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User's Manual

ND 780

ND 780 Screen

Status Bar Symbols

Datum · Tool · Feed Rate · Stopwatch · Unit of Measure · Actual Value · Distance-To-Go · Page Indicator · Set/Zero

`D:0 | T:1 | F: 0 | 0:00 | MM | ⊥ △ | ⇆ | SET`

Axis Label

0.000 **REF** X

0.000 Y

0.000 Z

Ref symbol

Display Area

Graphic Positioning Aid

Soft Key Functions

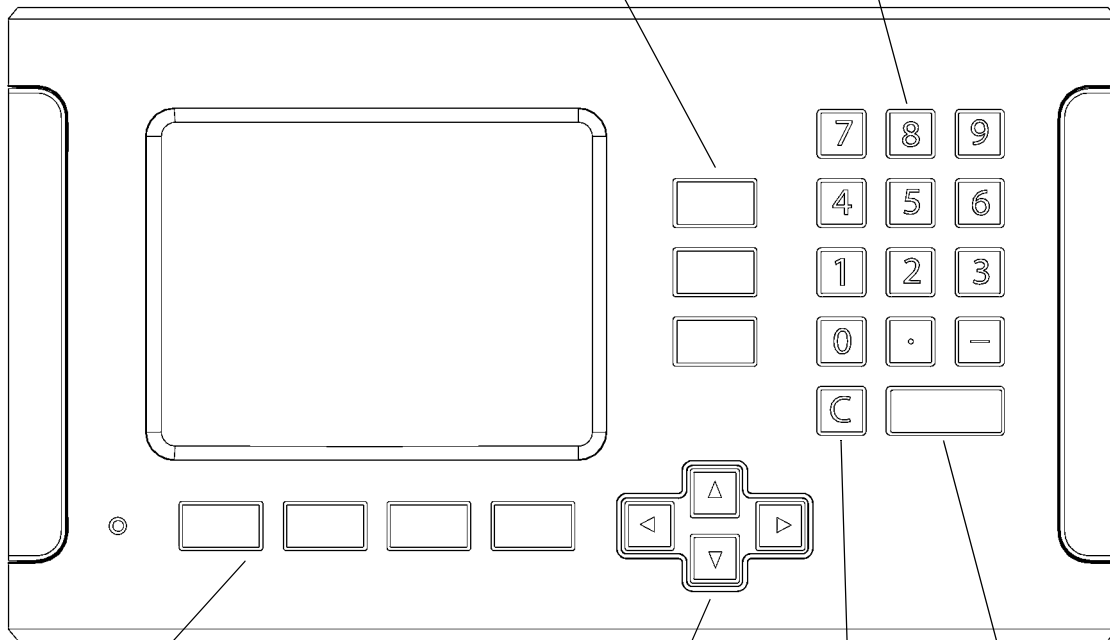| HELP | TOOL | ⊥/△ | SET ZERO |
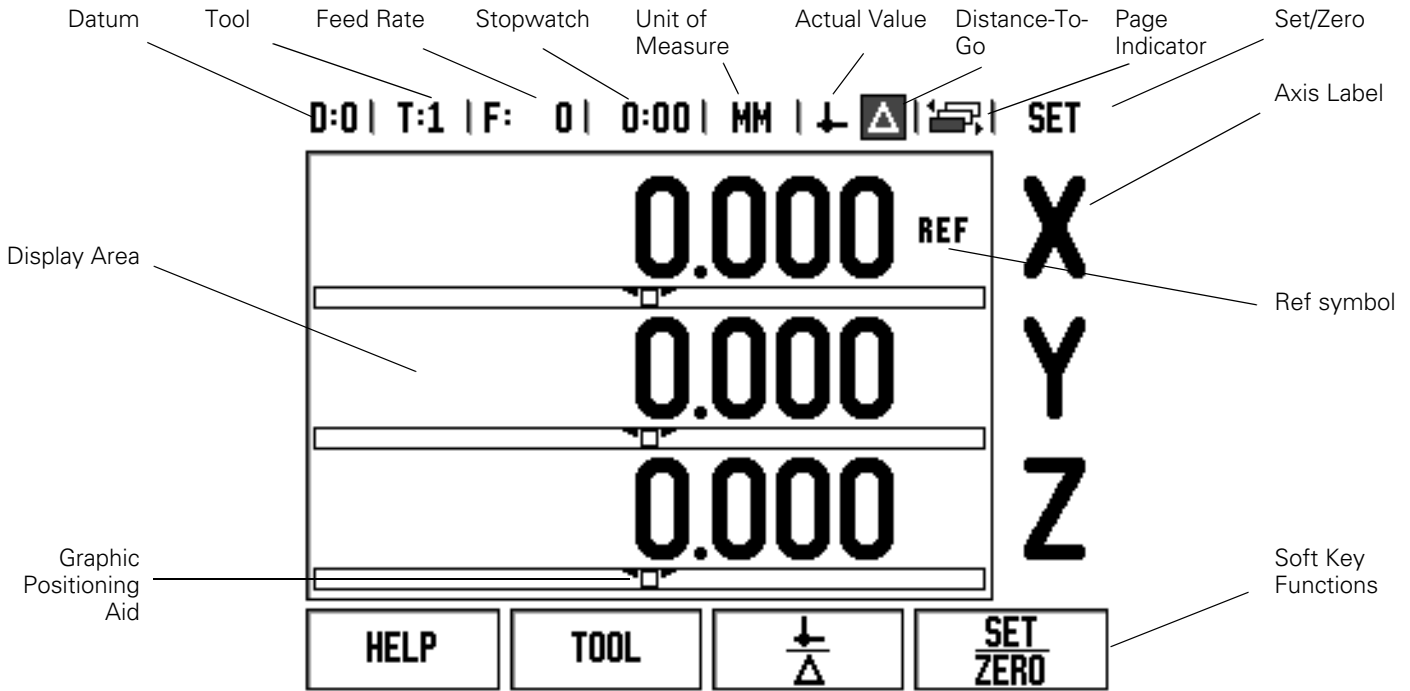
3 axis keys to select between X, Y and Z axes

