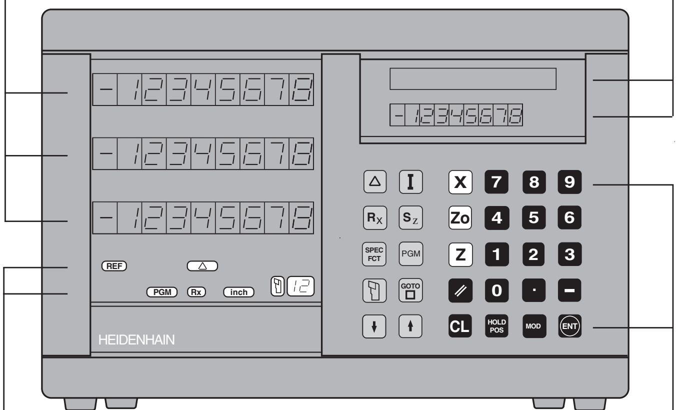
HEIDENHAIN

User´s Manual

ND 930
ND 970

Position Display Units for Lathes

5/95



inch	Inch display is active
△	Distance-to-go display is active
PGM	Program input is active
REF	Reference marks have been crossed
Rx	Radius display is active
12	Tool number

△	Distance-to-go display (traversing to zero)
I	For incremental dimensions (only with distance-to-go display and program input)
R_X	Radius/diameter display X axis
S_Z	Separate value/sum display (ND 970 only)
SPEC FCT	Special functions (tool datums, taper calculator, oversize)
PGM	Program input
	Tool compensation
GOTO □	Go directly to parameters or program steps
↑ ↓	Page in program or parameter list/ select function
X ••• Z	Select coordinate axis
0 ••• 9	Numerical input
//	Reset all axes to zero, functions for program input
•	Decimal point
–	Change sign or parameter
CL	Clear entry/cancel operating mode
HOLD POS	Hold current position
MOD	Select/deselect parameter list
ENT	Confirm entry

This manual is for ND display units with the following software numbers or higher:

ND 930 (two axes)	**246 112 05**
ND 970 (three axes)	**246 112 05**

About this manual

This manual is divided into two parts:

Part I: Operating Instructions

- Fundamentals of positioning
- ND functions

Part II: Installation and Specifications

- Mounting the display unit on the machine
- Description of operating parameters
- Switching inputs, switching outputs

Part I: Operating Instructions

Fundamentals

You can skip this chapter if you are already familiar with coordinate systems, incremental and absolute dimensions, nominal positions, actual positions and distance-to-go.

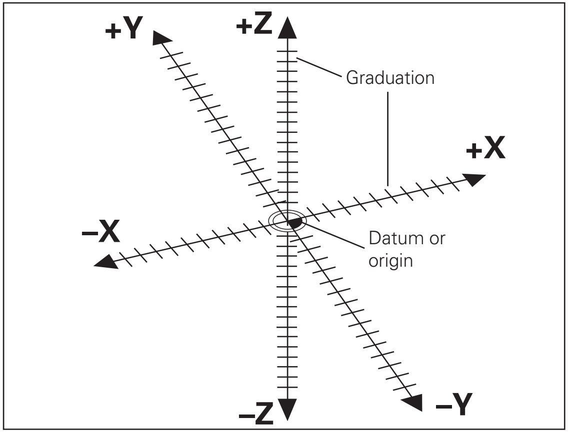
Coordinate system

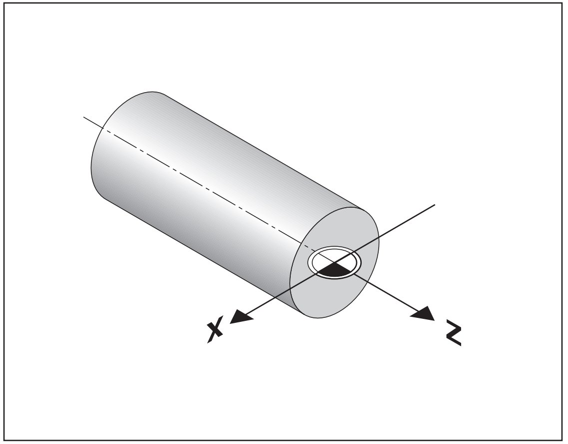
To describe the geometry of a workpiece, a rectangular or *Cartesian** coordinate system is used. The Cartesian coordinate system consists of three mutually perpendicular axes X, Y and Z. The point of intersection of these axes is called the **datum** or origin of the coordinate system.

Think of the axes as scales with divisions (usually in millimeters) that allow us to fix points in space referenced to the datum.

To determine positions on a workpiece, the coordinate system is "laid" onto the workpiece.

With lathe work (i.e., rotationally symmetrical workpieces), the Z axis moves along the axis of rotation, and the X axis moves in the direction of the radius or diameter. The Y axis can be disregarded since it would always have the same values as the X axis.



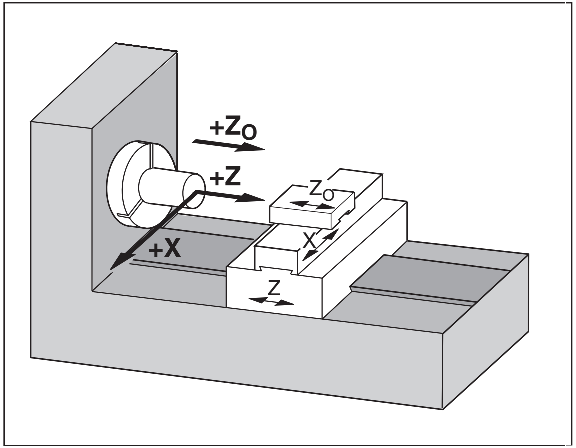


* Named in honor of the French mathematician and philosopher René Descartes (1596 to 1650)

Cross slide, saddle and top slide

On conventional lathes, the tool is mounted on a slide that moves in the direction of the X axis (the cross slide) and in the direction of the Z axis (the saddle).

Most lathes have a top slide above the saddle. The top slide moves in Z axis direction and is designated Zo.



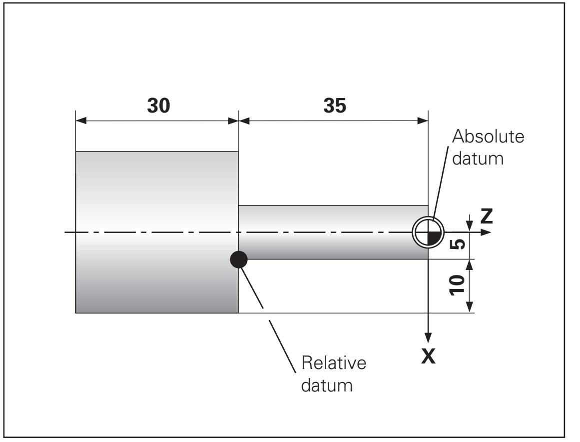
Datum setting

The workpiece drawing is used as the basis for machining the workpiece. To enable the dimensions in the drawing to be converted into traverse distances of machine axes X and Z, each drawing dimension requires a datum or reference point on the workpiece (since a position can only be defined in relationship to another position).

The workpiece drawing always indicates **one** absolute datum (the datum for absolute dimensions). However, it may contain additional, relative datums.

In the context of a numerical position display unit, *datum setting* means bringing the workpiece and the tool into a defined position in relation to each other and then setting the axis displays to the value which corresponds to that position. This establishes a fixed relationship between the actual positions of the axes and the displayed positions.

