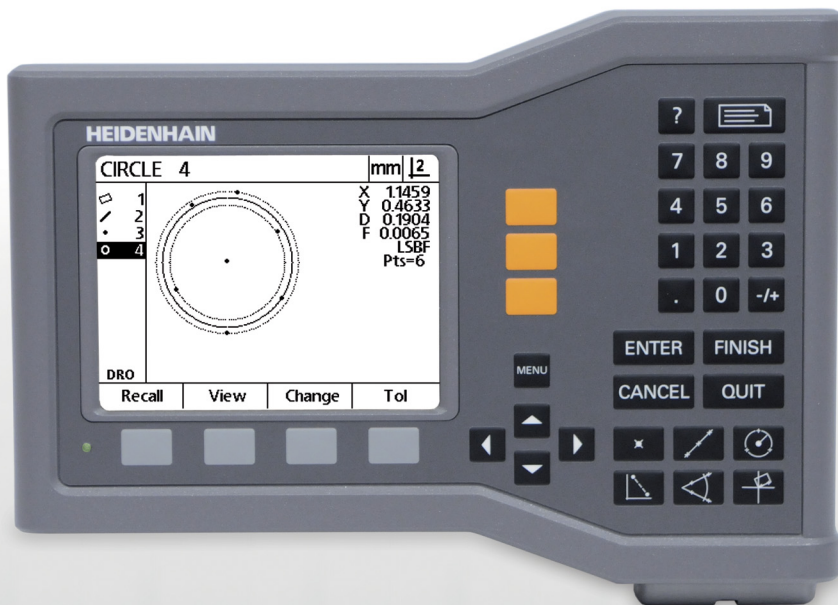# HEIDENHAIN

Operating Instructions

ND 120
QUADRA-CHEK
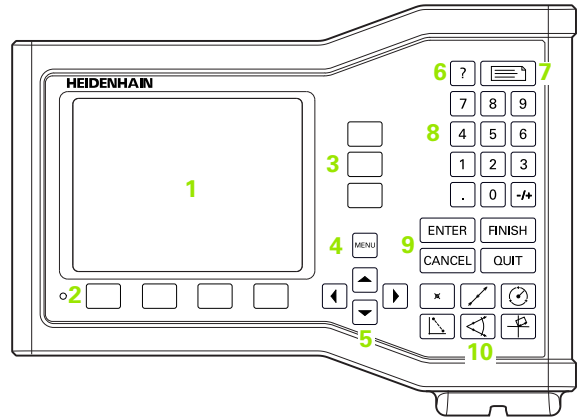
**Software Version
2.0.x**

**English (en)
4/2013**

Introduction

1 LCD screen
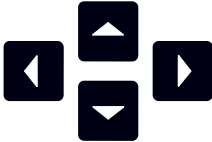**2** Soft keys
3 Axis keys
4 Menu key
5 Arrow keys
6 Help key
7 Send key
8 Numeric keypad
9 Command keys
10 Measure keys

Front panel keys

Panel keys are used to initiate feature measurements, apply tolerances, send reports of measurement results and configure operational parameters.

Panel function key	Panel key
Soft keys: Functions change in support of the activities displayed on the LCD.	
Axis keys: Select axes for zeroing or presetting datums prior to measurements.	
Menu key: Displays soft key menus for system setup, extra functions and clearing data.	MENU
Arrow keys: Used to scroll through lists and navigate menus and setup screen data fields. The **Up Arrow** key is also used to begin a feature construction process, as described in "Constructing Part Features" on page 47.	
Help key: Displays help topics for current function.	?
Send key: Used to transmit measurement results to a computer.	

Panel function key	Panel key
Numeric keypad: Used to enter numeric data.	7 8 9 4 5 6 1 2 3 . 0 -/+
Command keys: Control measurement and data entry processes.	ENTER FINISH CANCEL QUIT
Measure keys: Select a feature measurement type. Feature measurement types include points, lines, circles distances, angles and skew alignments.	

Rear panel

1 Power switch
2 Power cord connector
3 Replaceable fuse holder
4 USB (type B) interface
5 Encoder inputs
6 Earth (ground) terminal

> **Notice**
>
> Do not engage, or disengage any connections while the unit is under power. Damage to internal components may result.

> **Notice**
>
> It is necessary to connect the earth (ground) terminal on the rear of the product to the star point of machine ground. Minimum cross section of the connecting wire: 6 mm2. Never use this equipment without proper grounding.

> **Notice**
>
> Periodically inspect the display unit, connectors and connection cables for damage and poor connections.
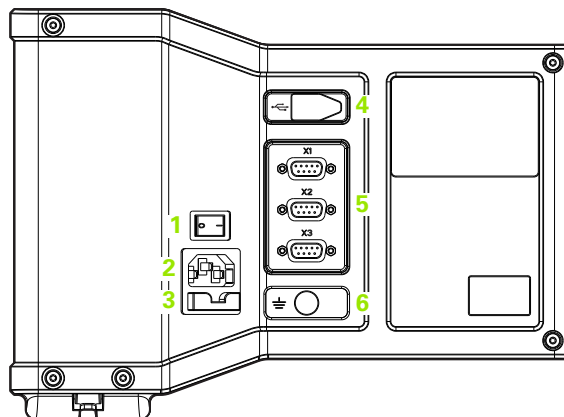
Information contained in this manual

These Operating Instructions cover the operation, installation, setup and specifications of the following models:

Product name	ID	Index
ND 122 QUADRA-CHEK	749315-02	-, A, B
ND 122 QUADRA-CHEK	749315-03	-, A, B
ND 123 QUADRA-CHEK	749315-12	-, A, B
ND 123 QUADRA-CHEK	749315-13	-, A, B

Operating information is contained in chapter 1. Installation, setup instructions and specifications are contained in chapter 2. For detailed Installation Instructions refer to the ND 120 Installation Instructions (ID 1029950-xx).

Software version

The software version is shown in the About setup screen. See "Language selection and product version" on page 71.

Fonts used in this manual

The following fonts are used to indicate operator controls or to show emphasis:

- Operator controls - **Soft Keys** and other **Panel Keys** are shown in letter gothic bold font.

- Emphasis - **Items of special interest** or **concepts** that are emphasized to the user are shown in bold type.

Showing sequences of key presses

The user performs sequences of soft key and panel key presses to measure features and complete other tasks. These sequences are indicated using text as shown in the following example:

- Press the **MENU** key, press the **Clear** soft key and then press the **Yes** soft key is sometimes abbreviated as:

- Press **MENU>Clear>Yes**

Safety symbols

Where the following safety symbols appear on the product they alert you to important safety information.

Symbol	Description
⚠	This symbol denotes "Caution, risk of danger". Refer to the accompanying information or documentation to protect against personal injury or damage to the unit.
⏚	This symbol is used to denote "Earth (ground) terminal".
		This symbol is used to denote the power switch "On (supply)" position.
○	This symbol is used to denote the power switch "Off (supply)" position.

Messages shown in these instructions

The following examples show how safety, property damage and general advice messages are shown in these instructions. Read and understand these types of messages before proceeding to prevent personal injury or property damage.

⚠ Messages about other safety messages. These supplemental directives do not address specific hazards, but instead provide information that promotes awareness and use of specific safety messages.

⚠ **Warning!**

Messages that provide information about the nature of a hazardous situation, the consequences of not avoiding a hazardous situation, and method(s) for avoiding a hazardous situation.

➡ **Notice**

Messages that provide information primarily about situations that can lead to property damage, the potential consequences of not avoiding the situations, or method(s) for avoiding the situations and general advice messages.

Safety

The following messages provide safety information for preventing personal injury and product damage:

Read and understand these instructions before use to avoid the possibility of personal injury or death.

Hazardous live parts may be exposed if the unit is opened. Do not open the unit. There are no serviceable items inside.

The protection provided by the equipment may be impaired if used in a manner not specified. Do not use this product in any way other than its intended use.

Notice

For safety, operation and handling of the unit, keep this document for future reference.

Cleaning

Warning! Risk of electrical shock

While cleaning it is possible to conduct electricity from hazardous live parts if liquid enters the product.

To avoid the hazard, always power off the product, disconnect the power cable and never use a cloth that is dripping or saturated with water.

Notice

Never use abrasive cleaners, strong detergents or solvents to avoid damage to the product.

▶ Power-off the DRO.

▶ Disconnect the power cable from the source of power.

▶ Clean exterior surfaces with a cloth dampened with water and a mild detergent.

Measurement axes

The ND 120 DRO's display 2 or 3 axes depending on the model purchased. DRO screen images used throughout this manual show different numbers of axes and are for illustration only.

Supervisor password

Critical setup parameters are password protected. Only qualified personnel should be given password access to setup screen parameters. This prevents inadvertent adjustments to the installation setup parameters.

> **Notice**
>
> The password is 070583.

Enter the supervisor password

MENU   Press the **MENU** key to display the menu soft keys.

Setup   Press the **Setup** soft key to display the setup menu.

Navigate up or down in the menu to highlight the Supervisor menu item using the **Up/Down Arrow** keys.

Navigate from the menu to the Password setup field using the **Right Arrow** key.

Enter the supervisor password **070583** using the numeric keypad.

FINISH   Press the **FINISH** key to save the password and return to the setup menu.

FINISH   Press the **FINISH** key to return to the DRO.

> **Notice**
>
> Supervisors may wish to remove this page from the Operating Instructions after initially setting up the readout system. Retain in a safe place for future use.

2 Installation, Setup and Specifications 59

1

Operation

1.1 Overview

The ND 120 is an advanced digital readout (DRO) system for performing 2 or 3 axis measurements using TTL encoders. The ND 120 can be used with optical comparators, toolmaker's microscopes or video measurement systems as part of in-line production or in final quality inspection.

The following functions are available:

- Reference mark evaluations for distance-coded and single reference encoders

- Linear, segmented linear and nonlinear error correction

- Scaling factor for parts that expand or shrink

- Multilingual LCD user interface: language is selected by the user

- Soft key functions under LCD change to support different user activities

- Arrow keys for easy navigation of lists and menus

- Skew compensation for part alignment prior to measurement, eliminating the need for time-consuming fixturing

- Two datums for absolute and incremental measurements

- Axis zero and preset keys for establishing datums

- Easy selection of feature measurement type using clearly marked measure function keys:

  - Points, lines, circles, distances, angles
  - Skew for part alignment

- Feature measurement can include:

  - Dimensional measurements of geometric part features
  - Creation of features by entering dimensional data
  - Construction of new features from existing features
  - Applying tolerances
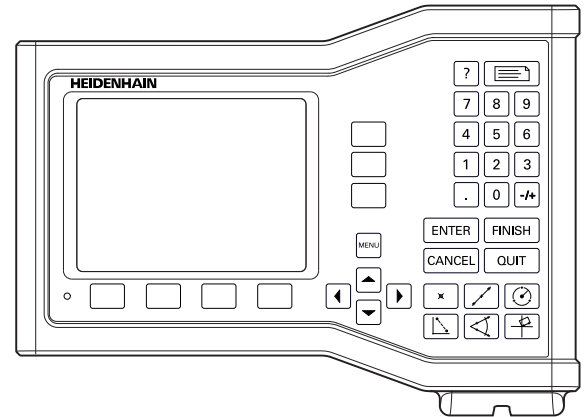
ND 123 Front panel

- Number keypad with:
  - Number keys for data entry
  - Decimal point and +/- keys for data entry
- User-defined hot keys that program panel keys to initiate commonly used functions.
- Reports of measurement results sent to a computer over USB-to-Serial connection
- User-defined settings sent to a computer over USB-to-Serial connection

1.2 Basic Functions

Initial power-up
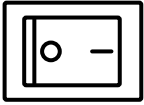
[power switch icon]	Switch on the power (located on the rear of the enclosure). After switching the power on, or after a power failure, the power-up screen will be displayed.
ENTER	Press the **ENTER** key to advance from the power-up screen to the DRO.

Your DRO is now ready for operation and is in the Current Position operating mode. Encoder position values will be displayed for all axes.

ND 122/123
Software Version 2.0.0
ID 749312-03

Press Enter to continue.
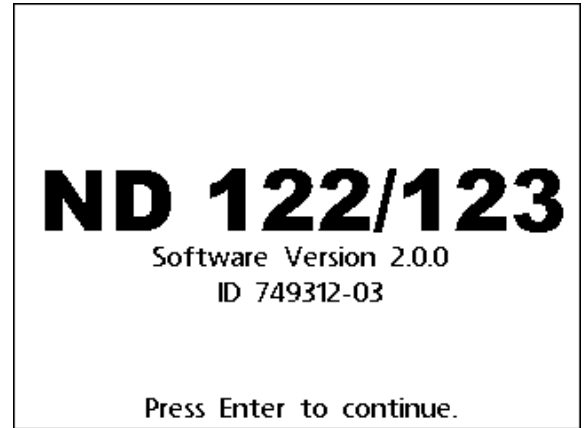
Power-up screen

Current Position   mm |1

X   0.0000
Y   0.0000
Z   0.0000

DRO

DRO screen

Establishing a repeatable machine zero

If your DRO was configured to establish a machine zero upon power-up, a message will be displayed asking you to cross reference marks or enter hard-stop axis reference positions. The machine zero is used by the DRO to apply error correction data as measurements are performed. To establish a repeatable machine zero you must either:

▶ Move the stage to have encoder reference mark crossings recognized on each axis **or**

▶ move the stage to the hard-stop reference position and press **ENTER** on each axis when no encoder reference marks are present.

Notice

If the requirement to cross reference marks is bypassed by pressing the **Cancel** soft key, error correction data that might be stored in your DRO **will not be applied**.

Power-off
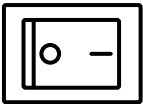
Switch the power off. The parameter settings and error compensation tables that have been saved during operation will be retained in memory.

Panel key descriptions

Descriptions of panel key functions are provided in the following pages for **Measurement** function, **Command, Help**, **Axis, Send** and **Menu** keys. Soft key functions are also described later in the next section as part of screen and soft key layout descriptions.

ND 123 panel keys

MEASURE keys	Function
✖	**Measure point:** Press the **Point** key once to measure one point, or twice to use auto repeat to measure a series of points. A minimum of one data point is required to measure a point.
✦	**Measure line:** Press the **Line** key once to measure one line, or twice to use auto repeat to measure a series of lines. A minimum of two data points are required to measure a line.
◷	**Measure circle:** Press the **Circle** key once to measure one circle, or twice to use auto repeat to measure a series of circles. A minimum of three data points are required to measure a circle.
◹	**Measure distance:** Press the **Distance** key once to measure one distance, or twice to use auto repeat to measure a series of distances. Two points are required to measure a distance.
◁	**Measure angle:** Press the **Angle** key once to measure one angle, or twice to use auto repeat to measure a series of angles. Collect a minimum of two data points, then press the **ENTER** key on each leg of an angle.
⊬	**Align part:** Press the **Skew** key to compensate electronically for non-square part alignment on the primary axis.
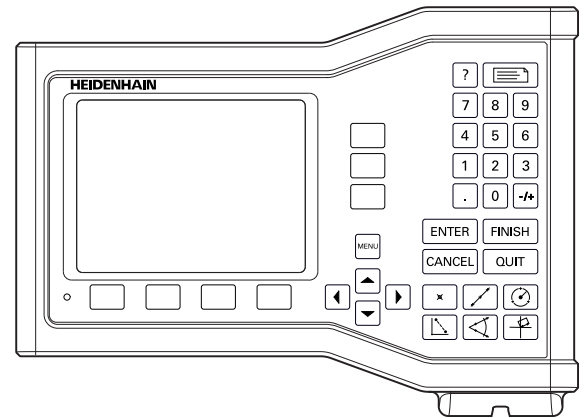
COMMAND keys	Function
ENTER	**Enter data:** Press the **ENTER** key to enter points during feature measurements or to enter values into configuration fields. Pressing the **ENTER** key indicates that data from a measurement or in a field is ready for use.
FINISH	**Finish a measurement:** Press the **FINISH** key to complete a feature measurement. Pressing the **FINISH** key a second time returns the user to the DRO screen.
CANCEL	**Delete data or features:** Press the **CANCEL** key to delete the last point entered, data in configuration fields or any highlighted feature from the feature list.
QUIT	**Quit current activity:** Press the **QUIT** key to abandon the current task and return to the DRO screen or to exit the feature list.

HELP key	Function
?	**Provide help:** Press the **Help** key to display help topics on the screen. Help topics explain how to use the current function.

AXIS keys	Function
	Zero an axis: Press the axis key to the right of the desired axis to zero the axis position value when establishing a zero datum.
	Preset an axis or axes: Press one or more axis keys to the right of the desired axis or axes when presetting axis position values for a new datum.

SEND key	Function
	Transmit measurement results: Press the **Send** key to transmit measurement data to a computer.

MENU key	Function
MENU	**Display soft key menus:** Press the **MENU** key to display the titles of menus above the soft keys. Menus include:
	■ **Setup:** Used by supervisors to configure the operational characteristics of the system.
	■ **Extra:** Used by operators to conduct measurements and send measurement result data.
	■ **Clear:** Used by operators to clear measurement data and datums.

ARROW keys	Function
	Navigate menus and setup screen data fields. The **Up Arrow** key is also used to begin a feature construction process.

Display modes and soft key layout

DRO screens display information in one of four operating modes:

- **DRO mode** displays current positions of axes
- **Feature evaluation mode** screens can be toggled between two displays that show all measurement results and the data cloud of collected points
- **Feature measurement mode** displays feature type, points collected and current positions of axes during measurements
- **Setup mode** displays installation and setup screens

Soft keys change to support activities shown on the screens.