Numeric input keys

Soft keys - Row of keys under the screen of the ND 780 whose functions vary according to associated fields that appear above them on the screen
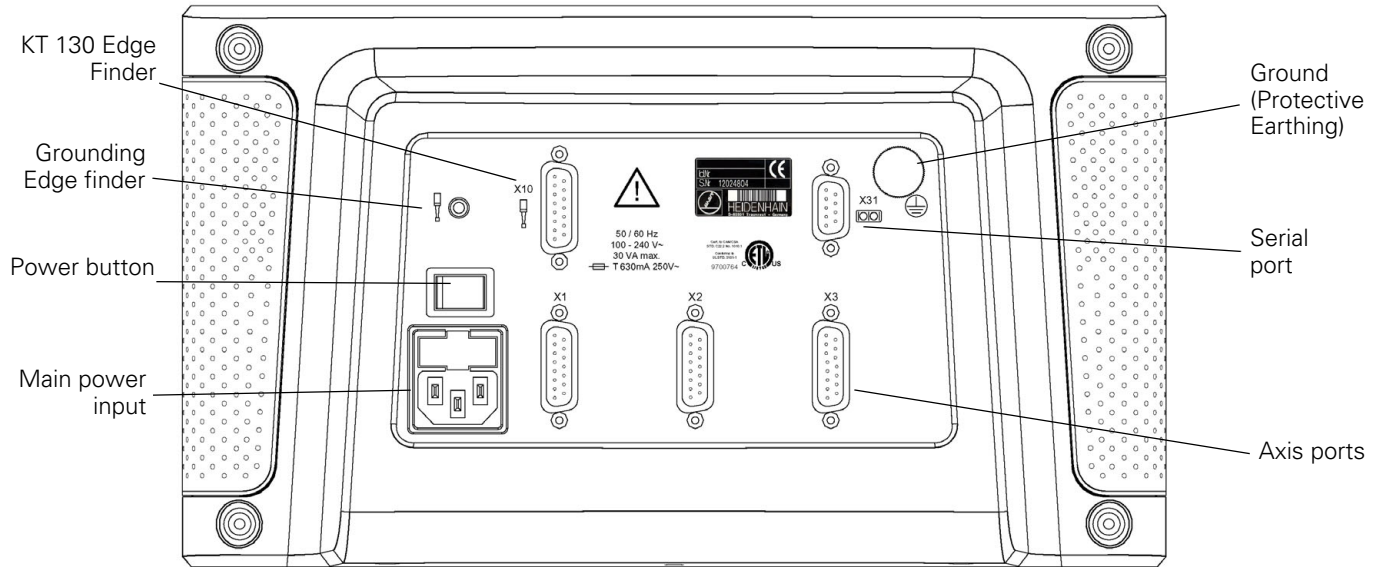
Up/Down arrow keys - are also used to adjust screen contrast

Clear key

Confirm entry and select entry field

ND 780 Back View

KT 130 Edge Finder

Grounding Edge finder

Power button

Main power input

Ground (Protective Earthing)

Serial port

Axis ports

X10

X31

X1 X2 X3

50 / 60 Hz
100 - 240 V~
30 VA max.
T 630mA 250V~

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Introduction

Software Version

The software version is shown on the initial power up screen.

> 🖘 This User's Manual covers the functions of the ND 780 for both **milling** and **turning** applications. Operational information is arranged in three sections: General Operations, Mill Specific Operations and Turn Specific Operations.

Symbols within notes

Every note is marked with a symbol on the left indicating to the operator the type and/or potential severity of the note.

> 🖘 **General Information**
>
> e.g. on the behavior of the ND 780.

> ⚠ **Warning** – Refer to accompanying documents
>
> e.g. when a special tool is required for a function.

> ⚡ **Caution - Risk of electric shock**
>
> e.g. when opening a housing.

> The ND 780 and the machine tool must be prepared by the machine tool builder to perform this function.