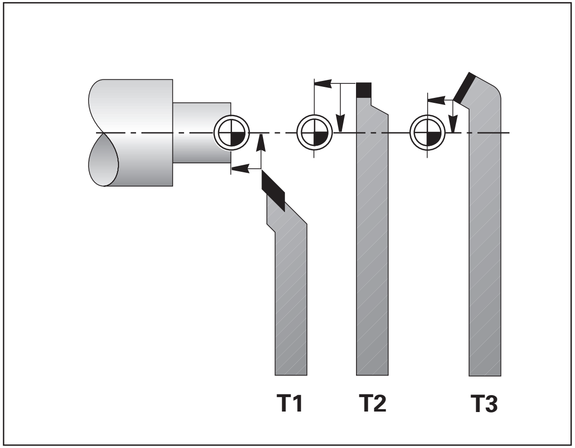
With the ND, you can set one absolute datum point and as many as 99 relative datum points (tool datums), and store them in nonvolatile memory.



Tool datums (tool compensation)

Your display unit should show you the absolute position of the workpiece, regardless of the length and shape of the particular tool being used. For this reason you must determine the tool data and enter them. First touch the workpiece with the cutting edge of the tool and then enter the associated display value for that position.

You can enter tool data for up to 99 tools. When you have set the absolute workpiece datum for a new workpiece, all tool data (= relative datum points) are referenced to the new workpiece datum.



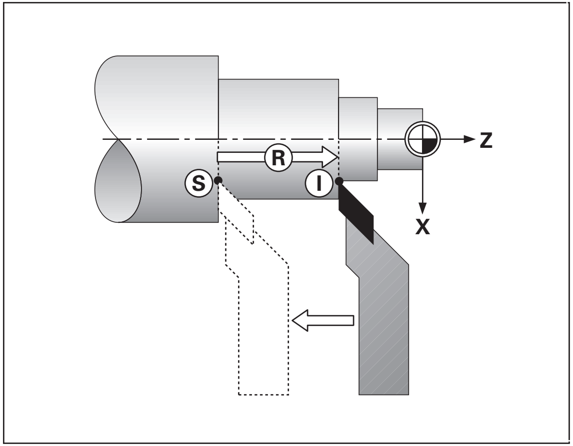
Nominal position, actual position and distance-to-go

The positions to which the tool is to move are called the **nominal** positions (Ⓢ). The position at which the tool is actually located at any given moment is called the **actual** position (Ⓘ).

The distance from the nominal position to the actual position is called the distance-to-go (Ⓡ).

Sign for distance-to-go

When you are using the distance-to-go display, the nominal position becomes the relative datum (display value 0). The distance-to-go is therefore negative when you move in the positive axis direction, and positive when you move in the negative axis direction.



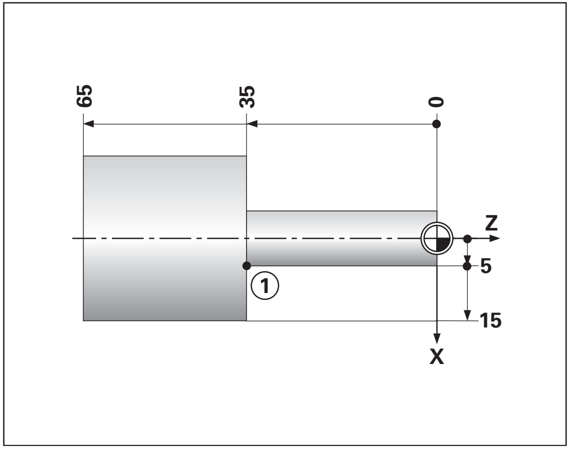
Absolute workpiece positions

Each position on the workpiece is uniquely defined by its absolute coordinates.

Example Absolute coordinates of position 1:

X = 5 mm
Z = –35 mm

If you are working according to a workpiece drawing with absolute dimensions, you are moving the tool **to** the coordinates.



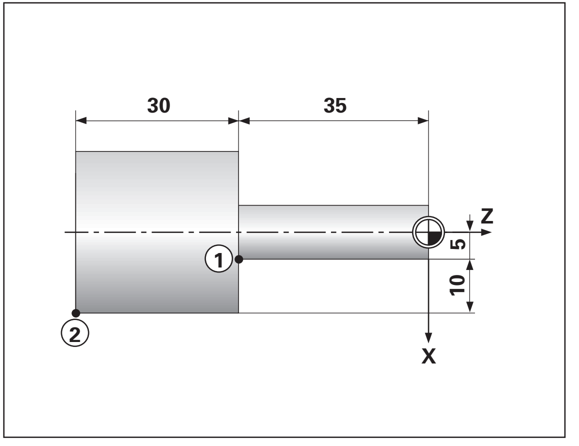
Relative workpiece positions

A position can also be defined relative to the previous nominal position. The datum for the dimension is then located at the previous nominal position. Such coordinates are termed **incremental coordinates** or chain dimensions. Incremental coordinates are indicated by a preceding **I**.

Example Relative coordinate of position 2 referenced to position 1:

IX = 10 mm
IZ = –30 mm

If you are working according to a workpiece drawing with incremental dimensions, you are moving the tool **by** the dimensions.



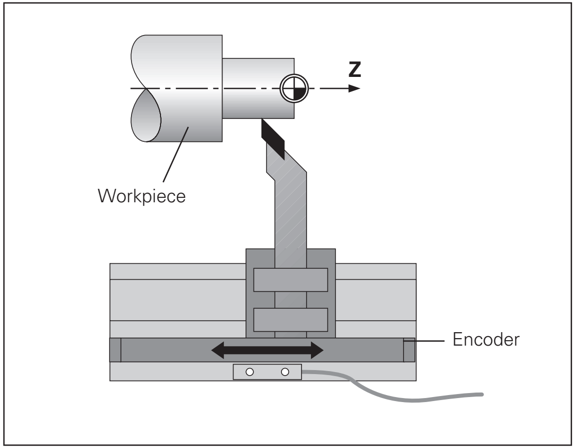
Sign for incremental dimensioning

A relative dimension has a **positive** sign when the axis is moved in the positive direction, and a **negative** sign when it is moved in the negative direction.

Position encoders

The position encoders on the machine convert the movements of the machine axes into electrical signals. The ND display unit evaluates these signals, determines the actual position of the machine axes and displays the position as a numerical value.

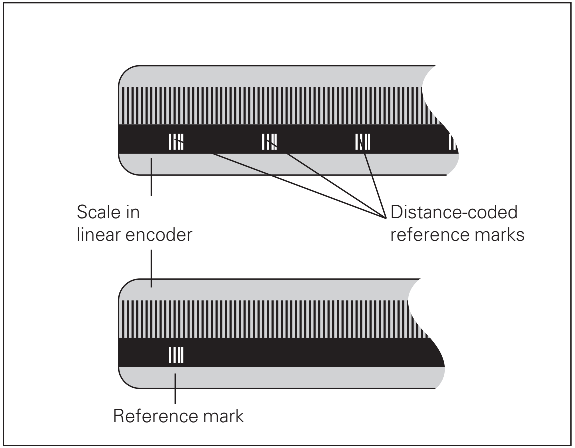
If the power is interrupted, the relationship between the machine axis positions and the calculated actual positions is lost. The reference marks on the position encoders and the REF reference mark evaluation feature enable the ND to quickly re-establish this relationship again when the power is restored.



Reference marks

The scales of the position encoders contain one or more reference marks. When a reference mark is crossed over, a signal is generated identifying that position as a reference point (scale datum = machine datum).

When this reference mark is crossed over, the ND's reference mark evaluation feature restores the relationship between axis slide positions and display values as you last defined it by setting the datum. If the linear encoders have **distance-coded** reference marks, you need only move the machine axes a maximum of 20 mm to restore the datum.



Switch-On, Crossing Over the Reference Marks

0 ➡ 1	Turn on the power (switch located on rear panel). REF and decimal points blink.

`REF ?  ENT ...CL`

ENT	Press ENT before crossing reference marks.

`PASS OVER REF.`

	Cross over the reference marks in all axes (in any sequence). Each axis display becomes active when its reference mark is crossed over.