> ➡ **Notice**
>
> Installation and setup screens and soft keys are described later in Chapter 2: Installation, Setup and Specifications.

DRO mode screen

The DRO screen shows:

- Feature list of measured features on the left side
- Unit of measure and current datum in the upper right corner
- The current positions of all axes
- Part alignment status: a small rectangle over the axis letter indicates that the part is aligned to a measurement axis (a skew was performed)

DRO current position screen showing current axis positions

Feature evaluation mode screens and soft keys

The feature evaluation screens can be toggled between two displays by pressing the **View** soft key to show:

■ Feature list of measured features on the left side

■ Unit of measure and current datum in the upper right corner

■ The feature type and number of the highlighted feature

■ Feature position

■ Geometric and dimensional values such as diameter, length or angle

■ Number of data points used to define the feature

■ Form error

■ Parent features used if the feature was constructed

■ An indication that the feature was created if applicable

■ Data cloud of collected data points used to define the feature

DRO soft keys	Function
Recall	Displays a different feature from the feature list by specifying its feature number.
View	Toggles between the default screen showing axis values and the screen showing data points collected to define the feature.
Change	Shows alternative fit algorithms for the current feature type, such as LSBF (least squares best fit) and ISO.
Tol	Displays the alternative tolerances that can be applied to the current feature.

Notice

Tolerances are discussed later in this chapter.
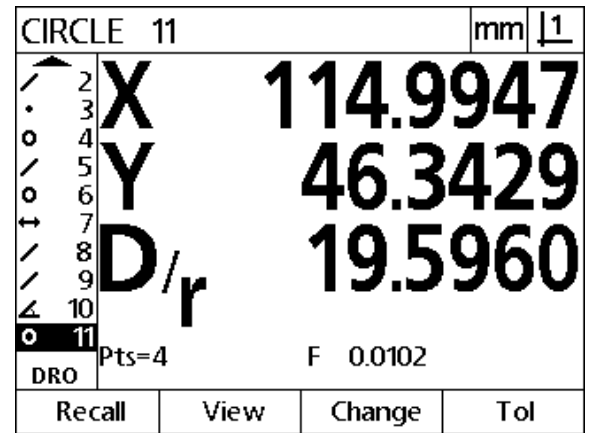
Feature evaluation mode screen showing feature values
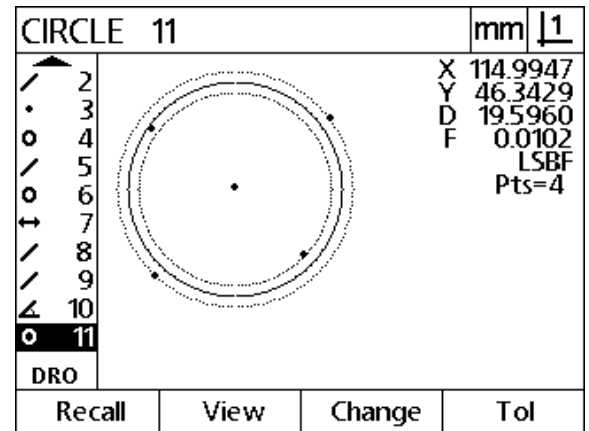
Feature evaluation mode screen showing data points

Feature measurement mode screen and soft keys

The feature measurement screen is displayed after initiating a feature measurement by pressing a **Measurement** key and shows:

■ Feature list of measured features on the left side

■ Unit of measure and current datum in the upper right corner

■ The feature type being probed and the number of collected data points

■ The current positions of all axes

DRO soft keys	Function
Recall	Recalls the first parent feature of a new feature construction.
Create	Displays fields for entering data to create the specified feature type.
Constr	Initiates a new feature construction.
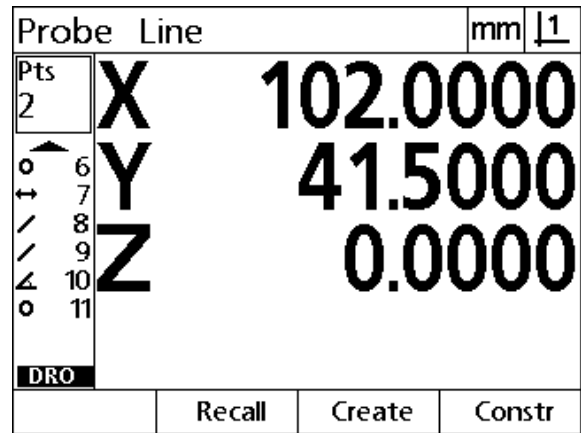
Feature measurement mode screen showing feature type and points collected

Menus

MENU

Press the **MENU** key to display menu titles over the soft keys at the bottom of the LCD screen. Press a menu soft key to display the corresponding menu screen. Menus include:

SETUP menu	SETUP functions

```
About                        mm  1

About      Language      English
Display    Configuration  XYZ
Encoders
Hot Keys
Print
Form Chars
Measure
Supervisor  v2.0.0
LEC         ID 749312-02
            (c) HEIDENHAIN
```

Press the **Setup** soft key to display the collection of Setup screens used to configure the DRO. Use of the Setup menu is explained in Chapter 2: Installation, Setup and Specifications.

```
LINE  12                      mm  1
  3
○ 4    X    65.0000
/ 5
○ 6    Y    65.5000
↔ 7
/ 8    ∠    0°00'00"
/ 9
∠ 10
○ 11
/ 12  Pts=2      F   0.0000
DRO

  Setup           Extra    Clear
```

Menu titles are displayed over soft keys at the bottom of the LCD screen

Notice

Access to setup menu configuration data fields is password restricted to supervisors and other technically qualified personnel. Configuration mistakes can result in serious measurement errors.

EXTRA menu	EXTRA functions

```
Annot.
DMS/DD
Inch/mm
MCS
MinMax
Preset
Preset!
Prt RS
Ref 1/2
```

Press the **Extra** soft key to display the Extra pop-up menu. The Extra menu is used perform many measurement and data transmission functions. Highlight a function and then press the **ENTER** key. Extra menu functions include:

Annot	Toggles between forward and backward annotation.
DMS/DD	Toggles between the display of degrees, minutes, seconds and decimal degrees.
Inch/mm	Toggles between the display of inches and millimeters.
MCS	Clears datums and re-establishes machine coordinates.

EXTRA menu	EXTRA functions
MinMax	Collects and stores minimum and maximum values until the **finish** key is pressed.
Preset	Sets the position of one or more axes to specified values.
Preset!	Recalls the last preset position.
Prt RS	Sends current data to the RS-232 port.
Send 2	Sends current X, Y data to a computer.
Send 3	Sends current X, Y, Z/Q data to a computer.
Send D	Sends current diameter to a computer.
Send F	Sends current form error to a computer.
Send L	Sends current distance to a computer.
Send Q	Sends current Q-axis value to a computer.
Send r	Sends current radius to a computer.
Send X	Sends current X-axis value to a computer.
Send Y	Sends current Y-axis value to a computer.
Send Z	Sends current Z-axis value to a computer.
Send <	Sends current angle to a computer.
Zero 2	Zeros X and Y axes.
Zero Q	Zeros Q-axis protractor value.

CLEAR menu

CLEAR functions

```
Current Position        mm | 1
  3 X    0.0787
o 4
/
o
↔
/        Clear the system of all features,
∠ 10        datums, and skews?
o 11
/ 12 Z   0.0000
DRO
  No    Yes
```
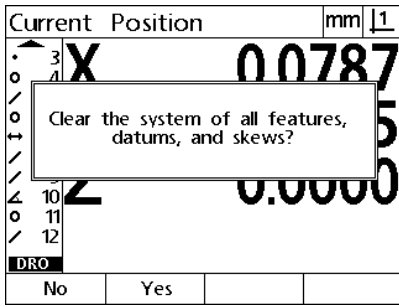
Press the **Clear** soft key to clear feature, datum and part alignment data.

1.3 Preparing to Measure

Power-up

▶ Switch on the product. The power switch is located on the rear of the enclosure. After switching the power on, or after a power failure, the power-up screen will be displayed. See "Initial power-up" on page 20.

▶ Press the **ENTER** key to advance from the power-up screen to the DRO.

If the product was configured to establish a machine zero upon powering up, a message will be displayed asking you to cross reference marks or specify axis references manually.

Establish machine zero

A repeatable machine zero is required for the DRO to apply the calibration chart to the machine geometry correctly.

> It is not recommended to use the machine without active calibration. This would lead to unknown position errors.

Usually the calibration is based on referencing via reference marks on the encoders. To establish the machine zero after power-up:

▶ Move the stage to have the reference mark crossings recognized on each axis.

If the machine zero is determined via hard stops:

▶ Move the stage to the hard-stop reference position and press **ENTER** on each axis.

Select the desired annotation

Annotation determines the number of measurement points collected for each feature type.

■ **Forward annotation:** Use forward annotation to require a previously specified number of points for each feature type. When using forward annotation, the number of required points is shown in the top left corner of the screen. As points are entered, the number of required points counts down. Since a fixed number of points is required using forward annotation, the system automatically completes the measurement and displays the feature after the last required point is entered. It is not necessary to press the **FINISH** key in forward annotation measurements to complete a measurement.

■ **Backward annotation:** Use backward annotation to allow the operator to determine the number of points for each feature. Backward annotation displays the total number of points collected in the top left corner of the screen as they are entered. It is necessary to press the **FINISH** key to complete backward annotation measurements.

Toggle between forward and backward annotation

▶ Press **Menu>Extra>Annot>Enter**

Align the part to a measurement axis

Accurate measurements require the part to be perfectly aligned along a measurement axis. Misaligned parts result in cosine measurement errors. Use the skew function to convert machine coordinates to part coordinates and compensate for part misalignment. Measure a skew each time a new part is mounted on the measuring system.

Measure a skew line by probing a straight edge of the part on a major measurement axis. A minimum of two points is required for a line, but probing more points will improve accuracy.

> **Notice**
>
> The alignment is performed on a part edge here as an example. Part alignments can be made on part features other than an edge. For example, a line constructed between the centers of two holes could be aligned to a measurement axis if desired.
>
> The skew alignment edge or line must be oriented within 45 degrees of the measurement axis.

Perform a part alignment (Skew)

▶ Press the **Skew** key.

▶ Probe a minimum of two points along the part edge. In the example shown here, the part is aligned to the X-axis by probing three points along the bottom edge of the part.

> **Notice**
>
> The part could alternately have been aligned along a vertical edge to the Y-axis.
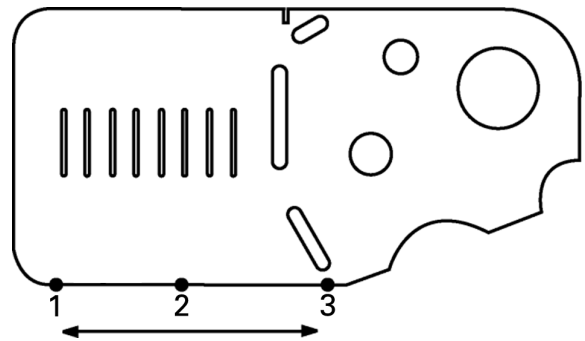
Three points are probed to align the bottom edge of a part to the X-axis

Establish a datum

Establish a reference datum once the part is skewed. Two datums can be created. Typically, datum 1 is a zero reference and used as an absolute or primary datum, while datum 2 is used as an incremental or temporary datum.

Datums can be set to zero or can be preset to specified values.

Two methods can be used to establish a datum:

- Zero or preset the X and Y axes on a point or on the center point of a circle

- Zero or preset the X and Y axes on a point or on a center point constructed from parent features

While the datum can be created from a probed point or from the center point of a probed circle, it is more commonly created from a point that has been constructed from important parent features, such as the skew alignment line and a second part edge line. An example of a datum created from a constructed point is shown below.

> **Notice**
>
> Constructions and the feature measurements necessary for constructions are discussed in detail later in this chapter. However, a brief example of constructions is shown here to adequately cover the topic.

Probe skew and part edge lines for point construction

Probe a skew alignment line along the bottom of the part and probe a line on the left side of the part. These lines will be used to construct a datum point.

Perform skew part alignment to the X-axis on the bottom edge

▶ Press the **Skew** key.

▶ Probe 3 points along the bottom edge (points 1, 2 and 3).

▶ Press the **FINISH** key to complete measuring the skew line.

Probe a line along the left edge

▶ Press the **Line** key.

▶ Probe 3 points along the left edge (points 4, 5 and 6).

▶ Press the **FINISH** key to complete measuring the second line.

The skew and left edge lines will now be shown in the feature list on the left side of the DRO screen. The point construction using these parent features is shown next.
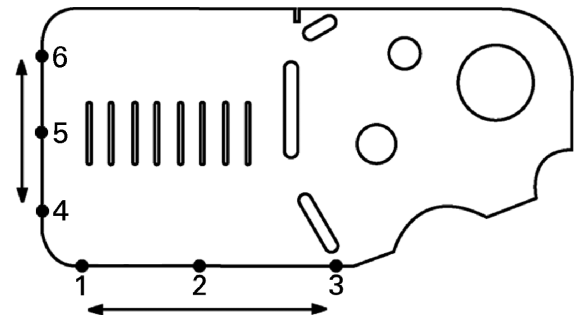
A skew is performed along the bottom and a line is probed on the left side

Construct a datum point from line features

Construct a point from the skew line and the left edge line to create a datum.

▶ Press the **Point** key. The Probe Point screen will be displayed.

▶ Press **Up Arrow>ENTER** to start the construction and select the line feature (2). The screen will change to the Construct Point screen, feature 2 will be checked and skew line feature 1 will become highlighted.

▶ Press **ENTER** to check feature 1.

▶ Press the **FINISH** key to complete the point construction from the intersection of the two checked parent line features.

Probe Point	mm �
Pts 0	X 6.5000
1 2	Y 24.5000
	Z 0.0000
DRO	Recall Create Constr

POINT key is pressed

Construct Point	mm
✓ 1 ✓ 2	X 0.0000
	Y 0.0000
	0°00'00"
DRO Pts=2	F 0.0000 Recall View Probe

Features are selected

POINT 3	mm
1 2 3	X -4.2500
	Y 0.0000
	Z 0.0000
DRO Fts=2	Recall View Change Tol

Point is constructed

Zeroing the datum

Datums can be zeroed or preset. This example creates a zero reference datum from a point feature.

▶ Press the **X** and **Y Axis** keys to zero the point position.

POINT 3	mm
1 2 3	X -4.2500
	Y 0.0000
	Z 0.0000
DRO Fts=2	Recall View Change Tol

Point is highlighted

POINT 3	mm
1 2 3	X 0.0000
	Y 0.0000
	Z 0.0000
DRO Fts=2	Recall View Tol

Point is zeroed as datum

Presetting the datum

Datums can be zeroed or preset. This example creates a preset reference datum from a point feature.

▶ Press **MENU>Extra>Preset>Enter** to display the preset screen.

▶ Press the desired **Axis** key and enter the preset value for the axis.

▶ Press another **Axis** key if desired and enter the preset value for that axis.

▶ Press the **FINISH** key to preset the datum to the specified values.

Annot.
DMS/DD
Inch/mm
MCS
MinMax
Preset
Preset!
Prt RS
Ref 1/2

PRESET Selected from EXTRA menu

Preset axis...
X 2.0
Y 3.0
Z 0.0000
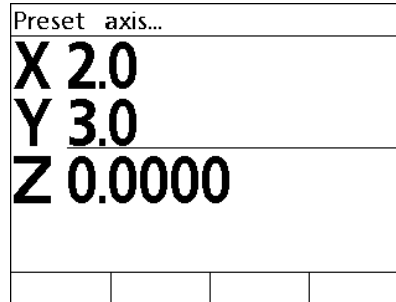
Preset values are entered

Current Position   mm 1
X   2.0000
Y   3.0000
Z   0.0000
DRO
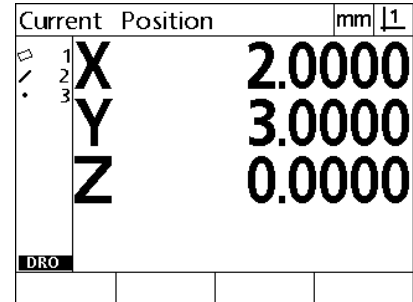
Point is preset as datum

1.4 Measuring Part Features

Part features

Features are measured by probing data points that characterize the dimensional geometry of the part. For example, several points probed around the circumference of a circle results in numeric and graphic representations of the circle geometry. Throughout this manual, a measured geometry is referred to as a **feature** and can alternately be displayed numerically or graphically by pressing the **View** soft key. There are several types of features and each has different dimensional information. For example, a circle has a center point position and a radius, a point has a position, and an angle has degrees.

CIRCLE 11	mm ⊥1
X	115.2301
Y	46.2339
D/r	19.8253
Pts=4	F 0.7298
DRO	
Recall	View	Change	Tol

Feature displayed numerically

CIRCLE 11	mm ⊥1
	X 115.2301
	Y 46.2339
	D 19.8253
	F 0.7298
	LSBF
	Pts=4
DRO	
Recall	View	Change	Tol

Feature displayed graphically

Feature list

Each feature is added to the feature list when it is measured. The feature list shows all features measured on the left side of the LCD screen and is visible in DRO and measuring modes. Each feature is identified by a number and an icon indicating its type (i.e. circle, line, etc.). Up to 100 features can be added to the feature list. Use the **Arrow** keys to scroll through the list. Highlight the desired feature to recall or send the feature data to a computer. Select parent features from the feature list to construct new features. Delete features using the **CANCEL** key or by pressing the **MENU** key and then the **Clear** soft key. In general, the user should delete old features, datums, and skews from the feature list before each new measurement session.

