	Self-explanatory	▶ Check the RS-232 settings.
Incomplete sequence.	Self-explanatory	▶ Correct the formula.
It's time to calibrate your channels.	Self-explanatory; in most cases due to drift.	▶ Calibrate the input channel.

Error message	Explanation	Action
StorageToUI called before UI-ToStorage.	Internal error: The settings were loaded from memory before the previous settings were stored.	▶ Contact HEIDENHAIN service agency.
The default clause of a case function is missing.	Self-explanatory	▶ Check the program.
T_saved is too big for nov ram.	Internal error: Size of the settings exceeds memory capacity.	▶ Contact HEIDENHAIN service agency.
Unable to locate probe. Please try again.	The connected measuring device was not found.	▶ Check the communication. ▶ Check the measuring device.
You cannot copy a part onto itself.	Self-explanatory	▶ Create a new part.
The new part was not successfully loaded.	The part file cannot be loaded from the USB flash drive.	▶ Check the USB drive. ▶ Check the file.
The values for Tolerances must go from largest to smallest.	Self-explanatory	▶ Correct the sequence of tolerance values.
UIToStorage called before StorageToUI.	Internal error: The settings were saved to memory before the previous settings were loaded.	▶ Contact HEIDENHAIN service agency.
Unknown formula problem.	Self-explanatory	▶ Correct the formula.
A unexpected units marker was encountered in the formula.	Formula error occurred.	▶ Correct the formula.
Warning: Unexpected response from Solartron module. Press CANCEL to ignore future communication warnings.	Self-explanatory	▶ Press «cancel» or check the measuring device.
While evaluating the formula, an unexpected value was encountered.	Self-explanatory	▶ Check the program.
Invalid parameter value for a function.	Self-explanatory	▶ Correct the formula.
Subgroup Size must be from 1 to 10.	Self-explanatory	▶ Correct the subgroup size.
The calibration difference between the min and max artifacts is too small. This part of the calibration will not be performed.	Self-explanatory	▶ Adjust the traverse path for the calibration.

## What to do if ...

### Error messages

Error message	Explanation	Action
An attempt was made to access a data record that does not exist.	Self-explanatory	▶ Correct the formula.
A Balance cannot be performed unless a channel has been linked.	Self-explanatory	▶ Link the channels.
Warning: Unexpected response from Marposs module. Press CANCEL to ignore future communication warnings.	Error message received from the connected measuring device.	▶ Press «cancel» or check the measuring device.
Warning: Unexpected response from Sony MG10 module. Press CANCEL to ignore future communication warnings.	Self-explanatory	▶ Press «cancel» or check the measuring device.
Sorry, but the number must be within the range %s to %s.	The entered value is outside the permissible limits.	▶ Observe limits.
Unable to capture counter values.	Measuring device information could not be read.	▶ Adjust the measuring velocity.
Solartron probe timeouts have occurred on channel %s. This channel will be disabled until the network is restarted.	The connected measuring device was not found.	▶ Repeat. ▶ Check the unit.

## 12 Removal, environmental protection and disposal

### Personnel requirement



Removal of the product is only to be performed by qualified personnel. For more information see "Personnel qualification", page 10.

#### NOTICE

Depending on the connected peripherals, the removal may need to be carried out by an electrical specialist.

The **safety precautions** to be taken when installing the respective components must also be observed when removing them, see "Installation", page 18 onwards.

### Preparation

- ▶ Set the power switch to the **0** position.
- ▶ Unplug the unit's power connector.
- ▶ Disconnect all plug connections on the side and rear of the unit.

### 12.1 Removal

The unit is basically removed in the reverse sequence used for mounting, see "Assembly", page 15.

#### Storage after removal

If the unit will be temporarily stored after removal, the specified ambient conditions must be maintained, see "Specifications", page 261.

#### Repackaging

Repackaging should correspond to the original packaging as closely as possible:

- ▶ Connect all screw-mounting elements to the unit or repackage them in the same way they were originally shipped from the factory.
- ▶ Repackage the unit, foam and cardboard box insert as originally shipped from the factory. The unit should be oriented face-up in the carton.
- ▶ Place all other components in the original packaging as received from the factory, see "Items supplied", page 14.
- ▶ Enclose all the documentation, instructions and warranty cards that were included in the original packaging, see "Storage and distribution of the documentation", page 8.



When returning the unit for service, it is **not** necessary to ship the accessories and measuring devices with the unit.

## 12.2 Environmental protection and disposal

### **NOTICE**

#### **Incorrect disposal of the product, accessories or peripherals!**

May cause environmental damage!

- Do not dispose of in domestic waste!
- Electrical waste and electronic components are subject to special-waste regulations and must be disposed of by authorized collection points only.
- The applicable country-specific regulations must be observed.  
More detailed information on legal regulations can be obtained from competent authorities (such as national and regional water management authorities and environmental agencies).



If you have any questions about disposal, please contact the manufacturers.