Crossing over the reference marks stores the last relationship between axis slide positions and display values for all datum points in nonvolatile memory.

Note that if you choose not to cross over the reference marks (by clearing the dialog `REF ?` with the CL key), this relationship will be lost if the power is switched off or otherwise interrupted.

> You must cross over the reference marks if you want to use the multipoint axis error compensation feature.
> (See "Multipoint Axis Error Compensation")

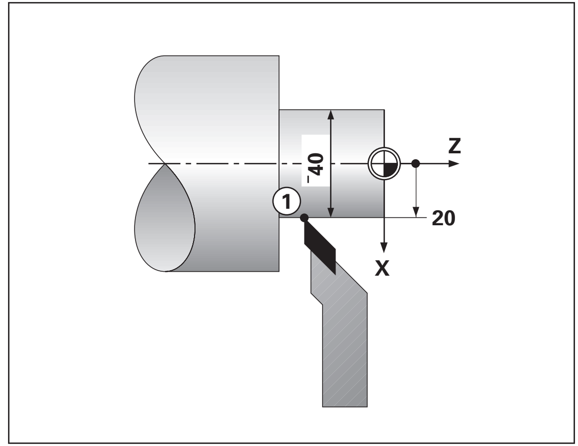
Switching Between Operating Modes

You can switch between the operating modes Distance-To-Go, Special Functions, Program Input, Set Tool Datum, Hold Position and Parameter Input at any time simply by pressing another operating mode key.

Selecting Radius or Diameter Display

Your ND can display positions in the cross slide as a diameter or as a radius. Drawings of lathe parts usually indicate diameters. When you are turning the part, however, you infeed the tool in the cross slide axis in radius values.

Example	Radius display, position)	X = 20 mm
	Diameter display, position)	X = 40 mm

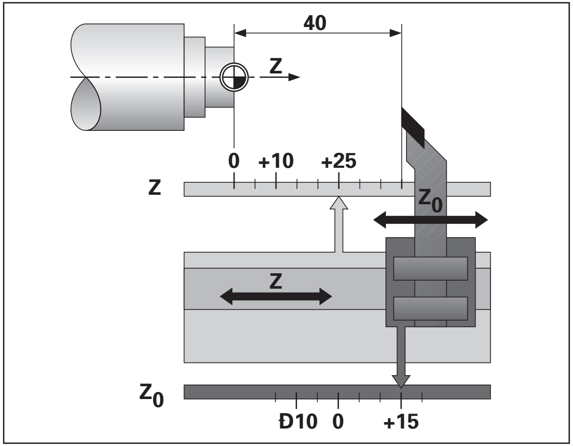


To switch the display

➤ Press R_X

When radius display for the X axis is selected, R_X lights up. When diameter display is selected, R_X goes out.

Separate Value/Sum Display (ND 970 only)



Separate value display

In this mode the positions of the saddle and top slide are displayed separately. The position displays are referenced to the datum points that you set for the Zo and Z axes. When an axis slide moves, only the position display for that axis changes.

Sum display

In this mode the position values of both axis slides are added together. The sum display shows the absolute position of the tool, referenced to the workpiece datum.

Example	Separate value display:	Z	=	+25.000 mm
(see illustra-)		Zo	=	+15.000 mm
tion at right)	Sum display:	Z_S	=	+40.000 mm

> The sum display will only show correct values if the actual position values of both axis slides were correctly added and entered (with sign) when setting the datum for the "sum."

To switch over the display:

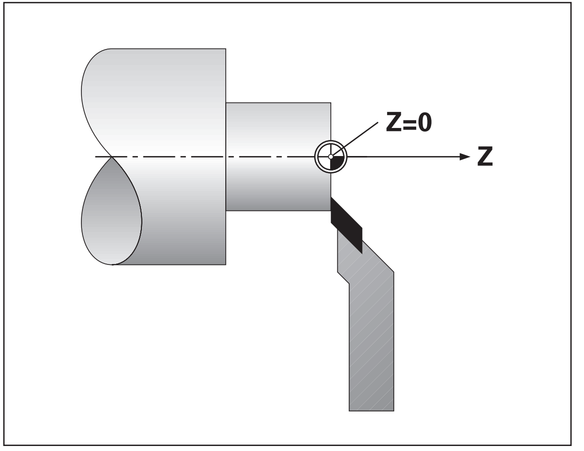
➤ Press S_Z

> When the ND 970 displays sums, the Zo display is switched off.

Datum Setting

If you want datum points to be stored in nonvolatile memory, you must first cross over the reference marks.

Note that the correct value to be entered for the datum in the X axis depends on whether you have selected radius or diameter display.



You can set **one** absolute workpiece datum and data for up to 99 tools (i.e., relative datums).

Setting the absolute workpiece datum

When you enter a new value for the absolute workpiece datum, all tool data are then based on the new workpiece datum.

	Touch the workpiece with the tool.
Z	Select the axis, for example Z.
DATUM Z =	
0 ENT	Enter the position of the tool tip (for example, 0 mm) and confirm with ENT.

Enter further axes in the same manner.

To enter tool data (relative datums)

Key / Display	Action
Tool key	Select the tool.
`TOOL NUMBER =`	
3 ENT	Enter the tool number (for example 3) and confirm with ENT.
Handwheel	Touch the workpiece with the tool.
SPEC FCT	Select Special Functions.
`SET TOOL ?`	
↓ ENT	Select Set Tool and confirm with ENT.
`SET TOOL Z =`	
Z 0 ENT	Select the axis (for example Z), enter the position of the tool tip (for example 0 mm), and confirm with ENT.
• • •	
Handwheel	Touch the workpiece or turn the first diameter.
`SET TOOL Z =`	
X 2 0 ENT	Select the axis (for example X), enter the position of the tool tip (for example 20 mm), and confirm with ENT.
Tool key	To set additional tools, change the tool, select a new tool number and enter the data for the next tool.
2 x SPEC FCT	End the function.

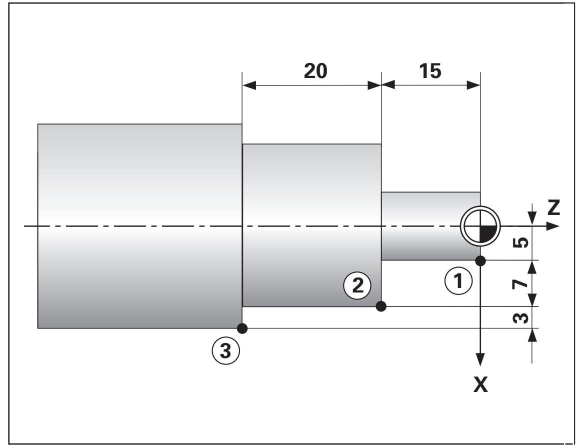
- When you work with the sum display, also set the tool data when the sum display is active (ND 970 only).
- Use the CL key to go back one level in the special functions.

Resetting all axes to zero

You can reset all axes to zero by pressing a single key. The last actual position then becomes the relative datum and is not stored (incremental positioning), and the status display shows **"– –"** instead of the tool number. Any tool datums already set remain in memory. You can activate these by entering the corresponding tool number.

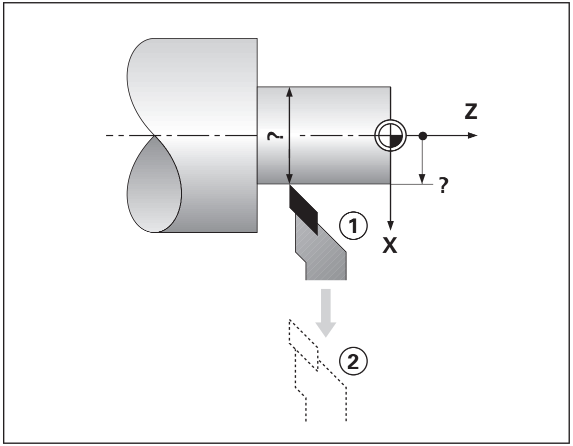
Example: Finish-turning steps

	Move to position ①.
	Reset all axes to zero.
	Move to position ② first in Z and then in X. The display shows the drawing dimensions (for example, X+7 and Z–15).
	Reset all axes to zero.
	Move to position ③ first in Z and then in X. The display shows the drawing dimensions (for example, X+3 and Z–20).