Probing part features

Part features are probed with crosshairs.

Probing with crosshairs

▶ Move the stage to position the crosshairs over the desired feature point and press the **ENTER** key. The probed point will be added to the points required for the feature.

Measuring features

The ND 12x measures point, line, circle, distance and angle features. To measure a feature using **backward annotation** (See "Select the desired annotation" on page 32):

▶ Press the desired feature **Measurement** key

▶ Probe the required points

▶ Press the **FINISH** key

Auto repeat

Use auto repeat to measure several features of the same type (such as a series of circles). Press the desired feature **Measurement** key twice to activate auto repeat. For example, press the **Circle Measurement** key twice to measure a series of circles. When auto repeat is selected, the Probe feature screen becomes the Probe features screen. For example, the Probe Circle screen becomes probe Circles screens as shown below.

Probe Circle screen

Probe Circles screen

Use **auto repeat and forward annotation** to speed up repetitive measurements. For example, the measurement of a dozen circles requires the user to press the **Circle Measurement** key before measuring each circle and press the **FINISH** key for each measurement. The same measurements using auto repeat and forward annotation requires the user to press the **Circle Measurement** key twice before and the **FINISH** key once after measuring all 12 circles. Pressing the **FINISH** key turns off auto repeat.

> **Notice**
>
> Examples of measurements are shown in the next few pages and will use crosshairs to probe points on the 2-D demo part shipped with each unit.

Measuring points

Points are the simplest features to measure. Only one point is required to define the location of a point. A maximum of 100 points can be probed and will be averaged by the system to measure a single point.

▶ Press the **Point Measurement** key. The Probe Point screen will be displayed. Press the key twice to measure a series of points using auto repeat.

▶ Move the stage to position the crosshairs over the desired point location and press the **ENTER** key.

▶ Press the **FINISH** key to complete the measurement. The point position will be shown and the point feature will be added to the feature list.
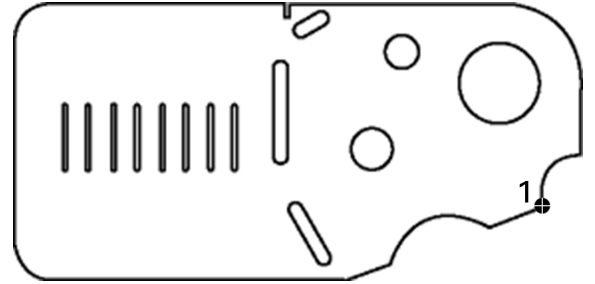
A point is probed on the part

The point position is shown and the point feature is added to the feature list

Measuring lines

A minimum of 2 points are required to measure a line. A maximum of 100 points can be probed and will be processed by a fit algorithm to define the line.

▶ Press the `Line Measurement` key. The Probe Line screen will be displayed. Press the key twice to measure a series of lines using auto repeat.

▶ Move the stage to position the crosshairs over an end point of the line and press the **ENTER** key.

▶ Move the stage to position the crosshairs over the other end point of the line and press the **ENTER** key.

▶ Press the **FINISH** key to complete the measurement. The line position and angle will be shown and the line feature will be added to the feature list.

▶ Press the **Change** soft key to change the line fit algorithm if desired.

Line fit algorithms include:

■ LSBF: Fit determined by minimizing the sum of the squared point deviations from the form fit.

■ ISO: Fit determined by minimizing the form deviation.
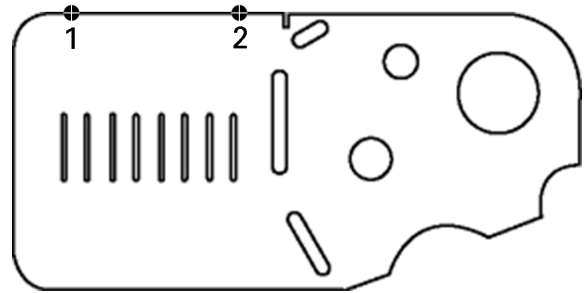
A line is probed on the part

The line position and angle are shown and the line feature is added to the feature list

Measuring circles

A minimum of 3 points are required to measure a circle. A maximum of 100 points can be probed and will be processed by a fit algorithm to define the circle.

▶ Press the **Circle Measurement** key. The Probe Circle screen will be displayed. Press the key twice to measure a series of circles using auto repeat.

▶ Move the stage to position the crosshairs over a point on the circumference of the circle and press the **ENTER** key.

▶ Move the stage to position the crosshairs over two other points evenly distributed around the circumference, pressing the **ENTER** key to collect each point.

▶ Press the **FINISH** key to complete the measurement. The circle position and diameter will be shown and the circle feature will be added to the feature list.

▶ Press the **Left** or **Right Arrow** key to toggle the display between Diameter and Radius if desired.

▶ Press the **Change** soft key to change the circle fit algorithm if desired.

Circle fit algorithms include:

■ LSBF: Fit determined by minimizing the sum of the squared point deviations from the form fit.

■ ISO: Fit determined by minimizing the form deviation.

■ Outer: Yields the biggest circle.

■ Inner: Yields the smallest circle.
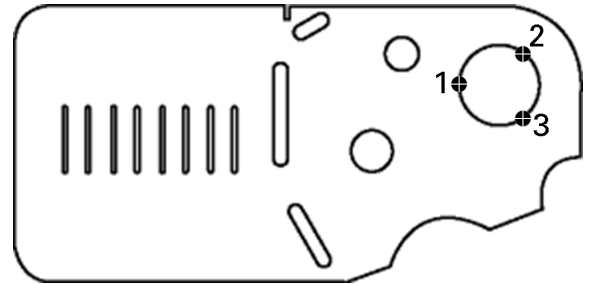
A circle is probed on the part

The circle position and diameter are shown and the circle feature is added to the feature list

Measuring distances

Two points are required to measure a distance.

▶ Press the **Distance Measurement** key. The Probe Distance screen will be displayed. Press the key twice to measure a series of distances using auto repeat.

▶ Move the stage to position the crosshairs over the first of the two points and press the **ENTER** key.

▶ Move the stage to position the crosshairs over the second of the two points, and press the **ENTER** key.

▶ Press the **FINISH** key to complete the measurement. The X, Y and vector distances will be shown and the distance feature will be added to the feature list.

▶ When a Z-axis is used, press the **Left** or **Right Arrow** key to toggle the display between the vector distance (L) and the Z height if desired. Z-axis height is not used in the calculation of vector distance.
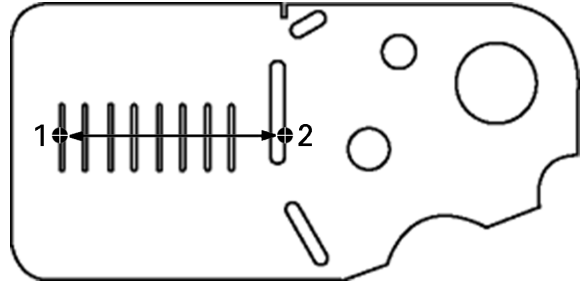
A distance is probed on the part

The X, Y and vector distances are shown and the distance feature is added to the feature list

Measuring angles

A minimum of 4 points evenly divided on two legs of an angle are required to measure an angle. A maximum of 100 points can be probed on the two angle legs. Once the minimum two points are probed on each angle leg, additional points can be distributed between the two legs in any proportion. For example, the first leg could be defined by 4 points, and the second by 8.

▶ Press the **Angle Measurement** key. The Probe Angle screen will be displayed. Press the key twice to measure a series of angles using auto repeat.

▶ Move the stage to position the crosshairs over a minimum of two points evenly distributed on one angle leg, pressing the **ENTER** key to collect each point.

▶ Press the **FINISH** key to complete the measurement of the first leg.

▶ Move the stage to position the crosshairs over a minimum of two points evenly distributed on the second angle leg, pressing the **ENTER** key to collect each point.

▶ Press the **FINISH** key to complete the angle measurement. The angle and angle vertex position will be shown. The angle feature and two angle leg features will be added to the feature list.

▶ Press the **Change** soft key to change the angle type if desired.

Angle types include:

■ INCLD: Included angle (A1).

■ 360-A1: 360 degrees - included angle.

■ 180+A1: 180 degrees + included angle.

■ 180-A1: 180 degrees - included angle
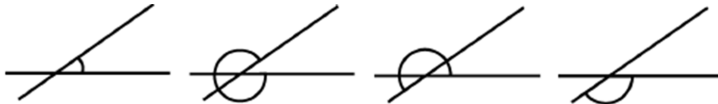
INCLD (A1)   360 - A1   180 + A1   180 - A1
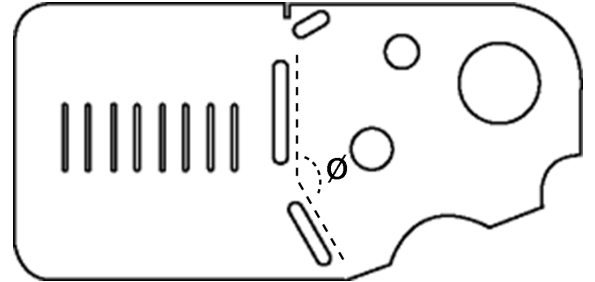
Slot features form an angle (Ø) on the part
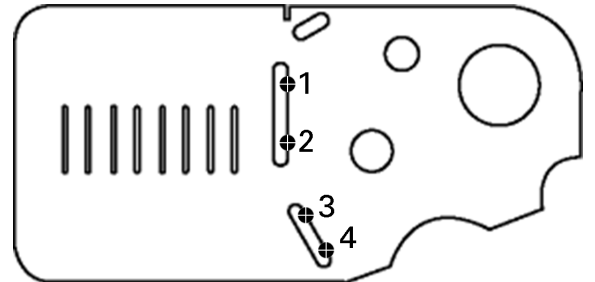
The two legs of an angle are probed on the part

The angle and angle vertex position are shown. The angle and angle legs are added to the feature list

1.5 Creating Part Features

Created features

The Create Part Feature function can be used to create features that are not found on the part geometry. These features can be used as reference points for inspection purposes. For example, in order to measure a feature that is referred to a point off the part geometry, the user could create the reference point.

Users can create points, lines, circles, distances, angles, and part skews. Created features are the same as probed features except that the created features are geometrically perfect, so form error and tolerance values do not apply.

Created features are not the same as constructed features, which are discussed in the next section of this chapter. Created features are defined by the user. For example, to create a circle, the user defines the location of the center point and the diameter or radius. Constructed features are built from previously measured or created parent features. For example, the user could construct a line between two or more points in the feature list. Constructed features can have form errors and tolerance values.

Creating features

The method of creating a feature is identical for all feature types. To create a feature:

▶ Press the desired feature **Measurement** key
▶ Press the **Create** soft key
▶ Enter the required feature data
▶ Press the **FINISH** key

> **Notice**
>
> An example of creating a feature is shown on the next page.

Example of creating a feature

In this example, a circle is created:

▶ Press the **CIRCLE MEASUREMENT** key to display the Probe Circle screen.

▶ Press the **Create** soft key to display the Create data entry screen.

▶ Enter the circle position and diameter (or radius) values.

▶ Press the **FINISH** key. The new circle will be shown on the screen and added to the feature list.

Probe Circle	mm	1
Pts 0	X	32.0000
1 2 3 4 5	Y	10.0000
	Z	0.0000
DRO		
Recall	Create	Constr

Circle Measurement key is pressed

Create Circle	mm	1
	Position	
	X 15	
	Y 1.5	
	Z 0	
	Size	
	D .75	
Radius				

Circle position and diameter values are entered

CIRCLE 6	mm	1
1 2 3 4 5 6	X	1.5000
	Y	1.5000
	D/r	0.7500
DRO	Created	
Recall	View		Tol

New circle is shown in the feature list

1.6 Constructing Part Features

Constructed features

New features can be constructed from probed, created, or other constructed features in the features list. Constructions are frequently used to perform skew alignments, set datums and measure relationships between parent features.

Users can construct points, lines, circles, distances, angles, and part skews. Constructed features are the same as probed features. They can have form errors and tolerances can be applied.

> **Notice**
>
> If a construction is requested that does not include the required parent features or is not supported, an error message is displayed indicating an "Invalid construction".

Constructing features

The method of constructing a feature is identical for all feature types. To construct a feature:

▶ Press the desired feature **Measurement** key
▶ Press the **Constr** soft key or the **Up Arrow** key
▶ Highlight a required parent feature, then press the **ENTER** key to select it
▶ Continue highlighting and selecting parent features until all the required features are selected
▶ Press the **FINISH** key

> **Notice**
>
> An example of constructing a feature is shown on the next page.

1.6 Constructing Part Features

Example of constructing a feature

In this example, a new point feature is constructed from two parent circle features:

▶ Press the **Point Measurement** key.

▶ Press the **Constr** soft key **or** press the **Up Arrow** key to highlight the last feature in the feature list. If the last feature in the feature list will not be one of the parent features, press the **Up Arrow** key until the first parent feature is highlighted. In this example, the first parent circle feature is at the bottom of the feature list.

▶ Press the **ENTER** key to select the highlighted feature. A checkmark will appear at the feature location in the list.

Point Measurement key is pressed

First circle feature is highlighted

First circle feature is selected as a parent feature

▶ Continue highlighting and then selecting features until all the required parent features are selected. In this example, the second circle feature is highlighted and selected.

▶ Press the **FINISH** key to construct the new feature. The new point feature is shown at the bottom of the feature list.

Second circle feature is highlighted

Second circle feature is selected as a parent feature

FINISH key is pressed to complete constructing the new point feature

► Press the **View** soft key to show a graphic image of the feature construction. In this example the image shows that the **Int 1 point feature** was constructed at the top intersection of the two circle circumferences.

► Press the **Change** soft key to show alternative point features that can be constructed from the two parent circle features.

► Press the desired construction alternative soft key to change the feature construction type. In this example, the **Mid Pt point feature** was selected, and the point is constructed at the mid point between the two circle center points.

POINT 6	mm ⊥1
	X 119.5669
	Y 54.8564
	Z 0.0000
	Fts=2

DRO

| Recall | View | Change | Tol |
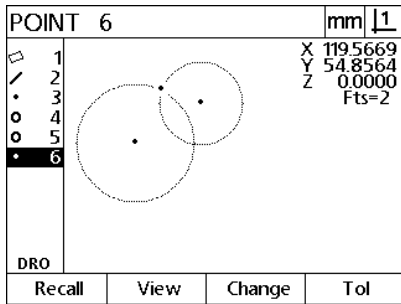
View soft key is pressed to show graphic image of constructed feature

POINT 6	mm ⊥1
	X 119.5669
	Y 54.8564
	Z 0.0000
	Fts=2

DRO

| Int 1 | Int 2 | Mid Pt | |
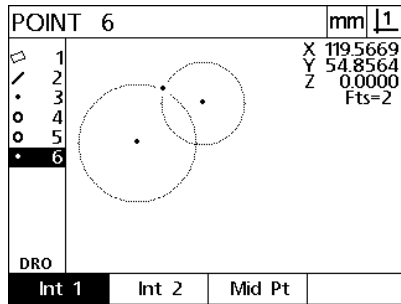
Change soft key is pressed to show alternative constructions

POINT 6	mm ⊥1
	X 120.6613
	Y 49.3206
	Z 0.0000
	Fts=2

DRO

| Recall | View | Change | Tol |
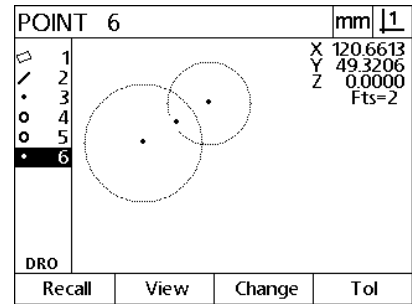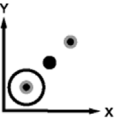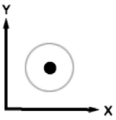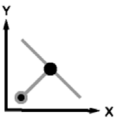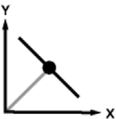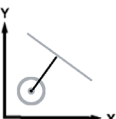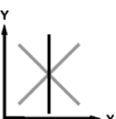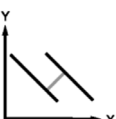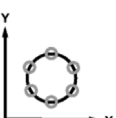
Point feature type is changed from Int 1 to Mid Pt
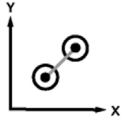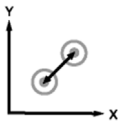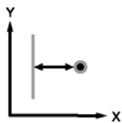
More feature construction examples

A collection of some typical feature constructions are shown here graphically as examples. Many more constructions are possible. Invalid construction requests will initiate an error message.

Construction	Parent features	Graphic
Point	Two lines: intersection	
Point	Line and circle: intersection	
Point	Two circles: intersection	
Point	Two points: mid point	

Construction	Parent features	Graphic
Point	Point and circle: mid point	
Point	Distance and point: offset	
Point	Circle: center point	
Point	Line and point: perpendicular	
Point	Line and datum: perpendicular	
Line	Points: Best fit	
Line	Line and circle: perpendicular	
Line	Two lines: bisector	
Line	Line and distance: offset	
Circle	Multiple circles: best fit	

Construction	Parent features	Graphic
Circle	Circle and distance: offset	
Distance	Two points: point to point	
Distance	Circle and circle: center to center	
Distance	Point and line: perpendicular	
Angle	Two lines: vertex	

1.7 Tolerances

Feature tolerances

The following tolerances are available.