## 13 Specifications

Device	
Housing	Die-cast metal enclosure
Type of mounting	<ul style="list-style-type: none"> <li>■ Mounting stand</li> <li>■ Mounting adapter</li> </ul>
Dimensions	<ul style="list-style-type: none"> <li>■ Unit: 287 mm x 195 mm x 93.5 mm</li> <li>■ Unit with mounting stand: 287 mm x 214 mm x 220.5 mm</li> <li>■ Unit with mounting adapter: 287 mm x 203.5 mm x 107 mm</li> </ul>
Display	
Visual display unit	<ul style="list-style-type: none"> <li>■ Color LCD 5.7" (14.5 cm)</li> <li>■ 0.50" (12.7 mm) display digit size</li> </ul>
Display step	Selectable, min. 0.000004" (0.00001 mm)
Electrical data	
Power supply	<ul style="list-style-type: none"> <li>■ 100 V to 240 V AC (–15 % to +10 %)</li> <li>■ 47 Hz to 63 Hz</li> <li>■ Max. 100 W</li> </ul>
Line fuse	Slow blow 1.6 A, 250 V AC; 5 mm x 20 mm; quantity: 2
Measuring device interfaces	4 or 8
1 V <sub>pp</sub> interpolation	10-fold
Switching inputs	5 TTL inputs (freely definable), 5 V DC (±10 %)
Switching outputs	<ul style="list-style-type: none"> <li>■ 12 TTL outputs (freely definable, 5 V DC (±10 %), max. current 24 mA)</li> <li>■ 2 relay outputs               <ul style="list-style-type: none"> <li>■ Max. switching voltage 30 V DC</li> <li>■ Max. switching current 0.25 A</li> <li>■ Max. continuous current 0.5 A</li> <li>■ Max. switching capacity 3.0 W</li> </ul> </li> </ul>
Other connections	<ul style="list-style-type: none"> <li>■ Foot-switch connector (2 functions) or remote keypad, RJ-45 connector</li> <li>■ Audio output, 3.5 mm speaker jack, min. impedance 8 Ω</li> </ul>
Datainterface	<ul style="list-style-type: none"> <li>■ RS-232-C/V24</li> <li>■ USB 2.0 (Type A, Full Speed)</li> </ul>

### Ambient conditions

Operating temperature	0 °C to 45 °C
Storage temperature	-20 °C to 70 °C
Relative air humidity	≤ 80 %
Altitude	≤ 2000 m

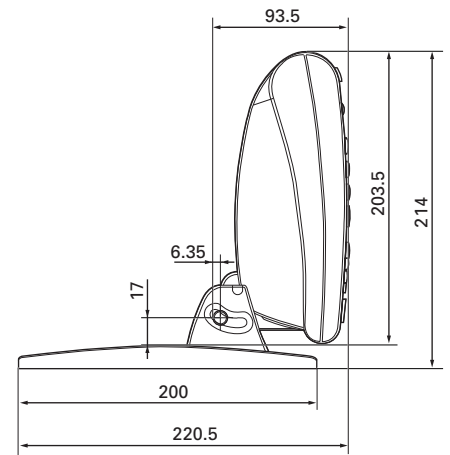
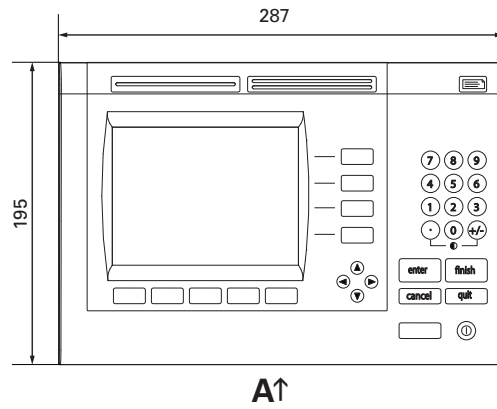
### General information

Directives	<ul style="list-style-type: none"><li>■ EMC Directive 2004/108/EC</li><li>■ Low Voltage Directive 2006/95/EC</li></ul>
Pollution degree	II
Protection EN 60529	IP 40
Weight	<ul style="list-style-type: none"><li>■ With mounting stand: approx. 4.8 kg</li><li>■ With mounting adapter: approx. 2 kg</li></ul>

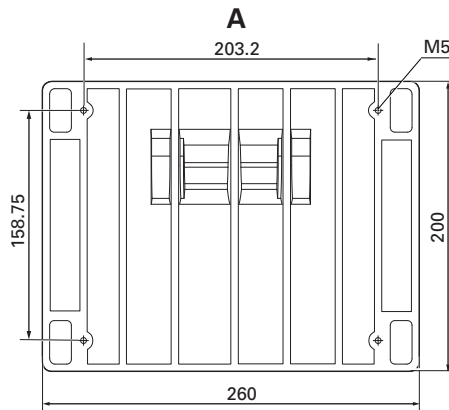
## Dimensions

All dimensions are in millimeters [mm].