ND 780 Fonts

The chart below shows how the different variables (soft keys, hard keys, forms and form fields) are represented within the text of this manual:

- Soft keys - **SETUP** soft key
- Hard keys - ENTER hard key
- Forms - *ANGULAR* forms
- Form Fields - RADIUS
- Data in fields - <u>ON</u>, <u>OFF</u>

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I – 1 Fundamentals of Positioning

Datums

The workpiece drawing identifies a certain point on the workpiece (usually a corner) as the **absolute datum** and perhaps one or more other points as relative datums.

The datum setting procedure establishes these points as the origin of the absolute or relative coordinate systems. The workpiece, which is aligned with the machine axes, is moved to a certain position relative to the tool and the display is set either to zero or to another appropriate value (e.g., to compensate for tool radius).

Actual Position, Nominal Position and Distance-To-Go

The position of the tool at any given moment is called the **actual position** while the position that the tool is to move to is called the **nominal position**. The distance from the nominal position to the actual position is called the **distance-to-go**. See Fig. I.1
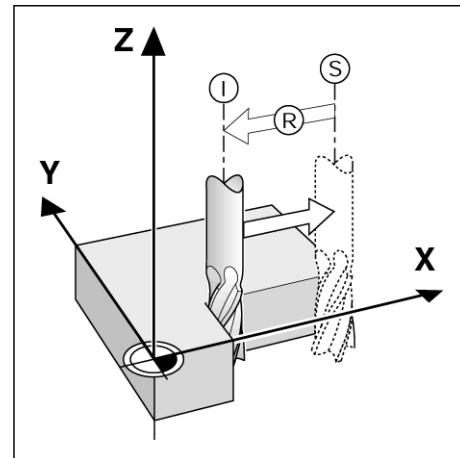
Fig. I.1   Nominal position S, actual position I and distance-to-go R

Absolute Workpiece Positions

Each position on the workpiece is uniquely identified by its absolute coordinates. See Fig. I.2.

Example: Absolute coordinates of position **1**:
X = 20 mm
Y = 10 mm
Z = 15 mm

If you are drilling or milling a workpiece according to a workpiece drawing with **absolute coordinates,** you are moving the tool to the value of the coordinates.
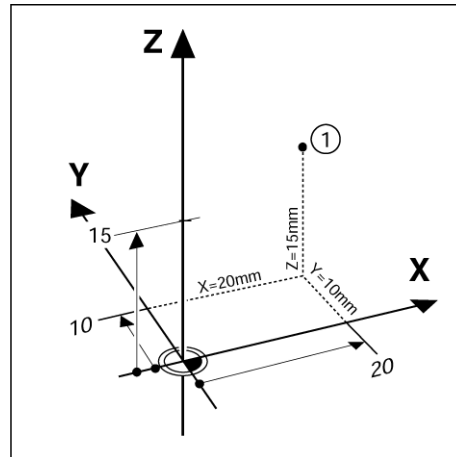
Fig. I.2   Position 1 definition through absolute coordinates

Incremental Workpiece Positions

A position can also be referenced to the preceding nominal position. In this case the relative datum is always the last nominal position. Such coordinates are referred to as **incremental coordinates** (increment = increase). They are also called incremental or chain dimensions (since the positions are defined as a chain of dimensions). Incremental coordinates are designated with the prefix **I**.

Example: Incremental coordinates of position **3** referenced to position **2**. See Fig. I.3

Absolute coordinates of position **2**:
X = 10 mm
Y = 5 mm
Z = 20 mm

Incremental coordinates of position **3**:
IX = 10 mm
IY = 10 mm
IZ = –15 mm

If you are drilling or milling a workpiece according to a drawing with incremental coordinates, you are moving the tool **by** the value of the coordinates.
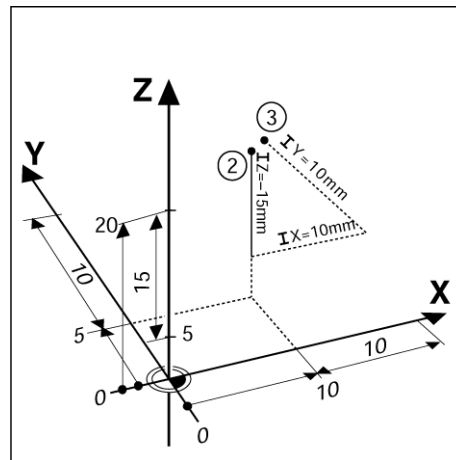
Fig. I.3   Position 3 using incremental coordinates

Zero Angle Reference Axis

The Zero Angle Reference Axis is the 0 degree position. It is defined as one of the two axes in the plane of rotation. The following table defines the Zero Angle where the position of the angle is zero for the three possible planes of rotation.

For angular positions, the following reference axes are defined:

Plane	Zero Angle Reference Axis
XY	+X
YZ	+Y
ZX	+Z

Positive direction of rotation is counterclockwise if the working plane is viewed in the negative tool axis direction. See Fig. I.4.