Feature type	Tolerance
Point	Bidirectional position
Point	True position
Line	Bidirectional position
Line	True position
Line	Straightness
Line	Perpendicularity
Line	Parallelism
Line	Angle
Circle	Bidirectional position
Circle	True position
Circle	LMC: Least material condition
Circle	MMC: Maximum material condition
Circle	Roundness
Circle	Concentricity
Circle	Runout
Distance	Width
Angle	Angle

Applying tolerances

The method of applying tolerances is identical for all feature types. To apply a tolerance:

▶ Highlight a feature in the feature list using the **Arrow** keys.

▶ Press the **Tol** soft key to display the tolerance soft keys.

▶ Press the soft key corresponding to the desired tolerance type, such as runout for a circle. A new screen will be displayed containing data fields for nominal and tolerance values.

▶ Enter the nominal and tolerance values and then press the **FINISH** key to display the tolerance results. Press the **FINISH** key again to return to the DRO screen.

Measurements that pass tolerance tests are indicated by a checkmark in the tol soft key box. Measurements that fail are indicated by a crossed circle in the **Tol** soft key box and by outlined characters in the DRO screen.

CIRCLE 4	mm	1
X	115.2004	
Y	46.0595	
D/r	19.6421	
Pts=4	F 0.0424	
DRO		
Recall	View	Change	✓ Tol

Passed tolerance indicated by checkmark in **Tol** soft key box

CIRCLE 4	mm	1
X	115.2004	
Y	46.0595	
D/r	19.6421	
Pts=4	F 0.0424	
DRO		
Recall	View	Change	⊗ Tol

Failed tolerance indicated by crossed circle in **Tol** soft key box and outline characters

> **Notice**
>
> An example of applying a tolerance is shown on the next page.

Example of applying a tolerance

In this example, a form tolerance (roundness) is applied to a circle feature:

▶ Use the **Arrow** keys to highlight the desired feature in the feature list. In this example, the circle feature is highlighted.

▶ Press the **Tol** soft key to display circle feature tolerance alternatives:
- Pos (Position)
- Form
- Runout
- Con (Concentricity)

▶ Press the soft key corresponding to the desired tolerance type to display the data entry screen. In this example, the **Form** soft key was pressed and the data entry screen for specifying the roundness tolerance is displayed. Initially, the tolerance data field (**Tol. Zone**) contains the measured deviation from ideal roundness.

CIRCLE 4	mm ⌊1
1 X	115.0216
2 3 Y	45.9038
4 D/r	20.0178
DRO Pts=4	F 0.1449
Recall	View	Change	Tol

Circle feature is highlighted using **Arrow** keys

CIRCLE 4	mm ⌊1
1 X	115.0216
2 3 Y	45.9038
4 D/r	20.0178
DRO Pts=4	F 0.1449
Pos	Form	Runout	Con

Tol soft key is pressed to display tolerance soft keys

CIRCLE 4	mm ⌊1
Tolerance:	Form
Tol.Zone	
0.1449	
None	

Form soft key is pressed to display the tolerance data entry screen

▶ Enter the desired nominal tolerance values into the data fields provided. In this example of circle form tolerance, only the roundness tolerance field is provided, and a tolerance of 0.15 is entered.

▶ Press the **FINISH** key to display the tolerance result. The tolerance and actual values will be displayed. In this example, the tolerance value was greater than the actual value and the tolerance passed. A checkmark is shown to indicate a passed test.

▶ Press the **FINISH** key again to return to the DRO screen. The checkmark is shown again in the **Tol** soft key box.

CIRCLE 4	mm ⌐1
Tolerance: Form	
Tol.Zone	
0.15	
None			

The form tolerance is entered

CIRCLE 4	mm ⌐1
Circle Tolerance Results	
Tol Type: Form	
Tol.Zone Actual	
0.1500 0.1449 ✓	
Edit			

The **FINISH** soft key is pressed to display the tolerance test result

CIRCLE 4	mm ⌐1
▱ 1	X 115.0216
╱ 2	
· 3	Y 45.9038
⊙ 4	D/r 20.0178
DRO Pts=4	F 0.1449
Recall	View	Change	✓ Tol

The **FINISH** key is pressed to return to the DRO screen

1.8 Reporting

Reporting

Reports of measurement results can be sent to a computer over a USB-to-Serial connection.

> ➡ **Notice**
>
> Report content and format are specified in the Print setup screen discussed in Chapter 2: Installation and Specifications.

Report types include:

Report type	Report content
Display	The data displayed on the DRO screen is sent as one row for each axis.
Report	All feature measurement data is sent in tabular form without tolerance data.
Tol Rpt	All tolerance data is sent in tabular form. Feature measurement data are not sent.
CSV	All feature measurement data is sent in as comma separated variables without tolerance data.
Tab	All feature measurement data is sent in as tab separated variables without tolerance data.
None	No data are sent.

Sending reports

Reports can be sent at any time. To send a report:

▶ Press the feature **Send** key.

1.9 Error Indications

Scale errors

Only input encoder scale errors are reported. Scale errors are indicated by the presence of graphic bars across the DRO screen instead of numbers. Scale errors can be caused by a few conditions shown in this table:

Possible cause	Corrective action
Damaged encoder reader head	Repair or replace the encoder.
Misaligned encoder reader head	Recalibrate the reader head.
Electrical noise on the encoder input	Verify that the earth ground provided by the power source is in good condition and is connected to the power system ground.
	Verify that the encoder cable is shielded and that the shield is connected to ground at the DRO end.
	Verify that the reader head is not generating electrical noise.
Stage (encoder) velocity too high	Restrict stage velocity. If the velocity required for error-free operation is slow, recalibrate the reader head.
Faulty encoder input connection	Repair or replace the encoder cable or seek the assistance of your HEIDENHAIN distributor.

2

Installation, Setup and Specifications

2.1 Installation, and electrical connection

Items supplied

- Display Unit
- Power cord
- Installation Instructions
- Tilt / Swivel Assembly

Accessories

- Tilting base (ID 625491-01)
- Mounting arm (ID 382893-01)
- Mounting frame (ID 647702-01)
- QUADRA-CHEK Wedge communication software (ID 709141-01)

Installation

The DRO may be installed by attaching the unit to a tilting base, a mounting arm or a mounting frame. Refer to the instructions provided with an accessory for additional information.

> ⚠ Do not mount in a position that makes it difficult to access the power switch or power cable.

Tilting base (ID 625491-01) (optional)

A locking handle is used to secure the DRO from below onto a tilting base.
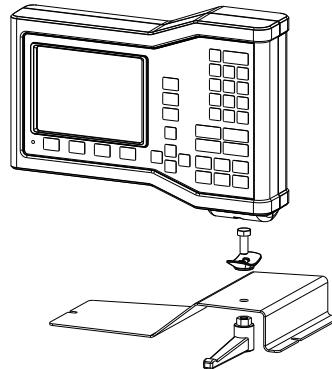
Mounting arm (ID 382893-01) (optional)

A locking handle is used to secure the DRO from below onto a mounting arm.
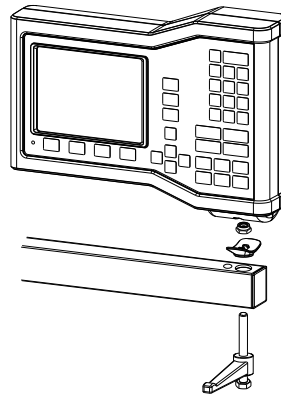
Mounting frame (ID 647702-01) (optional)

A mounting frame is used to secure the DRO for panel mount applications.
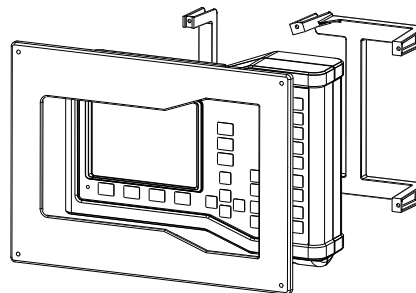
Electrical connection

Electrical requirements

Power input:	AC 100 V ... AC 240 V (–15 % to +10 %)
	50 Hz ... 60 Hz (±2 %)
	max.54 W
Replacable fuse:	T500 mA / 250 V, 5 mm x 20 mm

Environmental conditions

The ND 12x meets standards for normal environmental conditions.

Operating temperature:	0° C ... 45° C
Storage temperature:	-20° C ... 70° C
Protection (EN 60529)	IP40, IP54 front panel
Weight:	2.6 kg

Power connector wiring

L: Line voltage (brown)

N: Neutral (blue)

⏚ Protective conductor (ground) terminal (green/yellow)

3-conductor (grounded)

Minimum diameter: 0.75 mm^2

Maximum length: 3 meters
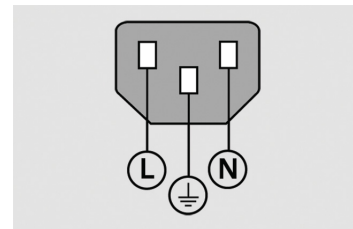
Power connector wiring

⚠ **Warning! Risk of electrical shock**

A risk of electrical shock exists if this product is not properly grounded.

To avoid the hazard, always use a 3-conductor (grounded) power cord and ensure the ground is properly wired to the building installation.

⚠ **Warning! Risk of fire**

A risk of fire exists if a power cord not meeting minimum specifications is used.

To avoid the hazard, always use power cords that meet or exceed the minimum listed specifications.

Replacing a fuse

⚠ **Warning! Risk of electrical shock**

When replacing a fuse it is possible to touch hazardous live parts.

To avoid the hazard, always power off the unit and disconnect the power cable.

➡ **Notice**

Use only replacement fuses meeting rated specifications to avoid damage to the product.

▶ Power-off the DRO
▶ Disconnect the power cable from the source of power
▶ Press the fuse holder release until the retaining mechanism is disengaged
▶ Remove the fuse holder and replace the fuse
▶ Re-insert the fuse holder and gently press until the retaining mechanism is engaged

Connecting encoders

This product can be used with **HEIDENHAIN** linear, and rotary encoders that provide digital TTL level signals.

The **connecting cable** must not exceed 30 meters in length.

The encoder connector locations are:

1   X-axis
2   Y-axis
3   Z/Q-axis

▶ Connect the axis encoder tightly to it's connector. An input label is provided near the connector.
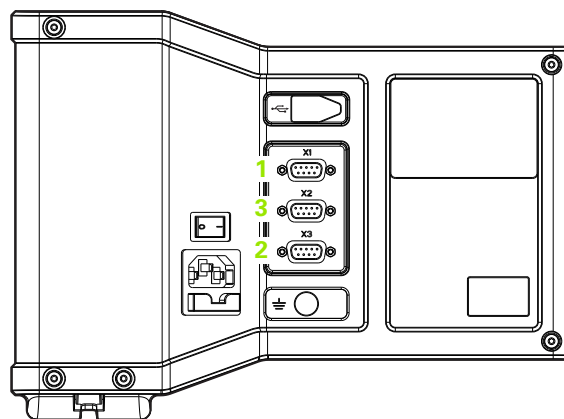
Encoder axis connectors
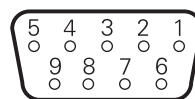
Encoder axis connector pins

Pin layout for encoder inputs:

D-sub connector 9-pin	Assignment
1	N/C
2	Ua1
3	$\overline{Ua1}$
4	Ua2
5	$\overline{Ua2}$
6	0 V (Un)
7	+ V (Up)
8	Ua0
9	$\overline{Ua0}$

Connecting a computer

The USB (type B) (**1**) port can be used to send measurement result data to a computer. Settings data can be sent and received from a computer using Hyperterminal or a similar serial communication program.

> **Notice**
>
> The **USB driver for virtual COM-Port** is required for communication between the DRO and a computer. The driver and installation instructions can be downloaded from www.heidenhain.de

To connect a computer:

▶ Verify that the product is off.

▶ Connect a computer USB (type A) port to the product's USB (type B) port (**1**) using a USB (type A) to USB (type B) cable.

▶ Apply power to the DRO.

▶ Launch the computer application that will be used to communicate with the DRO, and configure the communication properties of the COM port to match those of the DRO. Hyperterminal is used in this manual. See "Connecting to Hyperterminal" on page 66.

Bits per second	115,200
Data bits	8
Parity	None
Stop bits	1
Flow control	Hardware

Pin layout for USB inputs:

USB (type B)	Assignment
1	+5 V
2	Data (-)
3	Data (+)
4	GND
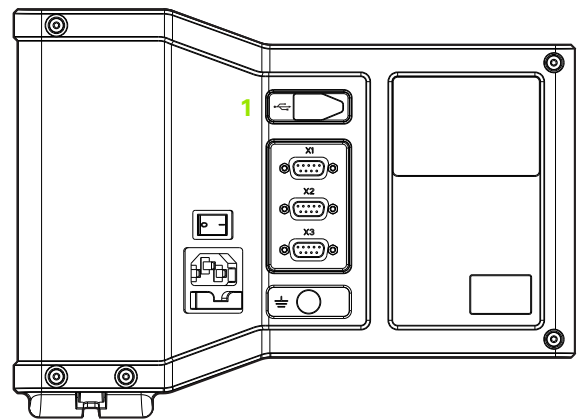
USB (Type B) connector
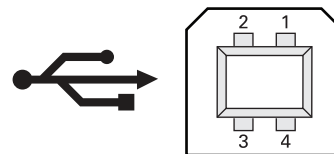
USB (type B) connector pins

Connecting to Hyperterminal

Hyperterminal or a similar serial communication application is required to send and receive settings data and can be used to receive measurement results.

To connect to Hyperterminal:

▶ Open Hyperterminal on the computer. The New Connection window is displayed.

▶ In the New Connection window enter a filename in the Name: field, select an icon and click **OK**.

▶ In the Connect To window, select the communications port being used by the DRO from the Connect using: drop-down menu and click **OK**.

▶ In the COM Properties window select the Port Settings to match the DRO port settings and click **OK**.
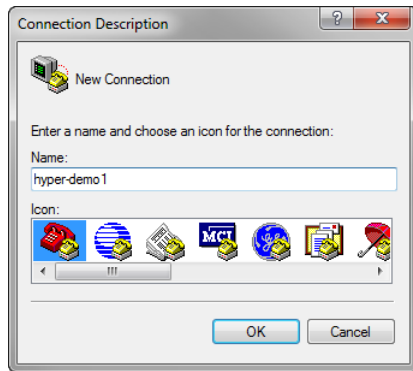
Enter a filename, select an icon and click **OK**
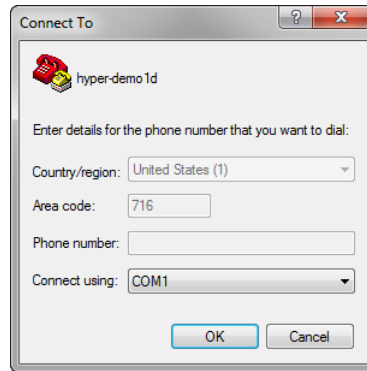
Select the communications port
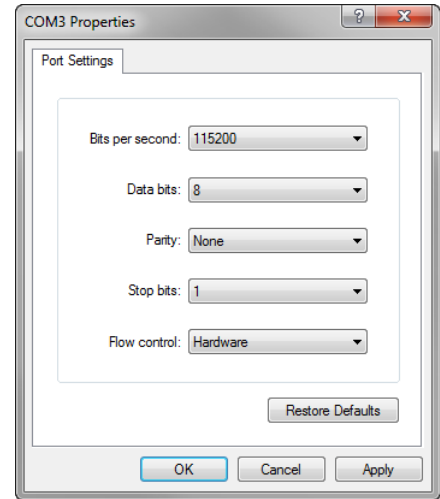
Select the Port Settings and click **OK**

2.2 Software setup

The operating parameters must be configured prior to using the DRO for the first time, and any time part measurement, reporting or communication requirements change. Day to day use of the product does not require reconfiguration of software settings.

> **Notice**
>
> Parameter changes made in any of the setup screens can change the operation of the DRO. For this reason, setup parameters are password-protected. Only qualified personnel should be given password access to setup screens. The unlocking of password-protected setup functions is described on page 73.

Software 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 a computer over a USB-to-Serial connection.

Parameters configured in setup screens will be retained until:

- The data-backup battery is changed
- The data and settings are cleared by maintenance personnel
- Parameters are changed using the Setup menu screens
- Certain software upgrades are performed
- Previously saved settings files are loaded

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 setup screen displays the corresponding setup parameter data fields and choice fields on the right side of the screen.

1 Setup menu item: Setup screen name
2 Setup data field: Setup data are entered
3 Setup choice field: Setup choices are made

The Setup menu is easy to use:

▶ Press the **MENU** key and then press the **Setup** soft key.
▶ Navigate up or down in the menu to highlight the desired menu item using the **Up/Down Arrow** keys.
▶ Navigate from the menu (left side) to the setup fields (right side) using the **Left/Right Arrow** keys.
▶ Navigate up or down to highlight the desired data or choice field using the **Up/Down Arrow** keys.
▶ Enter setup data using the **Numeric Keypad**, or choose a setup parameter choice from soft key selections or list. shown when the field is highlighted.
▶ Press the **FINISH** key to save the entry and return to the Setup menu.
▶ Press the **FINISH** key again to return to the DRO.