Holding Positions

If you want to measure the workpiece after turning the first diameter, your display unit has to capability to "freeze" (hold) the actual position before you retract the tool.



	Turn the first diameter, for example in the X axis.
HOLD POS	Select the HOLD POSITION function.
`KEEP X POS. ?`	
X ENT	Select the axis (for example X) whose position is to be held, and confirm with ENT.
	Retract the tool. The X axis display remains stopped. Measure the workpiece.
`SET POS. X =`	
1 2 ENT	Enter the measured position, for example 12 mm, and confirm with ENT. The display shows the current tool position.
HOLD POS	End the function.

Moving the Axes with the Distance-To-Go Display

Normally, the display shows the actual position of the tool. However, it is often more helpful to display the remaining distance to the nominal position (the distance-to-go). You can then position simply by moving the axis until the display value is zero.

You can enter the absolute or the relative (incremental) coordinates in the distance-to-go display.

Example: Finish-turning a shoulder

△	Select the distance-to-go function. The Δ symbol lights up.
`NOML. VALUE X =`	
X 1 5 ENT	Select the axis (e.g., X), enter the nominal coordinate (e.g., 15 mm) (radius), confirm entry.
	Move the X axis until the display value is zero. The tool is at position ①.
`NOML. VALUE X =`	
Z 2 0 – ENT	Select the axis (e.g., Z), enter the nominal coordinate (e.g., –20 mm), and confirm entry.

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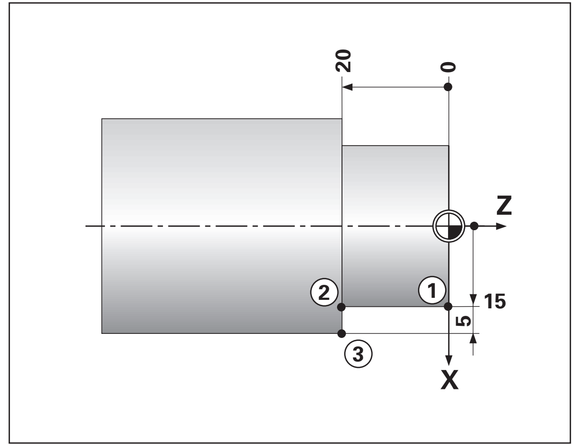
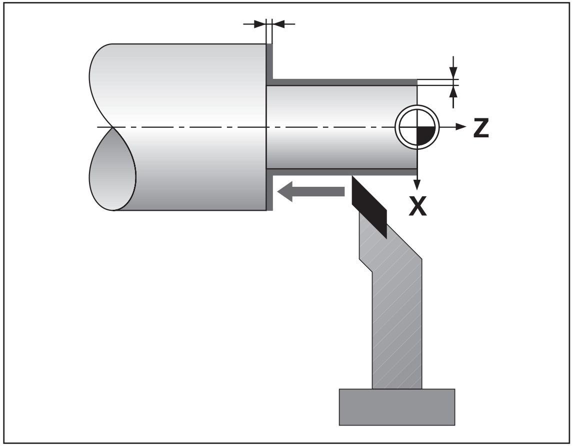


	Move the Z axis until the display value is zero. The tool is at position ②.
NOML. VALUE X =	
X I 5 ENT	Select the axis (for example X), mark as incremental dimension, enter the nominal coordinate (such as 5 mm) (radius), and confirm.
	Move the X axis until the display value is zero. The tool is at position ③.
△	End the distance-to-go mode. The Δ symbol goes out.

- If an oversize is active (see "Turning with Oversizes"), OVERSIZE ON will appear in the message field when you select the distance-to-go mode (clear the message with the CL key).
- For the oversize to be correctly applied you must enter the first nominal coordinate as an **absolute** dimension.
- Oversizes are applied correctly only in the sum display.

Turning with Oversizes

Your ND display unit can automatically take oversizes into account in the distance-to-go mode when the Oversize function is activated. Each axis can have a different oversize.



To active the oversize function

SPEC FCT	Select Special Functions.
SET TOOL ?	
↓	Select the Oversize function.
OVERSIZE ?	
ENT	Confirm selection.
OVERSIZE OFF	
– ENT	Switch oversize on or off. The message field then displays OVERSIZE ON or OVERSIZE OFF.
SPEC FCT	End the function.

Remember: oversizes are correctly compensated only for movement **toward the contour.**

To enter an oversize

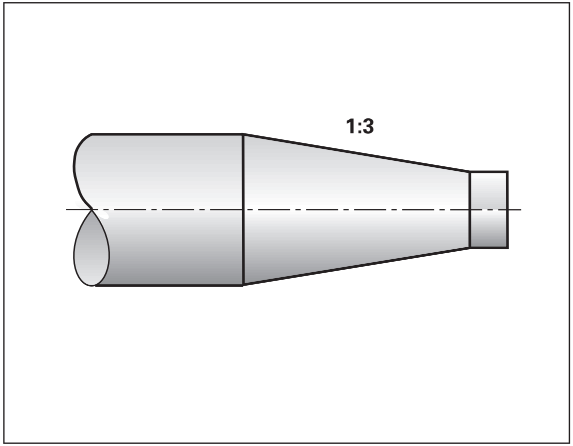
SPEC FCT	Select Special Functions.
SET TOOL ?	
↓	Select the Oversize function.
OVERSIZE ?	
ENT	Confirm selection.
OVERSIZE ON	
↓	If required, activate Oversize. Press the arrow down key.
OVERSIZE X ?	
X 1 ENT	Select the axis (for example X), enter the oversize (for example 1 mm), confirm with ENT.
SPEC FCT	End the function.

- If the Oversize function is active, this will be indicated by a message in the message field when you activate the distance-to-go mode.
- Use the CL key to go back one level in the special functions.

Taper Calculator

The taper calculator enables you to calculate the angle for the top slide. There are two possibilities:

- Calculation from the taper ratio:
  - Difference between the taper radii to the length of the taper
- Calculation from two diameters and the length:
  - Starting diameter
  - Final diameter
  - Length of the taper



Calculation from the taper ratio

SPEC FCT	Select Special Functions.

SET TOOL ?	
↓	Select Taper Calculator.

TAPER CALCULTR ?	
ENT	Confirm selection.

•
•
•

TAPER RATIO ?	
ENT	Confirm selection.
1. VALUE ?	
1 ↓	Enter the first value (for example, 1) and confirm with the arrow down key.
2. VALUE ?	
3 ↓	Enter the second value (for example, 3), confirm with the arrow down key (length of taper is three times as large as radius difference).
ANGLE = 18.435	
	The result is displayed in the message field.
SPEC FCT	End the taper calculator.

- You can change entered values later by selecting them with the arrow keys.
- Use the CL key to go back one level in the special functions.

Calculation from two diameters and the length

SPEC FCT	Select Special Functions.

SET TOOL ?

↓	Select the taper calculator.

TAPER CALCULTR ?

ENT	Confirm selection.

TAPER RATIO ?

↓	Select Taper Dimensions.

TAPER DIMENS. ?

ENT	Confirm selection.