Example: Angle in the working plane X / Y

Angle	Corresponds to the...
+ 45°	... bisecting line between +X and +Y
+/– 180°	... negative X axis
- 270°	... positive Y axis
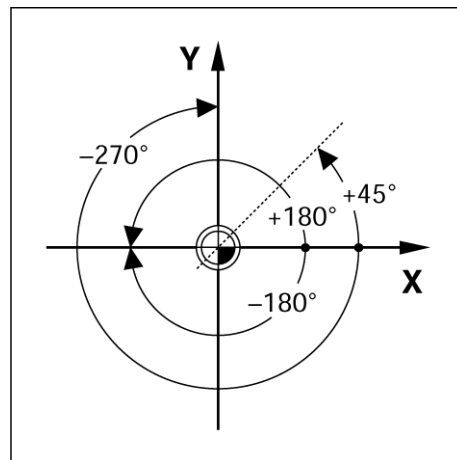
Fig. I.4   Angle and the angle reference axis, e.g. in the X / Y plane

Position Encoders

The **position feedback** encoders convert the movement of the machine axes into electrical signals. The ND 780 constantly evaluates these signals and calculates the actual positions of the machine axes, which it displays as a numerical value on the screen. See Fig. I.5.

If there is an interruption in power, the calculated position will no longer correspond to the actual position. When power is restored, you can re-establish this relationship with the aid of the reference marks on the position encoders and the ND 780's reference mark evaluation feature (**REF**).
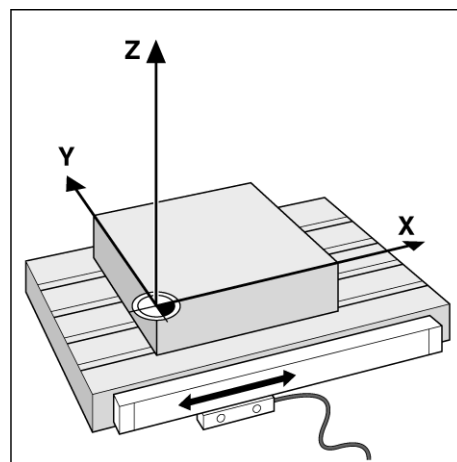
Fig. I.5   Linear position encoder, here for the X axis

Encoder Reference Marks

Encoders normally contain one or more reference marks (see Fig. I.6) which the ND 780's Reference Mark Evaluation feature uses to re-establish datum positions after a power interruption. There are two main options available for reference marks; fixed and distance-coded.

Encoders with **distance-coded reference marks** have marks separated by a specific encryption pattern that allows the ND 780 to use any two pair of marks along the length of the encoder to re-establish the prior datums. This configuration means that the operator only has to travel a very short distance, any where along the encoder, to re-establish the datums when the ND 780 is turned back on.

Encoders with **fixed reference marks** have one or more marks on fixed intervals. To re-establish the datums correctly, it is necessary to use the same exact reference mark, during the Reference Mark Evaluation routine, that was used when the datum was first established.

☞ The established datums' cannot be restored from one power cycle to the next if the reference marks were not crossed before the datums were set.
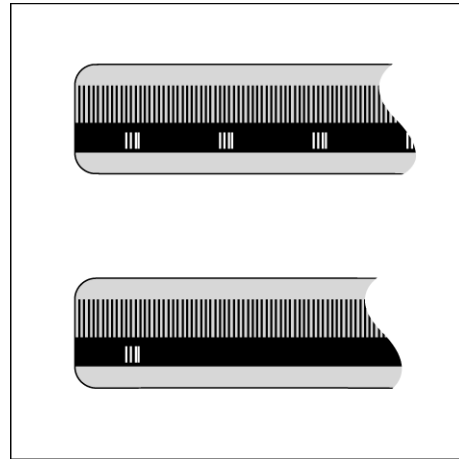
Fig. I.6 Linear scales: with distance-coded reference marks (upper illustration) and one reference mark (lower illustration)

I – 2 General Operations for ND 780

Layout of Screen

Status Bar Symbols

Datum   Tool   Feed Rate   Stopwatch   Unit of Measure   Actual Value   Distance-To-Go   Page Indicator   Set/Zero

Axis Labels

D:0 | T:1 | F: 0 | 0:00 | MM | ⊥ △ | 🖬 | SET

Display Area

0.000 REF **X**

0.000 **Y**

Graphic Positioning Aid (In Distance-To-Go mode only)