An example of using the Setup menu to enter the supervisor password is shown on the next page.

Setup screen menu items, data fields and choice fields

Setup example: entering the supervisor password

Critical setup parameters are password-protected. Only qualified personnel should be given password access to setup screen parameters. In this example, the Setup menu is navigated to the Supervisor screen and the supervisor password is entered.

To enter the supervisor password:

▶ Press the **MENU** key to display the menu soft keys.

▶ Press the **Setup** soft key to display the Setup menu.

▶ Navigate up or down in the menu to highlight the Supervisor menu item using the **Arrow** keys.

Current Position	mm ⌐1
X	0.0000
Y	0.0000
Z	0.0000
DRO	
Setup	Extra	Clear

The **MENU** key pressed to display the menu soft keys

About	mm ⌐1
About	Language English
Display	Configuration XYZ
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	v2.0.0
LEC	ID 749312-02
	(c) HEIDENHAIN

The **Setup** soft key is pressed to display the Setup menu

Supervisor	mm ⌐1
About	Password
Display	
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
LEC	

The **Arrow** keys are used to highlight the Supervisor menu item

▶ Navigate from the menu to the Password setup field using the **Right Arrow** key.

▶ Enter the supervisor password using the **Numeric Keypad**.

Supervisor	mm ⌐1
About	Password
Display	
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
LEC	

The right **Arrow** key is used to highlight the Password data field

Supervisor	mm ⌐1
About	Password XXXXXX
Display	
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
LEC	

The supervisor password is entered using the **Numeric Keypad**

Supervisor	mm ⌐1
About	Password XXXXXX
Display	
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
LEC	

The **FINISH** key is pressed to save the password and return to the Setup menu

▶ Press the **FINISH** key to save the password and return to the Setup menu.

▶ Press the **FINISH** key to return to the DRO.

Order of setup

The setup software is contained on up to 18 screens, depending on the hardware configuration. It is possible that not all the setup screens described in this chapter are active in your system. Disregard screen descriptions that do not apply to your DRO.

The initial setup tasks should be performed in the order listed here. Instructions are presented in this order on subsequent pages.

Initial setup tasks	Setup screens
1: Language selection, axis configuration and product version information	About
2: Supervisor password entry	Supervisor
3: Encoder configuration	Encoders and Misc
4: Loading settings data (instead of manual setup)	Supervisor
5: Stage squareness calibration	Squareness
6: Error correction	LEC, SLEC or NLEC screen
7: Measurement scaling for parts that expand or shrink	Scale factor
8: Measurement configuration	Measure
9: Display formatting	Display

The additional setup tasks can be performed in any order.

Remaining setup tasks	Setup screens
Hot key assignments	Hot keys
Print formatting	Print and Form characters screens

Setup configurations can be saved to a computer using USB-to-Serial connection.

Saving settings	Setup screens
Saving settings data	Supervisor

Language selection and product version

The About screen contains selections for changing the language of text displayed on the screen, included in transmitted data and printed on reports. Product software and hardware information is also provided on the About screen.

To select a language:

▶ Press **MENU>Setup** to display the Setup menu and highlight the About menu item.

▶ Highlight the Language choice field.

▶ Press the **List** soft key to display the list of languages.

▶ Highlight the desired language and press the **ENTER** key.

Highlight the About menu item

Highlight the Language choice field

Highlight a language and press the **ENTER** key

▶ Press the **FINISH** key to save the language and return to the Setup menu.

Notice

Language selection can also be made by pressing the **Send** key while the startup screen is displayed.

Axis configuration

The ND 122 supports a two axes configuration, the ND 123 supports two and three axes configurations.

To select a configuration:

▶ Press **MENU>Setup** to display the Setup menu and highlight the About menu item.

▶ Highlight the Configuration choice field.

▶ Press a soft key to select the desired configuration.

About	mm ⌊1
About	Language English
Display	Configuration XYZ
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	v2.0.0
Squareness	ID 749312-03
⬇	(c) HEIDENHAIN

About	mm ⌊1
About	Language English
Display	Configuration XY
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	v2.0.0
Squareness	ID 749312-03
⬇	(c) HEIDENHAIN
XY	XYZ XYQ

About	mm ⌊1
About	Language English
Display	Configuration XYZ
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	v2.0.0
Squareness	ID 749312-03
⬇	(c) HEIDENHAIN
XY	**XYZ** XYQ

Highlight the About menu item   Highlight the Configuration choice field   Press a soft key to select a configuration

▶ Press the **FINISH** key to save the configuration and return to the Setup menu.

Supervisor password and program unlocking

The Supervisor screen contains the Password data field.

Most setup parameters are password-protected and setup can only be performed after the password is entered. To enter the supervisor password:

▶ Press **MENU>Setup** to display the setup menu and then highlight the Supervisor menu item.

▶ Highlight the Password data field.

▶ Enter the supervisor password.

Supervisor	mm ⌊1
About	Password ▢
Display	
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
Squareness	
▾	

Highlight the Supervisor menu item

Supervisor	mm ⌊1
About	Password ▮
Display	
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
Squareness	
▾	

Highlight the Password data field

Supervisor	mm ⌊1
About	Password XXXXXX
Display	
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
Squareness	
▾	

Enter the password

Sending and receiving settings data

The Supervisor screen contains tools for sending and receiving configuration settings data. This eliminates the need to configure the DRO manually using the setup screens. The settings data also contains any error correction data that existed when the settings data was saved to a computer. Settings data can be sent to or received from a computer using Hyperterminal or a similar serial communications application. Hyperterminal is used in this manual.

To send settings data to a computer:

▶ Establish communication between the DRO and the computer. See "Connecting a computer" on page 65.

▶ Open and connect to Hyperterminal. See "Connecting to Hyperterminal" on page 66.

▶ In Hyperterminal, click **Transfer>Capture Text...** The Capture Text window is displayed.

▶ In the Capture Text window, enter a location and filename for sending settings to.

▶ Click **Start**.
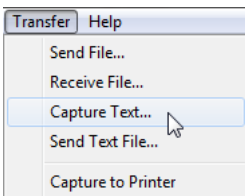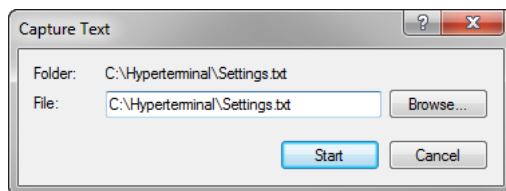
Click **Transfer>Capture Text...**   Enter a location and filename   Click **Start**

▶ On the DRO press **MENU>Setup** to display the Setup menu.

▶ Use the **Arrow** keys to highlight the Supervisor menu item.

▶ Highlight the Password data field, enter the password then press the **ENTER** key.

▶ Press the **Send** soft key. A pop-up window appears requesting confirmation.

▶ Press the **Yes** soft key to confirm sending settings.

▶ Press the **OK** soft key.
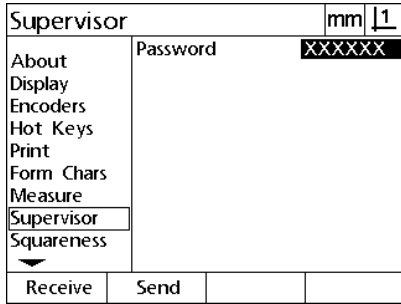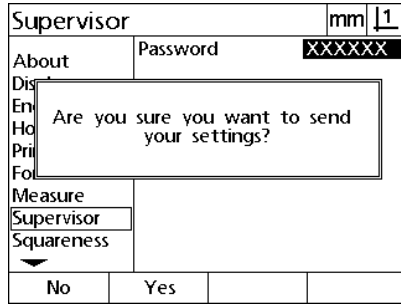
Supervisor		mm ⌊1
About	Password	XXXXXX
Display		
Encoders		
Hot Keys		
Print		
Form Chars		
Measure		
Supervisor		
Squareness		
▼		
Receive	Send	

Press the **Send** soft key

Supervisor		mm ⌊1
About	Password	XXXXXX
Dis		
En	Are you sure you want to send	
Ho	your settings?	
Pri		
Fo		
Measure		
Supervisor		
Squareness		
▼		
No	Yes	

Press the **Yes** soft key

Supervisor		mm ⌊1
About	Password	XXXXXX
Dis		
En	The settings have been	
Ho	successfully sent.	
Pri		
Fo		
Measure		
Supervisor		
Squareness		
▼		
OK		
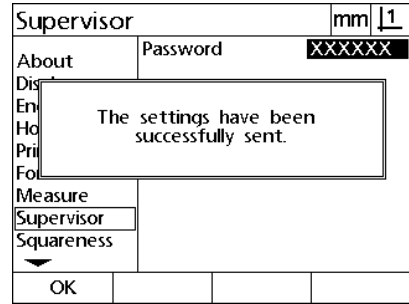
Press the **OK** soft key

▶ In Hyperterminal, click **Transfer>Capture Text>Stop**. The settings have been saved to the location and text file specified in the Capture Text window.

To receive settings data from a computer:

▶ Establish communication between the DRO and the computer. See "Connecting a computer" on page 65.

▶ Open and connect to Hyperterminal. See "Connecting to Hyperterminal" on page 66.

▶ On the DRO press **MENU>Setup** to display the Setup menu.

▶ Use the **Arrow** keys to highlight the Supervisor menu item.

▶ Highlight the Password data field, enter the password then press the **ENTER** key.

▶ Press the **Receive** soft key. A pop-up window appears requesting confirmation.

▶ Press the **Yes** soft key to confirm receiving settings. A pop-up window appears notifying to "Send settings data now...".

▶ In Hyperterminal, click **Transfer>Send Text File...**

Supervisor	mm ↓1
About	Password XXXXXX
Display	
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
Squareness	
Receive Send	

Press the **Receive** soft key

Supervisor	mm ↓1
About	Password XXXXXX
Dis	
En	Are you sure you want to
Ho	overwrite your existing settings?
Pri	
Fo	
Measure	
Supervisor	
Squareness	
No Yes	

Press the **Yes** soft key

Transfer Help
Send File...
Receive File...
Capture Text...
Send Text File...
Capture to Printer
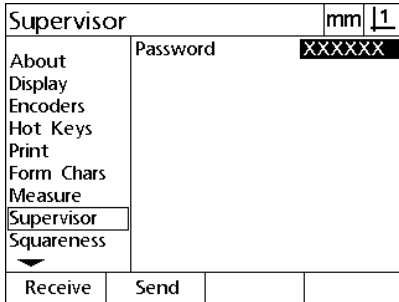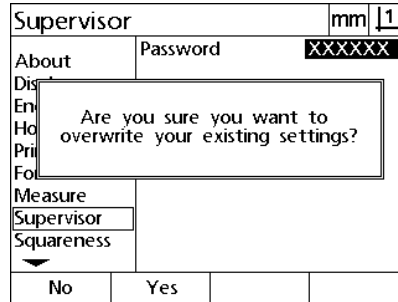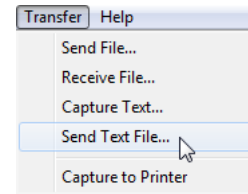
Click **Transfer>Send Text File...**

▶ Select the settings file to send to the DRO and click **Open**. A pop-up window is displayed on the DRO verifying "Receiving settings data...".

▶ A pop-up will notify "The settings have been successfully received. Reboot the system." Reboot the DRO by powering-off the unit then powering-on.

Encoder configuration

The Encoders and Misc screens contain data and choice fields for configuring the encoders.

Encoders screen

The Encoders screen configuration fields include:

- Axis selection
- Encoder resolution
- Reference mark selection
- Machine zero offset (MZ Cnts)
- Reversing encoder count direction
- Units of measure

To configure encoder settings in the Encoders screen:

▶ Press **MENU>Setup** to display the Setup menu and then highlight the Encoders menu item.

▶ Highlight the Axis choice field and then press a soft key to select the desired axis.

▶ Highlight the Res data field and then enter the encoder resolution in the units shown in the Units choice field.

Encoders		mm ⌐1
About	Axis	X
Display	Res	0.1300000000
Encoders		
Hot Keys		
Print		
Form Chars	Ref Marks	Ref
Measure	M.Z. Cnts	0
Supervisor	Reversed	No
LEC		
▼	Units	mm

Encoders menu item is highlighted

Encoders		mm ⌐1
About	Axis	**X**
Display	Res	0.1300000000
Encoders		
Hot Keys		
Print		
Form Chars	Ref Marks	Ref
Measure	M.Z. Cnts	0
Supervisor	Reversed	No
LEC		
▼	Units	mm
X	Y	Z

Press an axis soft key

Encoders		mm ⌐1
About	Axis	X
Display	Res	**0.1300000000**
Encoders		
Hot Keys		
Print		
Form Chars	Ref Marks	Ref
Measure	M.Z. Cnts	0
Supervisor	Reversed	No
LEC		
▼	Units	mm

Enter the encoder resolution

▶ Highlight the Ref Marks choice field and then press the **List** soft key
to display the reference mark choices. Highlight the required
encoder reference mark type and press the **ENTER** key.

➡️ **Notice**

Reference marks must be used if SLEC or NLEC error
correction will be performed later. Error correction is
discussed later in this chapter.

The M.Z. Cnts (Machine zero counts) data field is rarely used to specify
an offset from the machine zero position created by crossing encoder
reference marks.

▶ To specify a custom machine zero, highlight the M.Z. Cnts data field
and enter the machine zero offset in machine counts as determined
by: Machine counts = DRO value/encoder resolution.
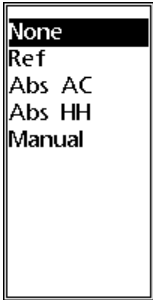
Select an encoder reference mark type
from the list
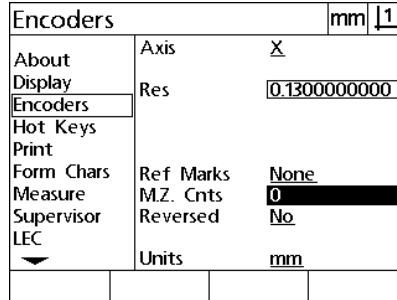
Enter machine zero offset counts if
required

▶ Highlight the Reversed choice field and press the **Yes** soft key to reverse the encoder count direction.

▶ Highlight the Units choice field and press the **In** or **mm** soft key for the resolution units.

Choose a count direction

Choose resolution units

▶ Press the **FINISH** key to save parameters and return to the Setup menu.

Misc screen

The Misc screen encoder configuration fields include:

■ Auto DRO counts: The number of least significant DRO counts required to refresh the DRO with new axis values.

■ External axis-zero enable for X, Y and Z/Q axes. Allows axes to be zeroed remotely from encoder zero buttons.

■ Slew limit for the axes: High input slew rates resulting from rapid input encoder motion can result in erroneous measurements. Erroneous measurements are avoided by displaying encoder error warnings when encoder values change at very high rates.

■ Screen saver minutes: The period of time that the DRO can be idle before going into activating the screen saver.

To configure encoder settings in the Misc screen:

▶ Press **MENU>Setup** to display the Setup menu and then highlight the Misc menu item.

▶ Highlight the Auto DRO Cnts data field and enter the number of DRO counts (axis motion) in the least significant digit position required to automatically refresh the DRO axis values.

▶ Highlight the X, Y or Z/Q External 0 choice field and then press the **Yes** or **No** soft key to enable or disable external axis zeroing by the remote encoder.

▶ Highlight the Slew Limit data field and enter the slew rate limit (increments of resolution per second). For example, at an encoder resolution of 0.001 mm, a slew rate limit of 50,000 will result in warning messages at encoder motion rates higher than 50 mm per second.

Enter Auto DRO counts

Enable or disable external zeroing for all axes

Enter the slew rate limit in encoder counts per second

▶ Highlight the Scr Saver Min data field and enter the number of minutes the DRO is idle before the screen saver is activated.

▶ Press the **FINISH** key to save parameters and return to the Setup menu.

Stage squareness calibration

The Squareness screen contains data and choice fields for calibrating the squareness of the measuring system. The calibration of stage squareness requires the use of a certified square artifact.

To calibrate squareness:

▶ Align the squareness calibration artifact with the reference axis for the squareness calibration. This axis will be the Master axis.

▶ Press **MENU>Setup** to display the setup menu and then highlight the Squareness menu item.

▶ Highlight the Master Axis choice field and press a soft key to select the reference (Master) axis for squareness calibration.

▶ Highlight the Angle data field and press the **Teach** soft key to begin the squareness calibration.

Squareness	mm ⌊1
About	Angle 90°00'
Display	Master Axis X
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
Squareness	

Highlight the Squareness menu item

Squareness	mm ⌊1
About	Angle 90°00'
Display	Master Axis X
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
Squareness	
X	Y

Select a Master Axis

Squareness	mm ⌊1
About	Angle 90°00'
Display	Master Axis X
Encoders	
Hot Keys	
Print	
Form Chars	
Measure	
Supervisor	
Squareness	
Teach	

Highlight the Angle data field and press the **Teach** soft key

▶ Follow instructions displayed on the LCD screen to complete the calibration.

▶ Press the **FINISH** key.

Error correction

There are three error correction methods:

- LEC: Linear Error Correction
- SLEC: Segmented Linear Error Correction
- NLEC: Nonlinear Error Correction

All DRO models are equipped with LEC, SLEC and NLEC. Each method compensates for encoder and machine travel variations with error correction coefficients. Coefficients are determined by comparing actual measurements of a standard to the nominal values imprinted on it.