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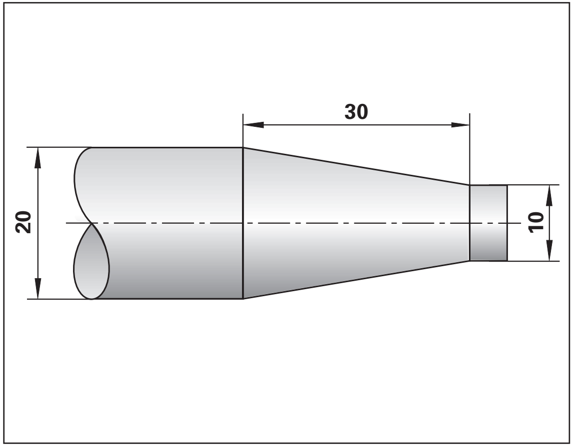


DIA. RIGHT =	
1 0 ↓	Enter value (for example, 10 mm) and confirm with the arrow down key.

DIA. LEFT =	
2 0 ↓	Enter value (for example, 20 mm) and confirm with the arrow down key.

LENGTH =	
3 0 ↓	Enter value (for example, 30 mm) and confirm with the arrow down key.

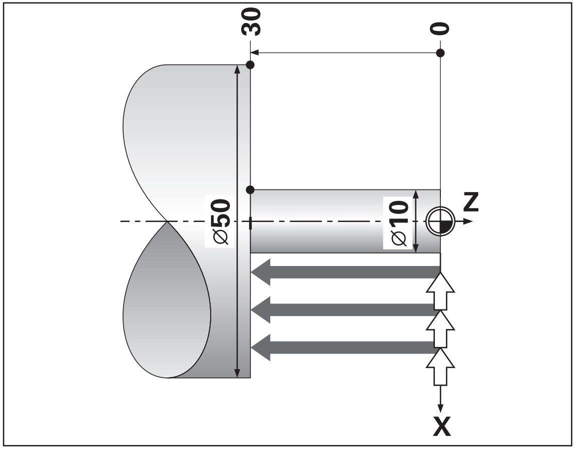
ANGLE = 9.462	
	The result is displayed in the message field.

SPEC FCT	End the taper calculator.

- You can change entered values later by selecting them with the arrow keys.
- Use the CL key to go back one level in the special functions.

Multipass Cycle

The multipass cycle allows you to turn a shoulder in any number of infeeds. This cycle is defined and executed in the special functions.



Define cycle and execute

SPEC FCT	Select Special Functions.
SET TOOL ?	
↓	Select multipass cycle.
MULTIPASS ?	
ENT	Confirm selection.
NOML. VALUE X =	
1 0 ↓	Enter nominal value for X, such as 10 mm (diameter), and confirm with arrow down key.

•
•
•

NOML. VALUE Zs=	
3 0 – ↓	Enter the nominal value for Zs (such as –30 mm) and confirm with the arrow down key.

START ?	
ENT	Press ENT to start the multipass cycle. Use the arrow down key if you need to correct your entries.

MOVE AXES	
	If you confirmed START with the ENT key, you can now turn the shoulder in any number of infeeds by moving to display value zero.

SPEC FCT	End the multipass cycle.

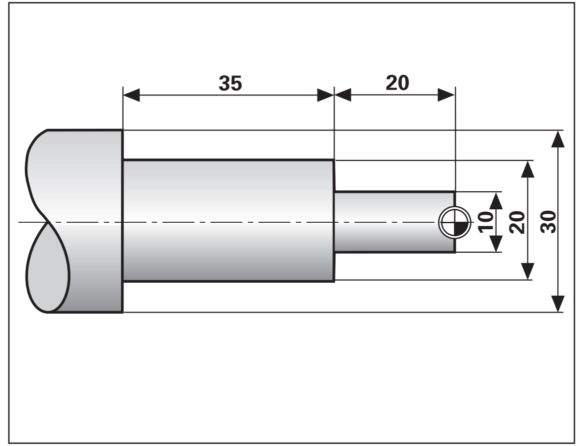
- When the multipass cycle is activated, the ND 970 automatically switches to the sum display.
- Use the CL key to go back one level in the special functions.

Program Input

For small-lot production you can enter the sequence of positioning steps in the Program Input mode (PGM key). Up to 99 positioning steps are possible. The program remains in memory even when the power is switched off or otherwise interrupted.

The display unit goes into sum display mode (ND 970 only) and distance-to-go mode when Program Input is activated. You can move to the entered positions simply by traversing to display value zero. The program blocks can be entered in absolute or incremental dimensions. The Δ symbol in the status display blinks until a block is completely entered. When you alter program blocks, the display values are updated as soon as you press ENT.

You can start from any positioning block in a finished program.



Example: Turning shoulders

PGM	Select Program Input.

AXIS ?
StEP :

Z 0 ENT	Select the axis (for example, Z), enter the nominal coordinate (for example, 15 mm) and confirm with ENT.

•
•
•

	If you are doing actual machining, traverse the Z axis until the display value is zero.
↓	Select the next step.

AXIS ?
StEP 2

X 1 0 ENT	Select the axis (such as X), enter the coordinate (such as 10 mm) (diameter), confirm entry.
	If you are doing actual machining, traverse the X axis until the display value is zero.

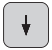
Enter further blocks in the same manner.

The complete program:

1	Zs	=	+0
2	X	=	+10
3	Zs	=	–20
4	X	=	+20
5	IZs	=	–35
6	X	=	+30

Deleting programs, deleting blocks, inserting empty blocks

Program Input is active.

	Select the deleting/inserting functions.
	With the arrow keys, select the desired function (for example, `DELETE BLOCK`).

`DELETE BLOCK ?`

	Press ENT to start the function.

Error Messages

Message	Problem
AMPL. X TOO LOW	The encoder signal is too weak. The scale may be contaminated.
INPUT ERROR	The entered value is not within the permissible input range.
ERROR: REF. X	The spacing of the reference marks as defined in P43 is not the same as the actual spacing.
FRQ. EXCEEDED X	The input frequency for this encoder input is too high. This can occur when the scale is moved too fast.
COMP. DELETED	Compensation values for non-linear axis error compensation erased.
PARAM. ERASED	Check the operating parameters. If this error recurs, contact your service agency.
PGM ERASED	The program has been deleted. If this error recurs, contact your service agency.
PGM TOO LARGE	The maximum program length is 99 blocks.

Message	Problem
OFFSET DELETED	Offset compensation values for encoder signals erased.
PRESET ERASED	The datum points have been erased. If this error recurs, contact your service agency.
KEY W/O FUNCTION	This key currently has no function.
TEMP. EXCEEDED	The temperature of the ND is too high.

To clear error messages

When you have removed the cause of the error,

➤ press the CL key.