0.000 **Z**

Ref Symbols

Soft key Labels

HELP	TOOL	⊥/△	SET ZERO
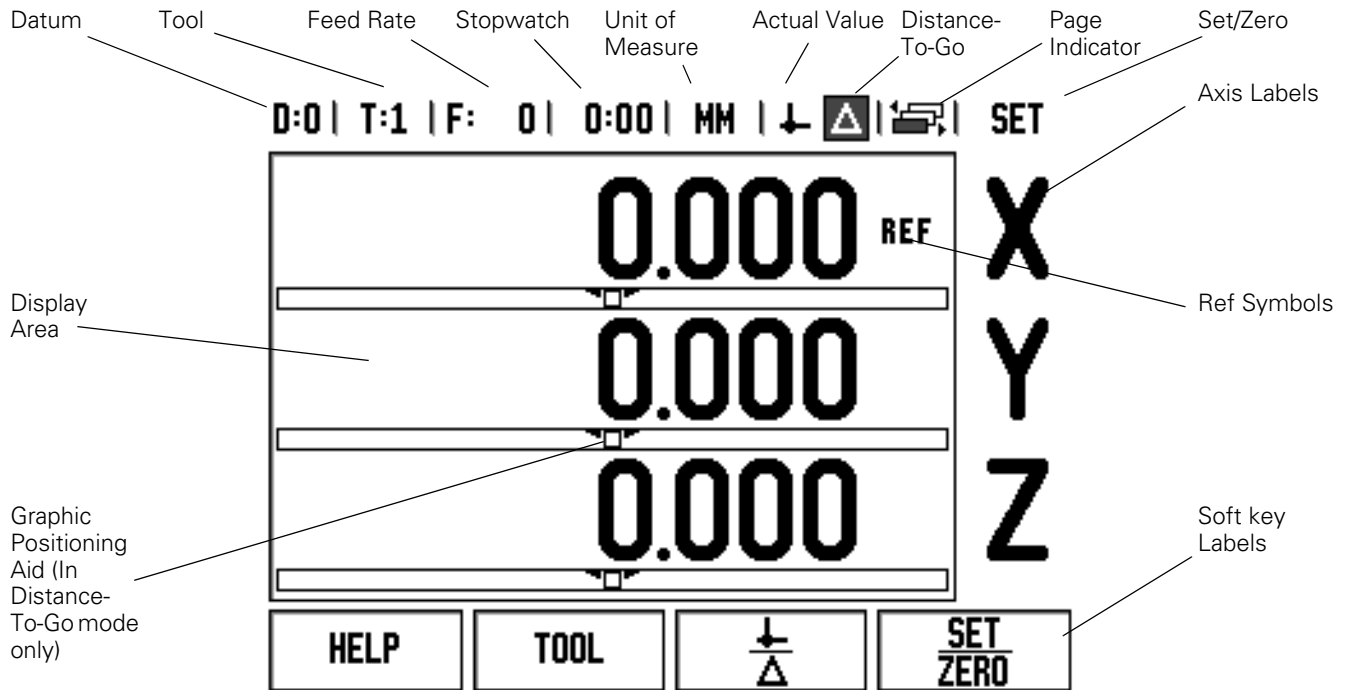
- **Status Bar** - This displays the current datum, tool, feed rate, stop watch time, unit of measure, actual value or distance-to-go status, page indicator, and set/zero. See Job Setup for details on setting up the Status Bar parameters.

- **Display Area** - Indicates the current position of each axis. Also shows forms, fields, instruction boxes, error messages and help topics.

- **Axis Labels** - Indicates axis for corresponding axis key.

- **Ref Symbols** - Indicates current reference mark status.

- **Soft key Labels** - Indicates the various milling or turning functions.

General Navigation

■ Use keypad to enter numeric values within each field.

■ The ENTER key will confirm the entry within a field and return to the previous screen.

■ Press the C key to clear entries and error messages or return back to the previous screen.

■ SOFT KEY labels show the various milling or turning functions. These functions are selected by pressing the corresponding soft key directly below each soft key label. There are 3 page of selectable soft key functions. These are accessed using the LEFT/RIGHT ARROW keys as indicated below.

■ The LEFT/RIGHT ARROW keys move through pages 1-3 of soft key selectable functions. The current page will be highlighted in the Status bar at the top of screen.

■ Use the UP/DOWN ARROW keys to move between fields within a form and list boxes within a menu. The orientation of the cursor is such that it will return to the top once it has reached the bottom of the menu.

Operating Modes

The ND 780 has two operating modes **Actual Value** and **Distance-To-Go.** The Actual Value Operations mode always displays the current actual position of the tool, relative to the active datum. In this mode, all moves are done by traveling until the display matches the nominal position that is required. The Distance-To-Go feature enables you to approach nominal positions simply by traversing to display value zero. When working within the Distance-To-Go mode you can enter nominal coordinates as either absolute or incremental dimensions.

While in the Actual Value Mode, if the ND 780 is configured for Milling applications, only the tool length offsets are active. Both the radius and length offsets are used in the Distance-To-Go mode to calculate the amount of "distance-to-go" required to get to the desired nominal position relative to the edge of the tool that will be doing the cutting.

If the ND 780 is configured for a lathe, all tool offsets are used in both the Actual Value and Distance-To-Go modes.

Press the **ACTUAL VALUE/DISTANCE-TO-GO** soft key to toggle between these two modes. To view soft key functions in either Actual Value or Distance-to-Go mode, use the LEFT/RIGHT ARROW keys.
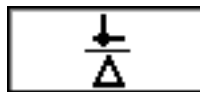
Fig. I.7   **ACTUAL VALUE/DISTANCE-TO-GO** soft key

Graphic Positioning Aid

When you are traversing to display value zero (in the Distance-To-Go mode), ND 780 displays a graphic positioning aid. See Fig. I.8.