Linear error correction (LEC) is performed in the LEC setup screen and compensates for variations along an axis using one correction coefficient for the entire range of motion on the axis. For example, an LEC coefficient of 0.0002 per inch applied to a 6 inch measurement along an axis produces a result of 6.0012 inches.

Segmented linear error correction (SLEC) is performed in the SLEC setup screen and compensates for variations along an axis by applying correction values to several individual segments of the measurement range. The use of multiple segments increases the accuracy of measurements beyond the accuracy obtained by applying a single (average) to the entire axis. The correction starting point is mapped to the axis machine zero MZ Offset) so that the correction coefficients can be applied to each segment location upon power up.

Nonlinear error correction (NLEC) is performed in the NLEC setup screen and compensates for variations in the entire measurement plane created by two axes by applying correction values to a grid of small areas included by the plane. The correction starting point for NLEC is mapped to the machine zeroes of the two axes (MZ Offset) so that the correction coefficients can be accurately applied to each grid area location upon power up.

NLEC can be performed using one of two methods:

- By measuring points on a certified calibration grid with the target ND 12x system
- By loading correction data from an NLEC data set generated by another ND 12x or other systems capable of generating NLEC data.

Notice

A repeatable machine zero, established by crossing reference marks or defining a manual hard-stop, must be present prior to performing SLEC or NLEC procedures.

Linear error correction (LEC)

LEC compensates for machine irregularities and encoder non-linearities by applying a single linear correction value to the entire range of measurement. To apply LEC to a measurement axis:

▶ Press **MENU>Setup** to display the Setup menu and then highlight the Scale Factor menu item.

▶ Verify that the Active choice field specifies No.

> **Notice**
>
> When scale factors are used, they must be applied after error corrections.

▶ Highlight the SLEC menu item and verify that the Enabled choice field specifies Off.

▶ Highlight the LEC menu item and make sure that all correction values are 1.0.

▶ Highlight the NLEC Setup menu item and verify that the NLEC choice field specifies Off.

> **Notice**
>
> LEC can not be performed if a different error correction is already enabled.

Scale Factor		mm ⊥1
Print	Active	No
Form Chars	Multiplier	1.000
Measure	User Access	No
Supervisor		
LEC		
SLEC		
NLEC		
Scale Factor		
Misc.		

Verify that the Scale Factor is not active

SLEC		mm ⊥1
Print	SLEC Axis	X
Form Chars	Enabled	Off
Measure		
Supervisor	Station	0
LEC	Standard	
SLEC	Observed	
NLEC		
Scale Factor	MZ Offset	0.00000
Misc.		

Verify that SLEC compensation is Off

NLEC		mm ⊥1
Print	NLEC	Off
Form Chars	X Pos	1
Measure	Y Pos	1
Supervisor	Nominal	Error
LEC	X 0.00000	0.00000
SLEC	Y 0.00000	0.00000
NLEC	Machine 0	Cell Size
Scale Factor	X 0.0000	0.0000
Misc.	Y 0.0000	0.0000
	X Grid Size	0
	Y Grid Size	0

Verify that NLEC compensation is Off

▶ Position the standard artifact along the measurement axis.

▶ Align the artifact as closely as possible to the axis and then perform a skew alignment as described in chapter 1 (see "Align the part to a measurement axis" on page 33).

▶ Perform a single measurement of the entire range of motion using the standard artifact and make a note of the result.

➡️ **Notice**

Use an artifact that allows measurements of as much of the axis range of motion as possible.

In this example of applying LEC, one point at end of the axis measurement range is measured using an 8 inch standard.

Arrow number	Descriptions
1: Standard length	Entire 8 inch length is measured
2: Standard values	The certified length of the standard
3: Observed values	The measured length of the standard
4: Deviation graph	Difference between standard and observed values (not entered into any screen)

To perform the linear error correction in the LEC screen:

▶ Highlight the LEC menu item.
▶ Enter the Standard value of the artifact and the Observed value measured by the DRO for the measurement axis. This example shows Standard and Observed values for the X axis.

➡️ **Notice**

The standard and observed values for axes should be 1.000 when no LEC correction is applied.
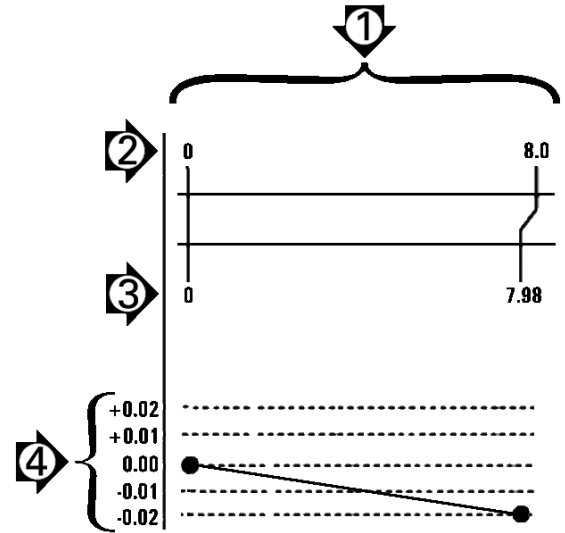
LEC example using an 8 inch standard

```
LEC                        mm |1
┌─────────────────────────────────┐
Print      │ Linear Error Correction
Form Chars │ X  Standard    1.0000
Measure    │ X  Observed    1.0000
Supervisor │ Y  Standard    1.0000
LEC        │ Y  Observed    1.0000
SLEC       │ Z  Standard    1.0000
NLEC       │ Z  Observed    1.0000
Scale Factor
Misc.
```

Highlight the LEC screen

```
LEC                        mm |1
┌─────────────────────────────────┐
Print      │ Linear Error Correction
Form Chars │ X  Standard    8.00000
Measure    │ X  Observed    7.9800
Supervisor │ Y  Standard    1.000
LEC        │ Y  Observed    1.0000
SLEC       │ Z  Standard    1.0000
NLEC       │ Z  Observed    1.0000
Scale Factor
Misc.
```

Enter the Standard and Observed values for the axis

▶ Perform LEC on other axes if desired and then press the **FINISH** key to save parameters and return to the Setup menu.

Segmented linear error correction (SLEC)

SLEC compensates for machine irregularities and encoder non-linearities by applying correction values to individual segments that cover the entire range of motion along an axis. To apply SLEC to a measurement axis:

▶ Verify that the appropriate encoder reference marks are selected in the Encoders setup screen (See "Encoders screen" on page 77).

▶ Verify that the Startup zero field of the Measure setup screen is set to Yes (See "Measure screen" on page 96).

▶ Cycle the DRO power off and then back on to establish the machine zero if necessary.

> **Notice**
>
> Reference marks, or a manual reference position must be recognized by the DRO upon startup to create a repeatable machine zero. Machine zero is required for SLEC error correction.

▶ Press **MENU>Setup** to display the Setup menu and then highlight the Scale Factor menu item.

▶ Verify that the Active choice field specifies No.

> **Notice**
>
> When scale factors are used, they must be applied after error corrections.

▶ Press **MENU>Setup** to display the Setup menu and then highlight the LEC menu item.

▶ Verify that all Standard and Observed data fields contain the value: 1.000 to eliminate the possibility that a previous LEC correction will influence this SLEC correction.

▶ Highlight the NLEC setup menu item and verify that the NLEC choice field specifies Off.

> **Notice**
>
> SLEC can not be performed if a different error correction is already enabled.

▶ Highlight the SLEC setup menu item and verify that the Enabled choice field is Off. SLEC correction can not be configured while SLEC is enabled.

LEC		mm ⌐1
Print	Linear Error Correction	
Form Chars	X Standard	1.0000
Measure	X Observed	1.0000
Supervisor	Y Standard	1.0000
LEC	Y Observed	1.0000
SLEC	Z Standard	1.0000
NLEC	Z Observed	1.0000
Scale Factor		
Misc.		

Verify that values in the LEC screen are all 1.000

NLEC		
	NLEC	Off
Print	X Pos	1
Form Chars	Y Pos	1
Measure	Nominal	Error
Supervisor	X 0.00000	0.00000
LEC	Y 0.00000	0.00000
SLEC	Machine 0	Cell Size
NLEC	X 0.0000	0.0000
Scale Factor	Y 0.0000	0.0000
Misc.	X Grid Size	0
	Y Grid Size	0

Verify that NLEC compensation is Off

SLEC		mm ⌐1
	SLEC Axis	X
Print	Enabled	Off
Form Chars		
Measure	Station	0
Supervisor	Standard	
LEC	Observed	
SLEC		
NLEC	MZ Offset	0.00000
Scale Factor		
Misc.		
Off	On	

Verify that the SLEC enable is Off

▶ Press **MENU>Setup** to clear all existing datums, part alignments and part data.

▶ Position the standard artifact along the measurement axis.

▶ Align the artifact as closely as possible to the axis and then perform a skew alignment as described in chapter 1 (see "Align the part to a measurement axis" on page 33).

In this example of applying SLEC, 4 points equally spaced along the measurement range are measured using an 4 inch standard.

| Arrow number	Descriptions
1: Standard length	Entire 4 inch length is measured
2: Standard values	The certified values shown on the standard
3: Observed values	The measured values
4: Deviation graph	Difference between standard and observed values (not entered into any screen)
5: Station numbers	Segment end points (standard and observed values) are entered into station data fields

The deviation graph in the example at the right shows a datum zero point and 4 certified and (corresponding) measured points. The certified value at the end of each segment is entered into the Standard data field manually using the **Keypad**. The actual measured value at the end of each segment is entered into the Observed field automatically by pressing the **Teach** softkey.
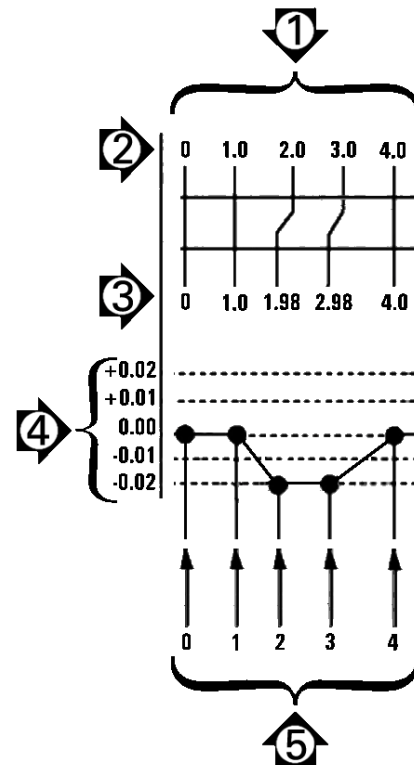
SLEC example using an 8 inch standard

To configure segmented linear error correction in the SLEC screen:

▶ Position the crosshair probe over the zero reference of the standard artifact and press the **Axis** key to zero the axis at the zero position of the standard.

▶ Highlight the SLEC menu item.

▶ Highlight the Axis choice field and select the axis for correction.

▶ Highlight the MZ Offset data field and press the **Teach** soft key. The offset between the zero reference location of the standard and the machine zero will be entered by the DRO.

▶ Highlight the Station field. The station must be zero at the beginning of the SLEC procedure. Enter zero values into the Standard and Observed data fields to define the zero station as the reference.

SLEC		mm |1
Print	SLEC Axis	X
Form Chars	Enabled	Off
Measure	Station	0
Supervisor	Standard	
LEC	Observed	
SLEC		
NLEC	MZ Offset	0.00000
Scale Factor		
Misc.		
X	Y	Z	

Select the axis for SLEC

SLEC		mm |1
Print	SLEC Axis	X
Form Chars	Enabled	Off
Measure	Station	0
Supervisor	Standard	
LEC	Observed	
SLEC		
NLEC	MZ Offset	0.285
Scale Factor		
Misc.		
Teach			

Press the **Teach** soft key to enter a machine zero offset

SLEC		mm |1
Print	SLEC Axis	X
Form Chars	Enabled	Off
Measure	Station	0
Supervisor	Standard	0.00000
LEC	Observed	0.00000
SLEC		
NLEC	MZ Offset	0.28500
Scale Factor		
Misc.		
Teach			

Enter zeros into the Standard and Observed fields of Station 0

▶ Position the crosshairs over the end of segment 1 on the standard, highlight the Station field again and press the **Inc** soft key to advance the station number to 1.

▶ Highlight the Standard field and enter the Standard value at the end of segment 1. In the example, the value is 1.00000. Then highlight the Observed field and press the **Teach** soft key. The system will enter the value measured at the end of the segment. In the example the Observed value at Station 1 is also 1.00000.Highlight the Station field again and press the **Inc** soft key to advance the station number to 2.

▶ Position the crosshairs over the end of segment 2 on the standard, highlight the Station field again and press the **Inc** soft key to advance the station number to 2.

▶ Highlight the Standard field and enter the Standard value at the end of segment 2. In the example, the value is 2.00000. Then highlight the Observed field and press the **Teach** soft key. The system will enter the value measured at the end of the segment. In the example the Observed value at Station 2 is 1.98000.

▶ Position the crosshairs over the end of segment 3 on the standard, highlight the Station field again and press the **Inc** soft key to advance the station number to 3.

▶ Highlight the Standard field and enter the Standard value at the end of segment 3. In the example, the value is 3.00000. Then highlight the Observed field and press the **Teach** soft key. The system will enter the value measured at the end of the segment. In the example the Observed value at Station 3 is 2.98000.

SLEC		mm ↓1
Print	SLEC Axis	X
Form Chars	Enabled	Off
Measure		
Supervisor	Station	1
LEC	Standard	1.00000
SLEC	Observed	1.0000
NLEC	MZ Offset	0.28500
Scale Factor		
Misc.		
Teach		

Enter Standard value and **Teach** the Observed value for Station 1

SLEC		mm ↓1
Print	SLEC Axis	X
Form Chars	Enabled	Off
Measure		
Supervisor	Station	2
LEC	Standard	2.00000
SLEC	Observed	1.9900
NLEC	MZ Offset	0.28500
Scale Factor		
Misc.		
Teach		

Enter Standard value and **Teach** the Observed value for Station 2

SLEC		mm ↓1
Print	SLEC Axis	X
Form Chars	Enabled	Off
Measure		
Supervisor	Station	3
LEC	Standard	3.00000
SLEC	Observed	2.9800
NLEC	MZ Offset	0.28500
Scale Factor		
Misc.		
Teach		

Enter Standard value and **Teach** the Observed value for Station 3

▶ Position the crosshairs over the end of segment 4 on the standard, highlight the Station field again and press the **Inc** soft key to advance the station number to 4. This is the last station in the example.

▶ Highlight the Standard field and enter the Standard value at the end of segment 4. In the example, the value is 4.00000. Then highlight the Observed field and press the **Teach** soft key. The system will enter the value measured at the end of the segment. In the example the Observed value at Station 4 is 4.0000.

SLEC		mm ↓1
Print	SLEC Axis	X
Form Chars	Enabled	Off
Measure		
Supervisor	Station	4
LEC	Standard	4.00000
SLEC	Observed	4.0000
NLEC	MZ Offset	0.28500
Scale Factor		
Misc.		
Teach		

Enter Standard value and **Teach** the Observed value for Station 4

SLEC		mm ↓1
Print	SLEC Axis	X
Form Chars	Enabled	On
Measure		
Supervisor	Station	4
LEC	Standard	4.00000
SLEC	Observed	4.00000
NLEC	MZ Offset	0.28500
Scale Factor		
Misc.		
Teach	On	

Press the **On** soft key when all desired axes have been compensated

▶ Repeat the SLEC process for other axes if necessary.

▶ When SLEC data are entered for all the desired axes, highlight the Enabled field for each axis and press the **On** soft key to activate SLEC for each axis.

▶ Press the **FINISH** key to save parameters and return to the Setup menu.

Nonlinear error correction (NLEC)

NLEC minimizes or eliminates the small inaccuracies in the X-Y measurement plane due to machine irregularities and encoder nonlinearity. Error correction coefficients are obtained by measuring a certified calibration grid. The actual values are then compared to the nominal grid values by the DRO. When NLEC is enabled, the corrections are applied across the measured area of the X-Y measurement plane. To apply NLEC to a measurement plane:

▶ Verify that the appropriate encoder reference marks are selected in the Encoders setup screen (See "Encoders screen" on page 77).

▶ Verify that the Startup Zero field of the Measure setup screen is set to **Yes** (See "Measure screen" on page 96).

▶ Cycle the DRO power off and then back on to establish the machine zero if necessary.

> **Notice**
>
> Reference marks, or a manual reference position must be recognized by the DRO upon startup to create a repeatable machine zero. Machine zero is required for NLEC.

▶ Press **MENU>Setup** to display the Setup menu and then highlight the Scale Factor menu item.

▶ Verify that the Active choice field specifies No.

> **Notice**
>
> When scale factors are used, they must be applied after error corrections.

▶ Press **MENU>Clear** to clear all existing datums, part alignments and part data.

▶ Press **MENU>Setup** to display the Setup menu and then highlight the LEC menu item.

▶ Verify that all Standard and Observed data fields contain the value: 1.000 to eliminate the possibility that a previous LEC correction will influence this NLEC correction.

▶ Highlight the SLEC setup menu item and verify that the Enabled choice field specifies Off.

> **Notice**
>
> NLEC can not be performed if a different error correction is already enabled.

▶ NLEC correction can not be configured while NLEC is enabled. Highlight the NLEC setup menu item and verify that the NLEC choice field specifies Off.