Items Delivered

- **ND 930** for two axes
  or
- **ND 970** for three axes

- **Power connector**
  Id.-Nr. 257 811 01

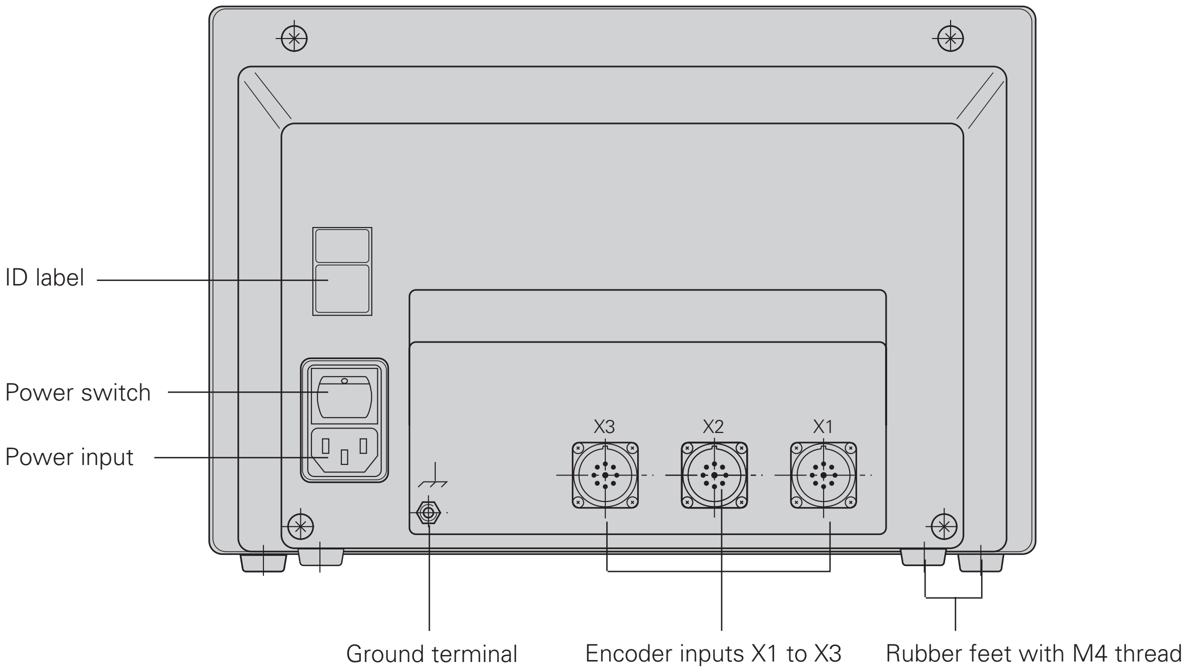
- **User's Manual**

Optional accessories

- **Tilting base**
  Id.-Nr. 281 619 01

Part II: Installation and Specifications

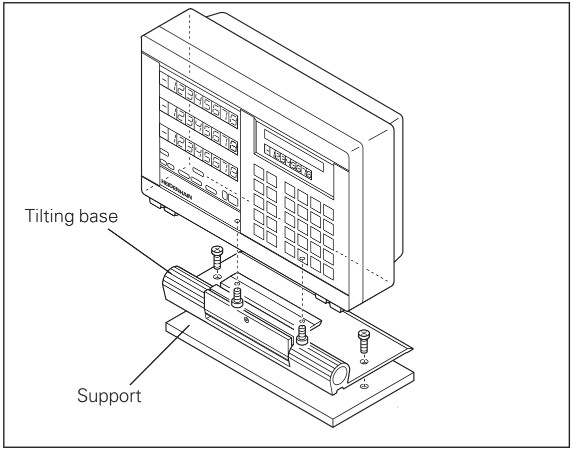
Connections on Rear Panel



Connections X1, X2, X3, are not shock hazardous according to EN 50178.

Mounting

To mount the display unit on a support, use the M4 threaded holes in the rubber feet. You can also mount the display unit on the optional tilting base.



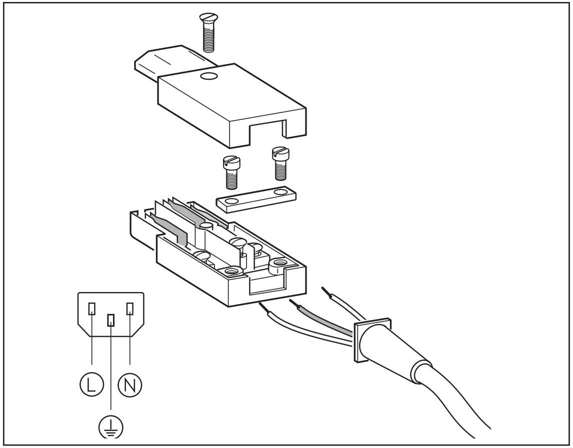
Power Connection

Hot leads: Ⓛ and Ⓝ
Protective ground: ⏚

- **Danger of electrical shock!**
  Connect a protective ground. This connection must never be interrupted.
- Unplug the power cord before opening the housing.

To increase the noise immunity, connect the ground terminal on the rear panel to the central ground point of the machine. (Minimum cross-section: 6 mm^2)

The display unit will operate over a voltage range of 100 V to 240 V AC. A voltage selector is not necessary.



Danger to internal components!
Use only original replacement fuses.
Two line fuses and a fuse for the switching outputs are inside the housing.
Fuse types: Line: F 2.5 A 250 V
Switching outputs: F 1 A

Connecting the Encoders

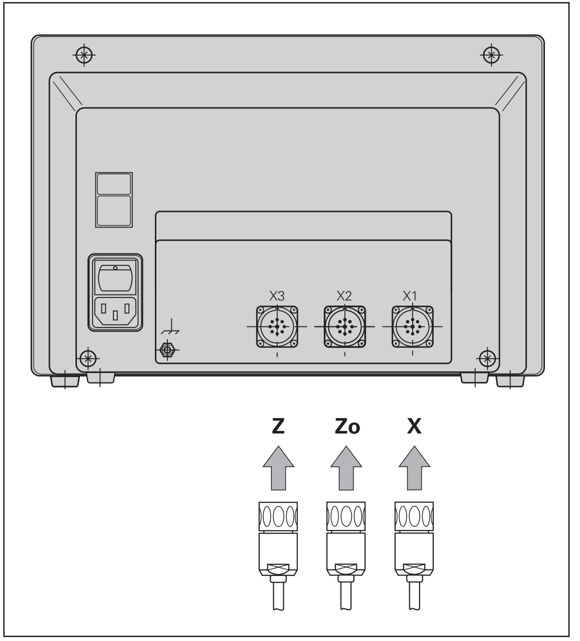
Your display unit will accept all HEIDENHAIN linear encoders with sinusoidal output signals (11 to 40 μA_{pp}) and distance-coded or single reference marks.

Assignment of the encoder inputs for the ND 930

Encoder input X1 is for the X axis
Encoder input X2 is for the Z axis

Assignment of the encoder inputs for the ND 970

Encoder input X1 is for the X axis
Encoder input X2 is for the Zo axis
Encoder input X3 is for the Z axis



Encoder monitoring system

Your display unit features a monitoring system for checking the amplitude and frequency of the encoder signals. If it detects a faulty signal, one of the following error messages will be generated:

```
AMPL.X TOO LOW
AMPL.X TOO HIGH
FRQ. EXCEEDED X
```

Encoder monitoring can be activated with parameter P45.

If you are using linear encoders with distance-coded reference marks, the encoder monitoring system also checks whether the spacing of the reference marks as defined in parameter P43 is the same as the actual spacing on the scales. If it is not, the following error message will be generated:

```
ERROR: REF. X
```

Operating Parameters

Operating parameters allow you to modify the operating characteristics of your display unit and define the evaluation of the encoder signals. Operating parameters that can be changed by the user are called user parameters, and can be accessed with the MOD key and the dialog PARAMETER (user parameters are identified as such in the parameter list). The full range of parameters can only be accessed through CODE NUMBER.

Operating parameters are designated by the letter P and a number. Example: **P11**. The parameter designation is shown in the input field as you press the arrow keys to select a parameter. The parameter setting is displayed in the message field.

Some operating parameters have separate values for each axis. Such parameters have an additional index number from 1 to 3 (ND 930: index 1 to 2).

Example P12.1 scaling factor, X axis
P12.2 scaling factor, Zo axis (ND 970 only)
P12.3 scaling factor, Z axis

Operating parameters P60 and P61 (definition of the switching ranges) have an index from 0 to 7.

The operating parameters are preset before the unit leaves the factory. These factory settings are indicated in the parameter list in **boldface type**.

Entering and changing operating parameters

To access the operating parameters

➤ Press the MOD key
➤ Confirm with ENT to access the user parameters, or select the dialog for entering the code number **(95148)** with the arrow down key to be able to change all operating parameters.

To page through the operating parameters

➤ Page forwards by pressing the arrow down key.