ND 780 displays the graphic positioning aid in a narrow rectangle underneath the currently active axis. Two triangular marks in the center of the rectangle symbolize the nominal position you want to reach.

A small square symbolizes the axis slide. An arrow indicating the direction appears in the square while the axis is moving. You can easily tell whether you are moving towards or away from the nominal position. Note that the square does not begin to move until the axis slide is near the nominal position. For setting up the graphic positioning aid. See "Graphic Positioning Aid" on page 24 under Job Setup.

Help Screen

The integrated operating instructions provide information and assistance in any situation. See Fig. I.9

To **call** the operating instructions:

▶ Press the **HELP** soft key.
▶ Information relevant to the current operation will be displayed.
▶ Use the UP/DOWN ARROW keys if the explanation is spread over more than one screen page.

To view information on another topic:

▶ Press the **LIST OF TOPICS** soft key.
▶ Press the UP/DOWN ARROW keys to scroll through the index.
▶ Press the ENTER key to select the item you need.

To **leave** the operating instructions:

▶ Press the C key.

Data Input Forms

Information required for various operational functions and setup parameters are entered through a data input form. These forms will appear after selecting features that require any additional information. Each form provides specific fields for entering the required information.

You must confirm your changes by pressing the ENTER key for them to become effective. If you do not want to save your changes, press the C key to return to the previous screen without saving changes.
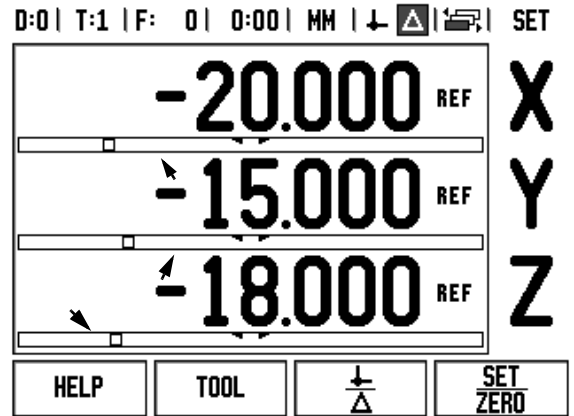
Fig. I.8   Graphic Positioning Aid in use (see arrows)
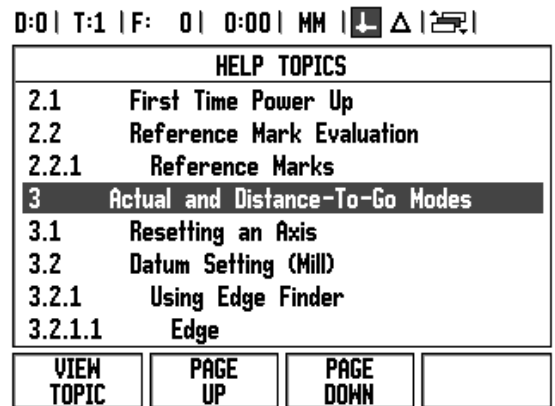
Fig. I.9   List of Topics under HELP mode

Instruction Box messages

Whenever a Menu, or Form is open an instruction box will also open immediately to the right of it. This message box will provide information to the operator on what the chosen function does and present instructions on the available options.

Fig. I.10   Example of Form and Instruction Box

Error Messages

If an error occurs while you are working with ND 780, the message will appear on the display and provide an explanation of what caused the error.

To clear the error message:

▶ Press the C key.

Power Up

Switch on the power (located on the back). The initial screen will appear. See Fig. I.11 (This screen will only appear the very first time the unit is powered up. The following steps may have already been completed by the installer).

- Select the proper language by pressing the **LANGUAGE** soft key.

- Choose your application of either **MILL** or **TURN.** The **APPLIC. [MILL/TURN]** soft key toggles between these two settings.

- Next select the number of axes required. When complete press the ENTER hard key.

If necessary, you can change the application later in Installation Setup under Counter Settings.

Power was off. Press any key to continue.

ND 780
SOFTWARE VERSION X.X.X
ID XXXXXX-XX

In ⊥ or △ screens, press the left or right arrow keys for other menu options.

| LANGUAGE [ENGLISH] | APPLIC. [MILL] | AXES [3] | HELP |

Fig. I.11   Initial screen

Your ND 780 is now ready for operation and is in the operating mode Actual Value. Each active axis will have a flashing"REF"sign next to it. At this point the reference mark evaluation should be completed.

Reference Mark Evaluation

The ND 780's reference mark evaluation feature automatically re-establishes the relationship between axis slide positions and display values that you last defined by setting the datum.

If the axis encoder has reference marks, the REF indicator will flash. See Fig. I.12. After crossing over the reference marks, the indicator will stop flashing and change to non-flashing REF.

Working without reference mark evaluation

You can also use the ND 780 without crossing over the reference marks. Press the **NO REF** soft key to exit the reference mark evaluation routine and continue.