LEC		mm ⌐1
	Linear Error Correction	
Print	X Standard	1.0000
Form Chars	X Observed	1.0000
Measure	Y Standard	1.0000
Supervisor	Y Observed	1.0000
LEC	Z Standard	1.0000
SLEC	Z Observed	1.0000
NLEC		
Scale Factor		
Misc.		
Teach		

Verify that values in the LEC screen are all 1.000

SLEC		mm ⌐1
	SLEC Axis	X
Print	Enabled	Off
Form Chars		
Measure	Station	0
Supervisor	Standard	0.00000
LEC	Observed	0.00000
SLEC		
NLEC	MZ Offset	0.00000
Scale Factor		
Misc.		

Verify that SLEC Enable is Off

NLEC		mm ⌐1
	NLEC	Off
Print	X Pos	1
Form Chars	Y Pos	1
Measure	Nominal	Error
Supervisor	X 0.00000	0.00000
LEC	Y 0.00000	0.00000
SLEC	Machine 0	Cell Size
NLEC	X 0.0000	0.0000
Scale Factor	Y 0.0000	0.0000
Misc.	X Grid Size	0
	Y Grid Size	0

Verify that the NLEC is Off

Once these initial steps have been completed, NLEC error correction can be performed using one of two methods:

■ By measuring points on a calibration grid

■ By importing NLEC data from a computer using the USB-to-Serial connection

In the example of applying NLEC, nine points are measured using a 3 X 3 calibration grid.

Arrow number	Descriptions
1: Grid alignment	A Skew alignment is performed to align the grid perfectly to the X axis.
2: Datum and grid data points	A zero datum is created at the lower left corner of the grid. This is the first position (X=1,Y=1) that will be entered into the NLEC setup screen.
	Other calibration data points to be entered into the NLEC setup screen are also shown in the X,Y format (1,1 through 3,3 in this example).
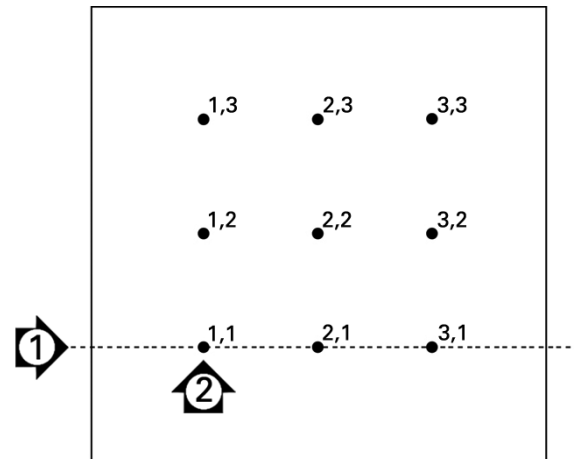
Nine points of a 3 X 3 calibration grid are shown with numeric X,Y grid locations

NLEC by measuring points on a calibration grid

▶ Position the standard artifact along the measurement axis.

▶ Align the artifact as closely as possible to the axis and then perform a skew alignment as described in chapter 1 (see "Align the part to a measurement axis" on page 33).

▶ Create a reference datum by probing the point at the 1,1 position of the calibration grid and pressing the **X** and **Y Axis** keys to zero the point.

▶ While the crosshair probe is positioned over the 1,1 grid point (datum), highlight the NLEC setup menu item.Highlight the X and Y Grid Size data fields and enter the number of calibration points in the X and Y axes. In the example, 3 points were entered in the X and Y Grid Size fields to describe the 3 X 3 calibration grid.

▶ Highlight the X and Y Cell Size data fields and enter the distance between calibration points on the X and Y axes. In the example, the distance between points is 1 inch (25.4cm) on the X and Y axes.Highlight the Machine 0 X or Y data field and press the **Use Cur** soft key to enter the offset from the DRO machine zero and the calibration grid datum. The offsets for both axes will be entered and displayed automatically by the DRO.

NLEC		mm ↓1
▲	NLEC	Off
Print	X Pos	1
Form Chars	Y Pos	1
Measure	Nominal	Actual
Supervisor	X 0.00000	0.00000
LEC	Y 0.00000	0.00000
SLEC	Machine 0	Cell Size
NLEC	X 0.0000	0.00000
Scale Factor	Y 0.0000	0.00000
Misc.	X Grid Size	**3**
▼	Y Grid Size	3
		Teach

Enter the X and Y calibration grid size

NLEC		mm ↓1
▲	NLEC	Off
Print	X Pos	1
Form Chars	Y Pos	1
Measure	Nominal	Actual
Supervisor	X 0.00000	0.00000
LEC	Y 0.00000	0.00000
SLEC	Machine 0	Cell Size
NLEC	X 0.0000	**1.0000**
Scale Factor	Y 0.0000	1.00000
Misc.	X Grid Size	3
▼	Y Grid Size	3
		Teach

Enter the X and Y cell size

NLEC		mm ↓1
▲	NLEC	Off
Print	X Pos	1
Form Chars	Y Pos	1
Measure	Nominal	Actual
Supervisor	X 0.00000	0.00000
LEC	Y 0.00000	0.00000
SLEC	Machine 0	Cell Size
NLEC	X **0.0260**	1.00000
Scale Factor	Y 0.42500	1.0000
Misc.	X Grid Size	3
▼	Y Grid Size	3
Use Cur		Teach

Enter the machine zero offset

▶ Highlight the X Pos data field. Initially the X Pos and Y Pos fields will contain values of 1. These values are incremented by the DRO as the calibration is performed. Press the **Teach** soft key to begin the NLEC calibration, then follow the instructions provided on the screen for conducting measurements. Grid measurement locations are indicated in the top left corner of the DRO screen during measurements. Upon completion of the grid measurements the nominal (certified) and actual (measured) values will be displayed in the Nominal and Actual data fields for each grid position.

```
NLEC stn. 1, 1                    mm |1
Pts  X          0.0000
0    Y          0.0000
     Z          0.0000
DRO
        Recall    Create
```

Grid measurement locations are
indicated in the top left corner of the
screen.

```
NLEC                              mm |1
Print      NLEC        Off
Form Chars X Pos       3
Measure    Y Pos       3
Supervisor   Nominal   Actual
LEC        X 2.00000   2.00000
SLEC       Y 2.00000   2.00000
NLEC         Machine 0 Cell Size
Scale Factor X 0.0260  1.00000
Misc.      Y 0.4250    1.0000
           X Grid Size 3
           Y Grid Size 3
     Dec    Inc              Teach
```

Nominal and actual grid values are
displayed when the calibration is
complete

```
NLEC                              mm |1
Print      NLEC        On
Form Chars X Pos       3
Measure    Y Pos       3
Supervisor   Nominal   Actual
LEC        X 2.00000   2.00000
SLEC       Y 2.00000   2.00000
NLEC         Machine 0 Cell Size
Scale Factor X 0.0260  1.00000
Misc.      Y 0.4250    1.0000
           X Grid Size 3
           Y Grid Size 3
     Off    On    Data    Teach
```

Press the **On** soft key to enable NLEC

▶ Highlight the NLEC choice field and press the **On** soft key to enable
NLEC correction. Then press the **FINISH** key to save parameters and
return to the Setup menu.

NLEC by importing an NLEC data .txt file

An NLEC data file created by measuring a certified calibration grid with an ND 12x or other systems capable of generating NLEC data can be used to provide NLEC correction data instead of measuring a calibration grid with the target DRO system. The NLEC data file is loaded from a computer using Hyperterminal or a similar serial communications application. Hyperterminal is used in this manual.
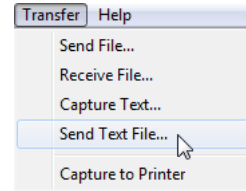
To import NLEC data to a computer:

▶ Establish communication between the DRO and the computer. See "Connecting a computer" on page 65.

▶ Open and connect to Hyperterminal. See "Connecting to Hyperterminal" on page 66.

▶ On the DRO, press **MENU>Setup** to display the setup menu.

▶ Use the **Arrow** keys to highlight the NLEC menu item.

▶ Highlight the NLEC choice field.

▶ Press the **Data** soft key then the **Receive** soft key. A pop-up window notifies to "Send NLEC data now..."

▶ In Hyperterminal, click **Transfer>Send Text File...**

Highlight the NLEC choice field and press the **Data** soft key
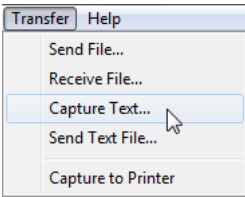
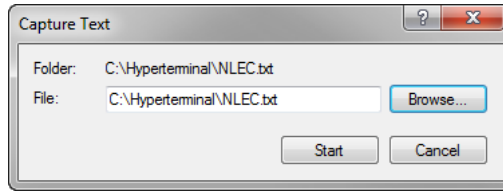Press the **Receive** soft key

Click **Transfer>Send Text File...**

▶ In the Send Text File window, select the NLEC data file to send to the DRO and click **Open**.

▶ A pop-up will notify "The NLEC data was successfully loaded. Reboot the system." Reboot the DRO by powering-off the unit then powering-on.

Saving an NLEC data .txt file

▶ Establish communication between the DRO and the computer. See "Connecting a computer" on page 65.

▶ Open and connect to Hyperterminal. See "Connecting to Hyperterminal" on page 66.

▶ In Hyperterminal, click **Transfer>Capture Text...** The Capture Text window is displayed.

▶ In the Capture Text window, enter a location and filename for capturing the NLEC data sent from the DRO.

▶ Click **Start**.

Transfer	Help
Send File...	
Receive File...	
Capture Text...	
Send Text File...	
Capture to Printer	

Click **Transfer>Capture Text...**

Capture Text

Folder: C:\Hyperterminal\NLEC.txt

File: C:\Hyperterminal\NLEC.txt [Browse...]

[Start] [Cancel]

Enter a location and filename

[Start]

Click **Start**

▶ On the DRO, press **MENU>Setup** to display the Setup menu.

▶ Use the **Arrow** keys to highlight the NLEC menu item.

▶ Highlight the NLEC choice field.

▶ Press the **Data** soft key then the **Send** soft key. A pop-up confirms the data was successfully sent.

▶ Press the **OK** soft key.

NLEC		mm ⌐1
Print	NLEC	On
Form Chars	X Pos	3
Measure	Y Pos	3
Supervisor	Nominal	Actual
LEC	X 2.00000	2.00000
SLEC	Y 2.00000	2.00000
NLEC	Machine 0	Cell Size
Scale Factor	X 0.0260	1.0000
Misc.	Y 0.4250	1.0000
	X Grid Size	3
	Y Grid Size	3
Off	**On**	Data	Teach

Highlight the NLEC choice field and press the **Data** soft key

NLEC		mm ⌐1
Hot Keys	NLEC	Off
Print	X Pos	3
Form Chars	Y Pos	3
Measure	Nominal	Actual
Supervisor	X 2.00000	2.00000
LEC	Y 2.00000	2.00000
SLEC	Machine 0	Cell Size
NLEC	X 0.0000	1.0000
Scale Factor	Y 0.0000	1.0000
	X Grid Size	3
	Y Grid Size	3
Receive	Send		

Press the **Send** soft key

NLEC		mm ⌐1
Hot Keys	NLEC	Off
Prin	X Pos	3
Fo		
Me	The NLEC data was successfully	
Su	saved to.	
LE		
SLEC	X 0.0000	1.0000
NLEC	Y 0.0000	1.0000
Scale Factor	X Grid Size	3
	Y Grid Size	3
OK			

Press the **OK** soft key

▶ In Hyperterminal, click **Transfer>Capture Text>Stop**. The NLEC data has been saved to the location and text file specified in the Capture Text window.

Measurement scaling for parts that expand or shrink

Scale factors scale measurement results using a multiplier and are useful when measuring parts that will expand or shrink after inspections have been performed.

Scale Factor screen

The Scale Factor screen contains configuration fields for:

- Enabling scale factor

- Specifying a scale factor multiplier value

- Providing the user access to scale factor editing

To configure scale factor settings:

▶ Press **MENU>Setup** to display the Setup menu and then highlight the Scale Factor menu item.

> **Notice**
>
> The setup process for all axes is identical and uses the Encoders and Misc setup screens.

▶ Highlight the Multiplier data field and enter the scale factor multiplier.

▶ Highlight the User Access choice field and press the **No** soft key to restrict access to those who can provide the supervisor password, or the **Yes** soft key to provide unrestricted access.

> **Notice**
>
> Password restricted access to setup parameters is explained earlier on page 69.

▶ Highlight the Active choice field and press the **No** soft key to disable the scale factor or the **Yes** soft key to enable it.

Scale Factor	mm ⌐1		Scale Factor	mm ⌐1		Scale Factor	mm ⌐1
Print	Active	No	Print	Active	No	Print	Active	No

Enter the scale factor multiplier   Select No to restrict access or Yes to allow user access to scale factor editing   Select No to disable or Yes to enable scale factor

▶ Press the **FINISH** key to return to the Setup menu.

Measurement configuration

The Measure screen contains data and choice fields for configuring DRO measurement parameters.

Measure screen

The Measure screen contains configuration fields for:

- Specifying forward or backward annotation point probing

- Specifying absolute or signed distances

- Specifying current datum screen

- Specifying if to prompt for machine zero at startup

To configure measurement parameters:

▶ Press **MENU>Setup** to display the Setup menu and then highlight the Measure menu item.

▶ Highlight the Annotation choice field and then press the **Back** soft key to allow the user to probe up to 100 points when measuring a feature. Press the **Forw** soft key to complete a feature measurement automatically when the number of points specified by the Fwd data fields have been probed. For example, when **Forw** is selected and the Fwd Circle value is 3, a circle measurement will be completed automatically when 3 points have been probed.

▶ Highlight each of the Fwd feature data fields and enter the number of probed points required to automatically complete a measurement for each feature type when forward annotation is used. The minimum numbers are:

Point	1 probed point
Line	2 probed points
Circle	3 probed points

Select backward or forward annotation

Enter the minimum number of points for forward annotation probing

Select Abs to display distances without + and - signs

▶ Highlight the Distances choice field and press the **Signed** soft key to display + and - distances. Press the **Abs** soft key to display distances as absolute values.

▶ Highlight the Current datum choice field and press the **1** or **2** soft key to select the current datum.

▶ Highlight the Startup Zero choice field and press the **Yes** soft key to require a machine zero upon startup by crossing reference marks or by prompting the user for a hard stop. Press the **No** soft key if no machine zero is required.

Measure		mm ⊥1
About	Annotation	Back.
Display	Fwd Point	1
Encoders	Fwd Line	2
Hot Keys	Fwd Circle	3
Print		
Form Chars	Distances	Abs
Measure	Current Datum	**1**
Supervisor	Startup Zero	No
Squareness		

| **1** | 2 | | |

Select the current datum

Measure		mm ⊥1
About	Annotation	Back.
Display	Fwd Point	1
Encoders	Fwd Line	2
Hot Keys	Fwd Circle	3
Print		
Form Chars	Distances	Abs
Measure	Current Datum	1
Supervisor	Startup Zero	**Yes**
Squareness		

| No | **Yes** | | |

Select Yes to require a machine zero upon startup

▶ Press the **FINISH** key to return to the Setup menu.

Display formatting

The Display screen contains data and choice fields for configuring display resolution and other display parameters.

Display screen

The Display screen configuration fields include:

■ Resolutions for linear and angular measurements

■ Startup linear and angular units of measure

■ Selection of a comma or decimal point radix

■ Unit of linear and angular measurement for the current session

■ Selection of current units of measure

■ Selection of a Cartesian or Polar display mode

■ Range of displayed angles for angular measurements

To configure display settings:

▶ Press **MENU>Setup** to display the setup menu and then highlight the Display menu item.

▶ Highlight the MM and Inch Disp Res data fields and enter the display resolution index numbers for each unit of measure. For example, an index number of 0.001 will round the display of MM or inch to 3 digits to the right of the radix character.

▶ Highlight the DMS Disp Res data field and enter the Degree/Minutes/Seconds index number. For example, an index number of 0.01 will round the display of 30°20′45″ to 30°21′.

▶ Highlight the DD Disp Res data field and enter the Decimal Degrees index number. For example, an index number of 0.01 will round the display of 30.786 degrees to 30.79 degrees.

Display		mm ⌊1
About	MM Disp Res	0.001
Display	Inch Disp Res	0.001
Encoders	DMS Disp Res	0.01
Hot Keys	DD Disp Res	0.001
Print	Startup Linear	mm
Form Chars	Startup Angular	DMS
Measure	Radix	Decimal
Supervisor	Current Angular	DMS
Squareness	Current Units	mm
▼	Display Mode	Cart
	Angle Display	-+360

Enter the display resolution index numbers for linear measurements

Display		mm ⌊1
About	MM Disp Res	0.001
Display	Inch Disp Res	0.001
Encoders	DMS Disp Res	0.01
Hot Keys	DD Disp Res	0.001
Print	Startup Linear	mm
Form Chars	Startup Angular	DMS
Measure	Radix	Decimal
Supervisor	Current Angular	DMS
Squareness	Current Units	mm
▼	Display Mode	Cart
	Angle Display	-+360

Enter the display resolution index number for angular measurements in Degrees/Minutes/Seconds

Display		mm ⌊1
About	MM Disp Res	0.001
Display	Inch Disp Res	0.001
Encoders	DMS Disp Res	0.01
Hot Keys	DD Disp Res	0.001
Print	Startup Linear	mm
Form Chars	Startup Angular	DMS
Measure	Radix	Decimal
Supervisor	Current Angular	DMS
Squareness	Current Units	mm
▼	Display Mode	Cart
	Angle Display	-+360

Enter the display resolution index number for angular measurements in Decimal Degrees

▶ Highlight the Startup Linear choice field and press a soft key to specify a unit of linear measure set by the DRO upon startup. Soft key selections are:

Soft key	Result
mm	The linear unit of measure will be millimeters
Inch	The linear unit of measure will be inches
Last	The linear unit of measure will not be changed

▶ Highlight the Startup Angular choice field and press a soft key to specify a unit of angular measure set by the DRO upon startup. Soft key selections are:

Soft key	Result
DD	The angular unit of measure will be Decimal Degrees
DMS	The angular unit of measure will be Degree Minutes Seconds
Last	The angular unit of measure will not be changed

▶ Highlight the Radix choice field and press a soft key to select a Decimal or Comma radix.