➤ Page backwards by pressing the arrow up key.

➤ Go directly to an operating parameter by pressing GOTO, keying in the parameter number and then pressing ENT.

To change parameter settings

➤ Press the minus key or enter the value and confirm with the ENT key.

To correct an entry

➤ Press CL. This restores the old value.

To leave the operating parameters

➤ Press MOD again.

List of operating parameters

P1 Unit of measurement [1)]

Display in millimeters	**mm**
Display in inches	inch

P11 Activate scaling factor [1)]

Scaling factor active	SCALING ON
Not active	**SCALING OFF**

P12.1 to P12.3 Enter scaling factor [1)]

Enter a scaling factor separately for each axis:
Entry value > 1: workpiece will "grow"
Entry value = 1: workpiece will remain the same size
Entry value < 1: workpiece will "shrink"

Input range:	0.111111 to 9.999999
Factory setting:	**1.000000**

P30.1 to P30.3 Counting direction

Positive counting direction with positive direction of traverse	**COUNTR. X : POS.**
Negative counting direction with positive direction of traverse	COUNTR. X : NEG.

P31.1 to P31.3 Signal period of encoder

2 µm / 4 µm / 10 µm / **20 µm** / 40 µm
100 µm / 200 µm / 12800 µm

P32.1 to P32.3 Subdivision of the encoder signals

128 / 100 / 80 / 64 / 50 / 40 / **20** / 10 / 5 / 4 / 2 / 1 /
0.5 / 0.4 / 0.2 / 0.1

P40.1 to P40.3 Define axis error compensation

Axis error compensation not active	**AXIS COMP X OFF**
Linear axis error compensation active	LINEAR COMP. X
Multipoint axis error comp. active	AXIS COMP X F(a)

(See "Multipoint Axis Error Compensation")

P41.1 to P41.3 Linear axis error compensation

Input range (µm):	–99999 to +99999
Factory setting:	**0**

Example Displayed length L_d = 620.000 mm
Actual length (as determined for example with the VM 101 from HEIDENHAIN)
L_a = 619.876 mm
Difference $\Delta L = L_a - L_d = -124$ µm
Compensation factor k:
$k = \Delta L / L_d = -124$ µm/0.62 m = **–200** [µm/m]

[1)] User parameter

P43.1 to P43.3 Reference marks

One reference mark	0
Distance-coded with 500 x SP	500
Distance-coded with 1000 x SP	**1000**
Distance-coded with 2000 x SP	2000
Distance-coded with 5000 x SP	5000

(SP = signal period)

P44.1 to P44.3 Reference mark evaluation

Reference mark evaluation active	**REF. MODE X ON**
Not active	REF. MODE X OFF

P45.1 to P45.3 Encoder monitoring

Amplitude and frequency monitoring active	**ALARM X ON**
Not active	ALARM X OFF

P48.1 to P48.3 Activate axis display

Axis display active	**AXIS DISPL.X ON**
Not active	AXIS DISPL.X OFF

P81.1 to P81.3 Encoder

Max. encoder signal 16 μA_{pp}	**ENCODER X 16µA**
Max. encoder signal 40 μA_{pp}	ENCODER X 40µA

P98 Dialog language [1)]

German	**DIALOG LANG. D**
English	DIALOG LANG. US
French	DIALOG LANG. F
Italian	DIALOG LANG. I
Dutch	DIALOG LANG. NL
Spanish	DIALOG LANG. E
Danish	DIALOG LANG. DK
Swedish	DIALOG LANG. S
Czech	DIALOG LANG. CZ
Japanese	DIALOG LANG. J

[1)] User parameter

Linear Encoders

Setting the display step with linear encoders

The display step depends on the
- **signal period** of the encoder **(P31)** and the
- **subdivision (P32).**

Both parameters are entered separately for each axis.

For linear measurement using nut/ballscrew arrangements and rotary encoders, calculate the signal period as follows:

$$\text{Signal period [µm]} = \frac{\text{Drivescrew pitch [mm] x 1000}}{\text{Line count}}$$

Display step, signal period and subdivision for linear encoders

Display step [mm]	[inches]	P31: Signal period [µm] 2	4	10	20	40	100	200	12800
		P32: Subdivision							
0.000 02	0.000 001	100	–	–	–	–	–	–	–
0.000 05	0.000 002	40	80	–	–	–	–	–	–
0.000 1	0.000 005	20	40	100	–	–	–	–	–
0.000 2	0.000 01	10	20	50	100	–	–	–	–
0.000 5	0.000 02	4	8	20	40	80	–	–	–
0.001	0.000 05	2	4	10	20	40	100	–	–
0.002	0.000 1	1	2	5	10	20	50	100	–
0.005	0.000 2	0.4	0.8	2	4	8	20	40	–
0.01	0.000 5	0.2	0.4	1	2	4	10	20	–
0.02	0.001	–	–	0.5	1	2	5	10	–
0.05	0.002	–	–	0.2	0.4	0.8	2	4	–
0.1	0.005	–	–	0.1	0.2	0.4	1	2	128
0.2	0.01	–	–	–	–	–	–	–	64

Compatible HEIDENHAIN linear encoders

Encoder	Signal period P31	Ref. marks P43	Display step		Sub-division P32
			mm	inches	
LIP 40x	**2**	**0**	0.001 0.000 5 0.000 2 0.000 1 0.000 05 0.000 02	0.000 05 0.000 02 0.000 01 0.000 005 0.000 002 0.000 001	**2** **4** **10** **20** **40** **100**
LIP 101 A LIP 101 R	**4**	**0**	0.001 0.000 5 0.000 2 0.000 1 0.000 05	0.000 05 0.000 02 0.000 01 0.000 005 0.000 002	**4** **8** **20** **40** **80**
LIF 101 R LIF 101 C LF 401 LF 401 C	**4**	**0** **5000** **0** **5000**	0.001 0.000 5 0.000 2 0.000 1	0.000 05 0.000 02 0.000 01 0.000 005	**4** **8** **20** **40**
LID xxx LID xxx C	**10**	**0** **2000**	0.001 0.000 5 0.000 2 0.000 1	0.000 05 0.000 02 0.000 01 0.000 005	**10** **20** **50** **100**
LS 103 LS 103 C LS 405 LS 405 C ULS/10	**10**	**0** **or** **1000**			

Encoder	Signal period P31	Ref. marks P43	Display step		Sub-division P32
			mm	inches	
LS 303 LS 303 C LS 603 LS 603 C	**20**	**0** **or** **1000**	0.01 0.005	0.000 5 0.000 2	**2** **4**
LS 106 LS 106 C LS 406 LS 406 C LS 706 LS 706 C ULS/20	**20**	**0** **or** **1000**	0.01 0.005 0.002 0.001 0.000 5	0.000 5 0.000 2 0.000 1 0.000 05 0.000 02	**2** **4** **10** **20** **40**
LIDA 10x LB 302	**40**	**0** **or** **2000**	0.002 0.001 0.000 5	0.000 1 0.000 05 0.000 02	**20** **40** **80**
LIDA 2xx LB 3xx LB 3xx C	**100**	**0** **1000**	0.01 0.005 0.002 0.001	0.000 5 0.000 2 0.000 1 0.000 05	**10** **20** **50** **100**
LIM 102	**12800**	**0**	0.1	0.005	**128**

Multipoint Axis Error Compensation

> If you want to use the multipoint axis error compensation feature, you must
> - activate this feature with operating parameter P40 (see "Operating Parameters")
> - traverse the reference marks after switching on the display unit.
> - enter compensation value table

Your machine may have a non-linear axis error due to factors such as axis sag or drivescrew errors. Such deviations are usually measured with a comparator measuring system. This allows you to determine, for example, the screw pitch error [X = F(X)] for the X axis. The display value is then automatically compensated by the error associated with the current position.