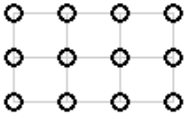You can still cross over reference marks at a later time, if it becomes necessary to define datums that can be re-established after a power interruption. Press the **ENABLE REF** soft key to activate the reference mark evaluation routine.

☞ If an encoder is setup without reference marks, then the REF indicator will not be displayed, and datums will be lost once power is turned off.

D:0 | T:1 | F: 0 | 0:00 | MM | ⊥ △ |

0.000 REF X

0.000 REF Y

0.000 REF Z

| DISABLE REF | | NO REF | HELP |

Fig. I.12   Screen for establishing Ref Marks

ENABLE/DISABLE REF function

The toggling **ENABLE/DISABLE** soft key, that is present during the Reference Mark Evaluation routine, allows the operator to select a specific Reference Mark on an encoder. This is important when using encoders with Fixed Reference Marks. When the **DISABLE REF** soft key is pressed, the evaluation routine is paused and any reference marks that are crossed during encoder movement are ignored. When the **ENABLE REF** soft key is then pressed, the evaluation routine once again becomes active and the next crossed reference mark will be selected.

Once reference marks for all desired axes are established, press **NO REF** soft key to cancel out of routine. You do not have to cross over the reference marks of all the encoders, only those that you need. If all reference marks have been found the ND 780 will return to the DRO display screen automatically.

> ☞ If you do **not** cross over the reference marks, ND 780 does not store the datum points. This means that it is not possible to re-establish the relationship between axis slide positions and display values after a power interruption (switch-off).

For everyday power up; turn on power and press any key.

Cross over the reference marks (in any order).

- ALTERNATIVE METHOD -

DISABLE REF	Press **DISABLE REF** soft key and cross over reference marks.
ENABLE REF	Move encoder to desired fixed reference mark. Press **ENABLE REF** soft key and cross over reference mark.

- ALTERNATIVE METHOD -

NO REF	Do **not** cross over the reference marks and press the **NO REF** soft key. Note: In this case the relationship between axis slide position and display value will be lost after a power interruption.

Setup

ND 780 offers two categories for setting up operating parameters. These categories are: Job Setup and Installation Setup. The Job Setup parameters are used to accommodate specific machining requirements for each job. Installation Setup is used to establish encoder, display and communication parameters.

The Job Setup menu is accessed by pressing the **SETUP** soft key. See Fig. I.13. When in the Job Setup menu, the following soft keys will be available:

■ **INSTALLATION SETUP**
Press to begin accessing the Installation Setup parameters. See "Installation Setup Parameters" on page 66.

■ **IMPORT/EXPORT** Press to begin importing or exporting operating parameters. See "Import/Export" on page 25.

■ **HELP**
Will open on-line help.
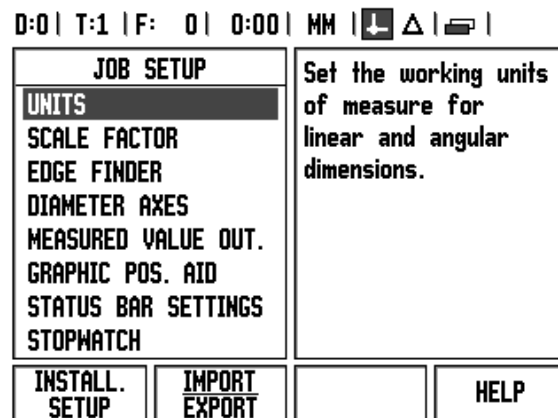
Fig. I.13 Job Setup screen in milling

Job Setup Parameters

To view and change Job Setup parameters use the UP/DOWN ARROW keys to highlight the parameters of interest and press the ENTER key.

Units

The *UNITS* form is used to specify the preferred display units and format. The system powers up with these settings in effect.

▶ Inch/MM - Measurement values are displayed and entered in the units selected in the LINEAR field. Choose between inch or millimeter by pressing the **INCH/MM** soft key. You can also select the unit of measure by pressing the **INCH/MM** soft key in either Actual Value or Distance-To-Go mode.

▶ Decimal Degrees, Radians or Degrees/Minutes/Seconds (DMS) - The ANGULAR field affects how angles are displayed and entered into forms. Choose between **DECIMAL DEGREES, RADIANS** or **DMS** using the soft key.

Scale Factor

The scale factor may be used to scale the part up or down. All encoder movements are multiplied by the scale factor. A scale factor of 1.0 creates a part with the exact size as dimensioned on the print. See Fig. I.14.

▶ The numeric keys are used to enter a number greater than zero. The number range is 0.1000 to 10.000.

▶ The scale factor settings will be retained on a power cycle.

▶ When the scale factor is a value other than 1, the scaling symbol ∇ is shown on the axis display.

▶ The **ON/OFF** soft key is used to disable the current scale factors.

Edge Finder (milling applications only)

The diameter and length offset of the edge finder are set in this form. Both values are in the units indicated in the form.

▶ The numeric keys are used to enter values of diameter and length. The diameter must be greater than zero. The length is a sign value (negative or positive).