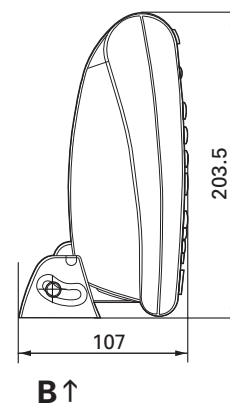
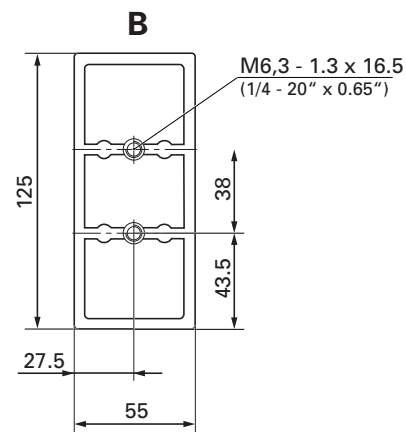
Left:  
Unit: Height and width  
Right:  
Unit with mounting  
stand



Mounting stand



Unit with mounting  
adapter



# 14 Glossary

Term	Definition
1 Vpp	Interface of an incremental measuring device: Over a signal period, the measuring device outputs a path-dependent sinusoidal voltage signal with a nominal amplitude of 1 V peak to peak
SLEC	One of two error correction types. In comparison to LEC, SLEC compensates for nonlinearities by applying multiple correction coefficients to individual nonlinear segments within the measurement range. SLEC requires more time to set up than LEC, but results in more accurate measurements
Addendum	An addendum supplements or supersedes the corresponding contents of the Operating Instructions and, if applicable, of the Installation Instructions
Alphanumeric	Entry using alphabetic characters and numbers
Bar	Type of display for a measured value and the specified tolerances. Represented as a bar graph on the screen
Datum	A point that establishes a reference between an auxiliary coordinate system and the machine coordinate system
Dial	Type of display for a measured value and the specified tolerances. Represented as an analog dial on the screen
DRO	Type of display for a measured value and the specified tolerances. "DRO" stands for "Digital Read-Out". Values are displayed as numbers on the screen
Input	Physical input of the product. A measuring device input is assigned to a dimension in formulas. The state of a logical input is also evaluated in dimensions
EnDat	Digital, bi-directional interface for HEIDENHAIN encoders for the transmission of measurement values and additional information
Globals	Variables that are available to all parts
Histogram	Term used in statistics: Graphic representation of the frequency distribution of dimensions. The data is divided into classes for this purpose.
Hot-key function	These functions for operating the unit or the program can be mapped to almost any desired keys. This special mapping defines a key as a Hot Key.
ID no.	Stands for identification number
Actual position	Display of the current position
Channel	Input channel for measuring devices
Label	Designation, fixed text
LEC	One of two error correction types. In comparison to SLEC, LEC compensates for nonlinearities by applying a single linear correction coefficient to the entire range of measurement. LEC is easier to set up than SLEC, but does not provide correction for local nonlinearities that could be present over small portions of the measurement range

Term	Definition
LVDT	Inductive measurement principle (Linear Variable Differential Transformer)
Dimension	Dimensions are defined when writing a measurement program for a part. They are created by mathematical or logic operations using information from the inputs, or they contain control formulas. Dimensions can be displayed on the screen (visible dimensions) or used in the program as auxiliary (hidden) dimensions.
Zero point	Defines the machine datum (= zero point of the coordinate system)
UCL	Upper Control Limit
Prompt	Pop-up window for entry of a response
Reference mark	Physical (fixed) mark on the measuring standard of a measuring device. When this mark is crossed and evaluated, the position of the measuring device relative to the machine coordinate system can be established.
Reference point	A measurement reference point should be established prior to conducting measurements. This can be done by calibrating input channels or by presetting dimensions.
r chart	Control chart for SPC: Plots the subgroup range values
SELV	Safety Extra Low Voltage Class I according to IEC 60449
Signal period	Term used in incremental metrology: Distance over which the measuring device outputs a sine period (360 °) as distance information.
Soft key	Key at the bottom of the LCD screen, which changes its function depending on the context.
SPC	Stands for Statistical Process Control. The term typically denotes a procedure for optimizing production and service processes on the basis of statistical methods.
Sampling	Term used in statistics: Selection of a subgroup of one or more parts to be inspected from a specified complete set of parts.
Part	A part defines dimensions that are required for measuring a workpiece to be inspected. In general, a part is an inspection program that specifies the sequence, calculations and evaluation of a measurement.
TTL	Interface of an incremental measuring device: Over a signal period, the measuring device outputs a path-dependent square-wave signal according to RS-485
UART	Interface for transmitting and receiving data over a serial connection
LCL	Lower Control Limit
$\bar{x}$ charts	Control chart for SPC: Plots the subgroup mean value

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