Select a Startup Linear unit of measure   Select a Startup Angular unit of measure   Select a Radix

▶ Highlight the Current Angular choice field and press a soft key to set the current session to Decimal Degrees (DD), or Degrees/Minutes/Seconds (DMS).

▶ Highlight the Current Units choice field and press a soft key to set the current session to inches (Inch), or millimeters (mm)

▶ Highlight the Display Mode choice field and press a soft key to set the current session to Cartesian (Cart), or Polar (Polar).

Display		mm ⌐1
About	MM Disp Res	0.001
Display	Inch Disp Res	0.001
Encoders	DMS Disp Res	0.01
Hot Keys	DD Disp Res	0.001
Print	Startup Linear	mm
Form Chars	Startup Angular	DMS
Measure	Radix	Decimal
Supervisor	Current Angular	**DMS**
Squareness	Current Units	mm
	Display Mode	Cart
	Angle Display	-+360
DD	**DMS**	

Set the display of angles for the current session

Set the display of units for the current session

Select the desired Display Mode

▶ Highlight the Angle Display choice field and press a soft key to select the desired protractor angle display format.

Display		mm ⌐1
About	MM Disp Res	0.001
Display	Inch Disp Res	0.001
Encoders	DMS Disp Res	0.01
Hot Keys	DD Disp Res	0.001
Print	Startup Linear	mm
Form Chars	Startup Angular	DMS
Measure	Radix	Decimal
Supervisor	Current Angular	DMS
Squareness	Current Units	mm
	Display Mode	Cart
	Angle Display	**-+360**
-+360	0 - 360	-+180

Select the desired protractor Angle Display format

Hot key assignments

The Hot Keys setup screen is used to map frequently used functions to front panel keys. Hot keys can save time by eliminating the need to navigate through menus to initiate a function, or by making a function more accessible through front panel keys.

Keys that are available for hot key mapping are shown here:

Arrow number	Descriptions
1	Soft keys
2	Unit keys

Hot keys screen

The Hot Keys screen configuration fields include:

■ Key type

■ Specific key for hot key assignment

■ Function to assign to the key
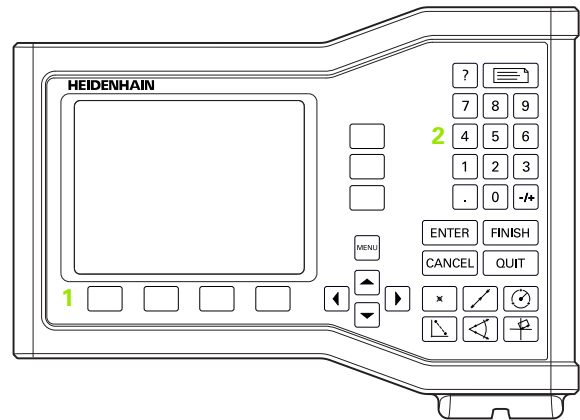
Front panel keys available for hot key mapping

To assign a function to a hot key:

▶ Press **MENU>Setup** to display the Setup menu and then highlight the Hot Keys menu item.

▶ Highlight the Keys choice field and then press a soft key to select the desired key type. In this example the Soft key type is selected.

▶ Highlight a specific key. In this example soft key 4 is selected.

▶ Press a soft key to select a function type to assign. In this example a Special function will be assigned.

Hot Keys		mm	↓1
About	Keys	Soft	
Display	1)	None	
Encoders	2)	None	
Hot Keys	3)	None	
Print	4)	None	
Form Chars			
Measure			
Supervisor			
Squareness			
▼			
Soft	Unit		

Press a soft key to select a key type

Hot Keys		mm	↓1
About	Keys	Soft	
Display	1)	None	
Encoders	2)	None	
Hot Keys	3)	None	
Print	4)	None	
Form Chars			
Measure			
Supervisor			
Squareness			
▼			
None	Key	Special	

Highlight a specific key for assignment

Annot.
Clear
DMS/DD
Inch/mm
MCS
MinMax
Preset
Preset!
Prt RS
▼

Press a soft key to select a function type

▶ Highlight the specific function and press the **ENTER** key to complete the assignment. In this example the Inch/mm function is assigned to soft key 4. After the assignment, pressing soft key 4 will toggle between inch and millimeter units of measure.

Annot.
Clear
DMS/DD
Inch/mm
MCS
MinMax
Preset
Preset!
Prt RS
▼

Highlight a specific function to assign

Hot Keys		mm	↓1
About	Keys	Soft	
Display	1)	None	
Encoders	2)	None	
Hot Keys	3)	None	
Print	4)	Inch/mm	
Form Chars			
Measure			
Supervisor			
Squareness			
▼			
None	Key	Special	

Press the **ENTER** key to complete the assignment

▶ Press the **FINISH** key to return to the Setup menu.

The functions contained in the Special menu are shown here:

Special menu function	Description
Annot	Toggles between forward and backward annotation probing
Clear	Clears the feature list, skews and datums
DMS/DD	Toggles the display of angles between degrees, minutes and seconds and decimal degrees.
Inch/mm	Toggles the display of linear units of measure between inches and millimeters.
MCS	Clears datums and reestablishes machine coordinates.
MinMax	Displays the maximum and minimum encoder count on the selected axis. An absolute range (from the minimum to maximum) is displayed as well.
Preset	Presets datums to user specified values that correspond to known part coordinates such as dimensions specified by a part drawing.
Preset!	Repeats the last preset datum performed.
Prt RS	Sends data for the current print request to the USB-to-Serial connection
Ref 1/2	Toggles the datum being used between datum 1 and datum 2.
Send 2, 3	Sends the current X-Y, X-Y-Z or X-Y-Q axes data to a computer.
Send D	Sends the current diameter data to a computer.
Send F	Sends the current form error data to a computer.
Send L	Sends the current length data to a computer.
Send Q	Sends the current protractor Q-axis data to a computer.
Send r	Sends the current radius data to a computer.
Send X	Sends the current X-axis data to a computer.
Send Y	Sends the current Y-axis data to a computer.
Send Z	Sends the current Z-axis data to a computer.
Send <	Sends the current angle measurement data to a computer.
Zero 2	Zeroes the X and Y axes
Zero Q	Zeroes the Q-axis

Print formatting

Print formatting data and choice fields are contained in the Print and Form Characters screens.

Print screen

The Print screen configuration fields include:

■ Report width in characters

■ Report length in lines per page

■ Form feed

■ Printer control characters before and after lines and after forms

■ Automatic labeling of report data

■ Including units of measure in reports

To format printing in the Print screen:

▶ Press **MENU>Setup** to display the Setup menu and then highlight the Print menu item.

▶ Highlight the Report Width choice field and then press a soft key to select a report width of 32, 40 or 80 characters.

▶ Highlight the Lines/Page choice field and then enter the desired number of lines per page from1 to 999 lines.

▶ Highlight the Form Feed choice field and press the **Yes** soft key to insert a form feed control character after the printed data if desired.

Print		mm ⌊1
About	Report Width	**80**
Display	Lines / Page	60
Encoders	Form Feed	No
Hot Keys	Pre Line	
Print	Post Line	10 13
Form Chars	Post Form	
Measure	Auto Label	Yes
Supervisor	Print Units	No
Squareness	Data	Display
▼	Prompt	No
32	40	**80**	

Select a report width

Print		mm ⌊1
About	Report Width	80
Display	Lines / Page	**60**
Encoders	Form Feed	No
Hot Keys	Pre Line	
Print	Post Line	10 13
Form Chars	Post Form	
Measure	Auto Label	Yes
Supervisor	Print Units	No
Squareness	Data	Display
▼	Prompt	No

Specify a report length

Print		mm ⌊1
About	Report Width	80
Display	Lines / Page	60
Encoders	Form Feed	**Yes**
Hot Keys	Pre Line	
Print	Post Line	10 13
Form Chars	Post Form	
Measure	Auto Label	Yes
Supervisor	Print Units	No
Squareness	Data	Display
▼	Prompt	No
No	**Yes**		

Select a form feed if desired

▶ Highlight the Pre Line, Post Line or Post Form data field and then enter the desired ASCII character. Up to four ASCII key codes can be entered for each data field. For example, ASCII key codes entered in the Pre Line field occur before each line of print on a report, so entering an ASCII key code 32 inserts a space before each line of print. Characters must be separated by a space. ASCII key codes are shown on the next page.

▶ Highlight the Auto Label choice field and press the **Yes** soft key to include descriptive labels with the printed data.

▶ Highlight the Print Units choice field and press the **Yes** soft key to include unit of measure labels with the printed data.

Print		mm ↓1
About	Report Width	80
Display	Lines / Page	60
Encoders	Form Feed	Yes
Hot Keys	Pre Line	
Print	Post Line	10 13
Form Chars	Post Form	
Measure	Auto Label	Yes
Supervisor	Print Units	No
Squareness		
▼	Data	Display
	Prompt	No

Enter Pre Line, Post Line or Post Form ASCII control characters

Print		mm ↓1
About	Report Width	80
Display	Lines / Page	60
Encoders	Form Feed	Yes
Hot Keys	Pre Line	
Print	Post Line	10 13
Form Chars	Post Form	
Measure	Auto Label	Yes
Supervisor	Print Units	No
Squareness		
▼	Data	Display
No	Yes	Prompt	No

Press the **Yes** soft key to specify automatic data labeling

Print		mm ↓1
About	Report Width	80
Display	Lines / Page	60
Encoders	Form Feed	Yes
Hot Keys	Pre Line	
Print	Post Line	10 13
Form Chars	Post Form	
Measure	Auto Label	Yes
Supervisor	Print Units	Yes
Squareness		
▼	Data	Display
No	Yes	Prompt	No

Press the **Yes** soft key to include units of measure

2 Software setup

ASCII codes:

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

106   2 Installation and Specifications

▶ Highlight the Data choice field and then press the **List** soft key to display data type choices.

▶ Highlight a data type choice field and press the **ENTER** key to select it. Data type choices include:

■ None: No data will be sent

■ Display: Contents of the current display

■ Report: All feature measurement data without tolerance results

■ Tol Rpt: All tolerance data without feature measurement results

■ CSV: All feature measurement data without tolerance results in comma separated variable format

■ Tab: All feature measurement data without tolerance results in tab separated variable format

▶ Highlight the Prompt choice field and press the **Yes** soft key to prompt the user for a data type. Press the **No** soft key to send the file using the data type specified in the Data field.

Print		mm ⌐1
About	Report Width	80
Display	Lines / Page	60
Encoders	Form Feed	Yes
Hot Keys	Pre Line	
Print	Post Line	10 13
Form Chars	Post Form	
Measure	Auto Label	Yes
Supervisor	Print Units	Yes
Squareness	Data	None
▼	Prompt	No
List		

None
Display
Report
Tol Rpt
CSV
Tab

Print		mm ⌐1
About	Report Width	80
Display	Lines / Page	60
Encoders	Form Feed	Yes
Hot Keys	Pre Line	
Print	Post Line	10 13
Form Chars	Post Form	
Measure	Auto Label	Yes
Supervisor	Print Units	Yes
Squareness	Data	Display
▼	Prompt	Yes
No	Yes	

Press the **List** soft key to display a list of data types

Highlight a data type and press the **ENTER** key to select it

Highlight the Prompt choice field and press the **Yes** or **No** soft key

▶ Press the **FINISH** key to return to the Setup menu.

Form Chars screen

The Form Chars (characters) screen contains printer configuration data fields for including ASCII control strings in front of the report data stream.

Up to 3 ASCII characters can be entered into each data field. Each character must be separated from the next by a space.

To format printing in the Form Chars screen:

▶ Highlight the Form Chars menu item.

▶ Highlight the first field and enter the required ASCII control characters.

```
Form  Chars                        mm  |1
           Pre  Form
About      ┌─────────────────┐
Display    ├─────────────────┤
Encoders   ├─────────────────┤
Hot Keys   ├─────────────────┤
Print      ├─────────────────┤
Form Chars ├─────────────────┤
Measure    └─────────────────┘
Supervisor
Squareness
   ▼
```

Enter Pre form ASCII control characters

▶ Continue highlighting fields and entering characters until the data stream is complete.

▶ Press the **FINISH** key to return to the Setup menu.

2.3 Specifications

Specifications	
Axes	2 to 3 axes
Encoder inputs	⊓⊔ TTL encoders, 5 V
Display	Monochrome display for position values, dialogue, and input display, graphic functions, graphic positioning aid
	■ 14.48 cm
	■ 1.27 cm display digit size
	■ 0.00001 mm Resolution
Error compensation	Linear (LEC), segmented linear (SLEC) and nonlinear (NLEC)
Data interface	**USB** (type B) 115 200 baud
Accessories	■ Tilting base (ID 625491-01)
	■ Mounting arm (ID 382893-01)
	■ Mounting frame (ID 647702-01)
	■ QC-Wedge communication software (ID 709141-01)
Power input	AC 100 V ... AC 240 V (–15 % to +10 %)
	50 Hz ... 60 Hz (±2 %)
	max.54 W
Replaceable fuse	T500 mA / 250 V, 5 mm X 20 mm
Environmental conditions	Meets standards for normal environmental conditions.
Operating temperature	0 °C ... 45 °C
Storage temperature	-20 °C ... 70 °C
Installation category	II
Protection EN60529	IP40, IP54 front panel
Enclosure	Benchtop; cast-metal enclosure
Weight	2.6 kg

Dimensions

The DRO enclosure, tilting base, arm mount bracket and mounting frame dimensions are shown in: mm.

ND 120
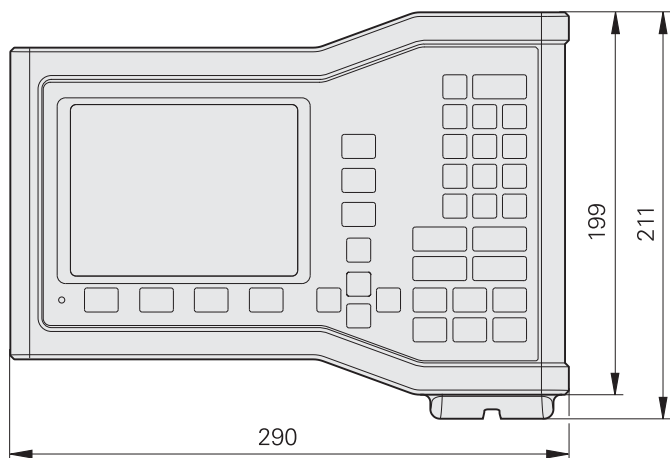
Front view with Dimensions
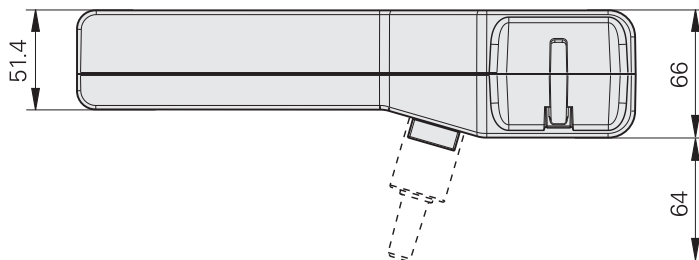
Bottom view with Dimensions

Tilting base (ID 625491-01)

248

259

42

Front view with Dimensions

18°   18°

50

150
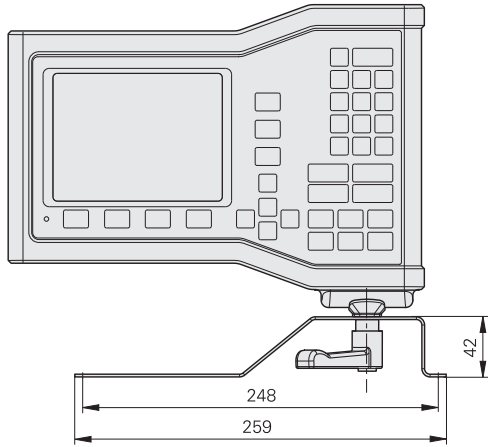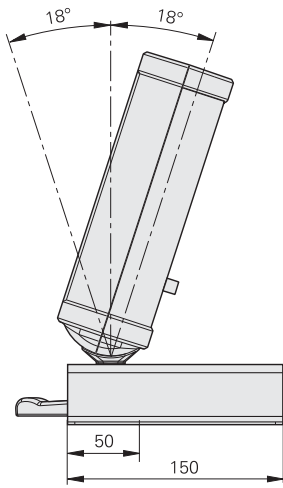
Side view with Dimensions

Mounting frame (ID 647702-01)

Front view with Dimensions

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