An axis can only be corrected in relation to **one** axis causing the error. You can create a compensation value table for each axis, with each table containing 64 compensation values. The tables can then be accessed with the MOD key and CODE NUMBER.

Entries in the compensation value table

- Axis to be compensated: X, Z or Zo (Zo only with ND 970)
- Axis with error: X, Z or Zo (Zo only with ND 970)
- Datum for the axis to be corrected:
  Here you enter the point starting at which the axis with error is to be corrected. This point indicates the absolute distance to the reference point.

> Do not change the datum point after measuring the axis error and before entering the axis error into the compensation table.

- Spacing of the compensation points
  The spacing of the compensation points is expressed as
  2^{X} [µm].
  Enter the value of the exponent *x* into the compensation value table.
  Minimum input value: 6 (= 0.064 mm)
  Maximum input value: 20 (= 1052.672 mm)
  Example: 600 mm traverse and 35 compensation points:
  results in 17.143 mm spacing between points.
  Nearest power of two: 2^{14} [µm] = 16.384 mm
  Entry in compensation value table: 14
- Compensation value
  You enter the measured compensation value (in millimeters) for the displayed compensation point.
  Compensation point 0 always has the value 0 and cannot be changed.

To select the compensation value table and enter an axis correction

MOD	Press MOD.

PARAMETER ?

↓ ENT	Select dialog for entering the code number.

CODE NUMBER ?

1 0 5 2 9 6 ENT	Enter 105296 and confirm with ENT.

COMP. AXIS = X

X ↓	Select the axis to be corrected (e.g., cross slide X), and confirm.

X = FCT (Z)

Z ↓	Enter the axis causing the error (e.g., saddle Z) and confirm.

•
•
•

DATUM Z =

2 7 ↓	Enter the active datum for the error on the axis to be corrected (e.g., 27 mm) and confirm.

POINT SPACING Z=

1 0 ↓	Enter the spacing of the compensation points on the axis to be corrected, for example 2^{10} µm (equals 1024 mm) and confirm.

X 27.000 X =

↓ 0 . 0 1 ↓	Select compensation point no. 1, enter the associated compensation value (e.g., 0.01 mm) and confirm.

X 28.024 X =

Enter all further compensation points. If you press and hold the arrow down key when selecting the next compensation point, the number of the current compensation point will be displayed in the input line. You can go directly to compensation points by using the GOTO key and entering the corresponding number.

MOD	Conclude entry.

To delete a compensation value table

Key	Action
MOD	Press MOD.

`PARAMETER ?`

Key	Action
↓ ENT	Select the dialog for entering the code number.

`CODE NUMBER ?`

Key	Action
1 0 5 2 9 6 ENT	Enter 105296 and confirm with ENT.

`COMP. AXIS = X`

Key	Action
Z ⁄⁄	Select the compensation value table (e.g., for the Z axis), and delete the table.

`DEL.COMP.AXIS Z?`

Key	Action
ENT	Confirm with ENT, or cancel with CL.

`COMP.AXIS = Z`

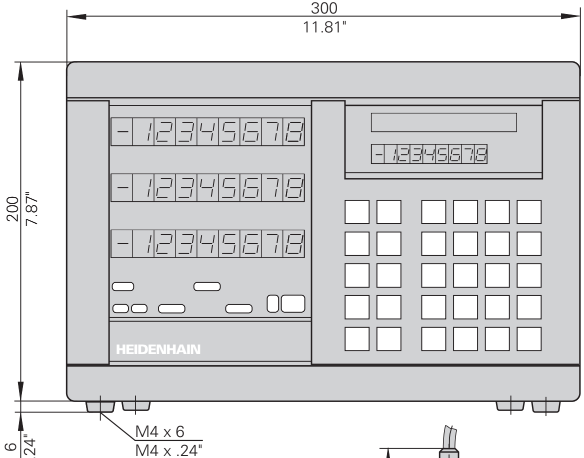
Key	Action
MOD	Conclude entry.

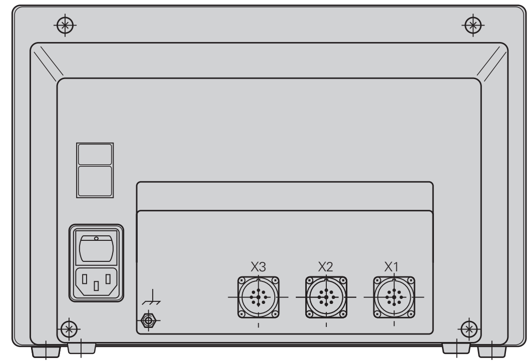
Specifications

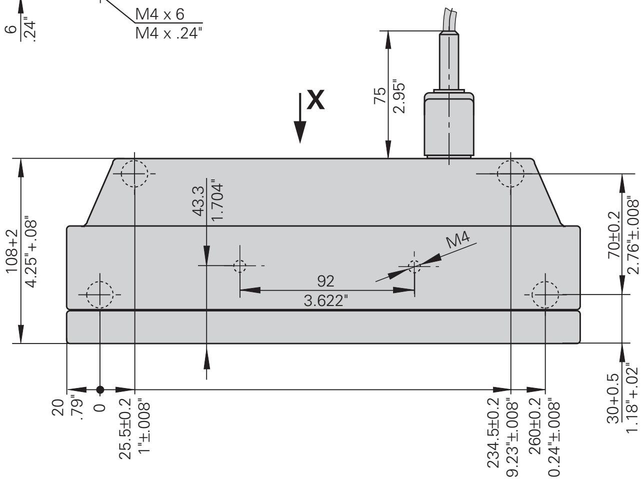
Housing	Bench-top design, cast metal Dimensions (W x H x D): 300 mm x 200 mm x 108 mm
Operating temp.	0° to 45°C (32° to 113°F)
Storage temp.	–30°to 70°C (–22 to 158°F)
Weight	Approx. 3 kg
Relative humidity	<75% annual average <90% in rare cases
Power supply	100 V to 240 V (–15% to +10%) 48 Hz to 62 Hz
Power consumption	ND 970: 19 W ND 930: 17 W
Protection	IP 40 (IEC 529)

Encoder inputs	Encoders with 7 to 16 μA_{pp} or 16 to 40 μA_{pp} output signals accepted. Grating period: 2, 4, 10, 20, 40, 100, 200 µm and 12.8 mm. Reference mark evaluation for distance-coded and single reference marks.
Input frequency	Max. 100 kHz with 30 m (66 ft) cable
Display step	Adjustable (see "Linear Encoders")
Tool datums	99 (nonvolatile)
Functions	– Distance-to-go display – Radius/diameter display – Separate value/sum display (ND 970 only) – Memory for 99 program steps – Hold position – Set absolute datum – Taper calculator – Turning with oversizes – Multipass cycle – Scaling factors

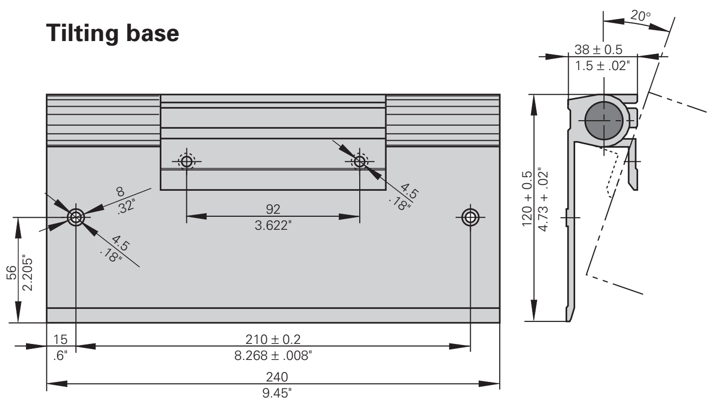
Dimensions in mm/inches







Tilting base



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