▶ A soft key is provided to indicate the units of measure for the edge finder.

The edge finder values will be retained on a power cycle.

Diameter Axes

Select Diameter Axes to set which axes can be displayed in either radius or diameter values. <u>ON</u> indicates that the axis position will be displayed as a diameter value. When <u>OFF</u>, the Radius/Diameter feature does not apply. See Fig. I.15. For turning applications see "R$_X$ (Radius/Diameter) Soft Key" on page 59 for the Radius/Diameter feature.

▶ Cursor to DIAMETER AXIS and press ENTER.

▶ The cursor will be in the X field. Depending on the parameter you need for that axis press **ON/OFF** soft key to turn feature on or off.
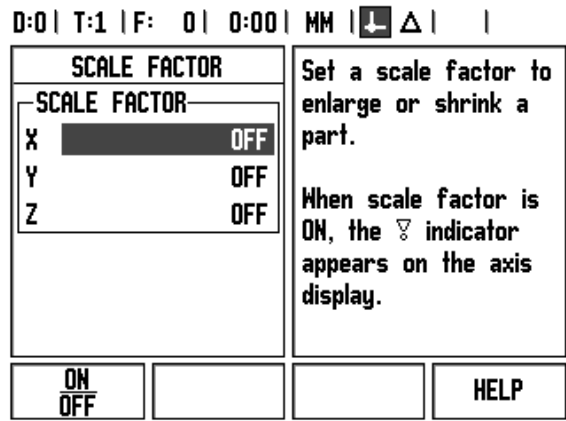
▶ Press ENTER.

Fig. I.14 Scale factor
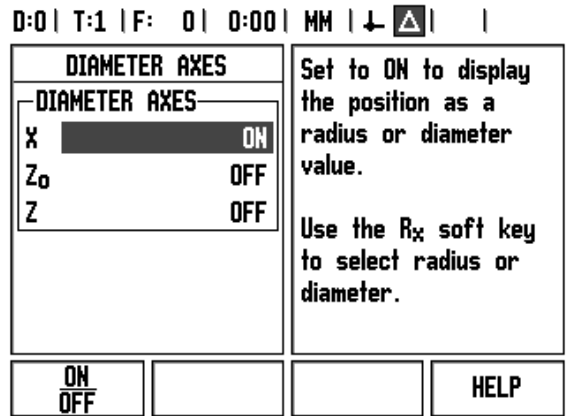
Fig. I.15 Diameter Axes form

Measured Value Output

With the measured value output feature, the current axis display positions and probe measurement values can be sent over the serial port. Output of the current display positions is activated via an external hardware signal or via a command (Ctrl B) sent to ND 780 over the serial port.

The *MEASURED VALUE OUTPUT* form is used to set data output during probing operations to <u>ON</u> or <u>OFF</u>. It is also used to set the display freeze option.

▶ Data Output Probing (Milling Only) - This may be set to either <u>ON</u> or <u>OFF</u>. When <u>ON</u>, the measurement data is output when the probe operation is completed.

▶ Display Freeze - Set to either:

  ■ <u>OFF</u> - The display is not stopped during measured value output.
  ■ <u>Concurrent</u> - The display is stopped during measured value output and remains stopped while the switching input is active.
  ■ <u>Freeze</u> - The display is stopped, but is updated by every measured value output.

Refer to Measured Value Output for information on the format of the output data.

Graphic Positioning Aid

The *GRAPHIC POSITIONING AID* form is used to configure the bar graph that is shown below the axes' display in Distance-To-Go mode. Each axis has its own range. See Fig. I.16.

▶ Press the **ON/OFF** soft key to enable or simply begin entering values using the numeric keys. The current position box will begin moving when the position is within range.

Status Bar Settings

The Status Bar is the segmented bar at the top of the screen which displays current datum, tool, feed rate, stop watch and page indicator.

▶ Press the **ON/OFF** soft key for each setting you want to see displayed.

Stopwatch

The stopwatch shows the hours (h), minutes (m), seconds (s). It operates like a stop watch showing elapsed time. (The watch starts timing from 0:00:00).

The elapsed time field shows the total accumulated time from each interval.

▶ Press the **START/STOP** soft key. The status field will read <u>RUNNING</u>. Press it again to stop time from elapsing.

▶ Press **RESET** to reset the elapsed time. Resetting will stop the watch if it is running.

Fig. I.16   Graphic positioning aid

Remote Switch

The **remote switch** sets the parameters so the external switch (pendant or foot switch) can be enabled to perform any or all of the following functions: Data Output, Zero and Next Hole. Refer to Section II for information on connecting remote switches via Grounding Edge Finder input (See Grounding Edge Finder Fig. II.6).

■ Data Output - to send position information out of the serial port or to print the current position.

■ Zero - to zero one or more axes. (If you are in Distance-To-Go mode it will zero the Distance-To-Go display. If in Actual Value mode it will zero the datum).

■ Next Hole - to move to the next hole within a pattern (i.e. Hole Pattern).

▶ While in the DATA OUTPUT field, press the **ON/OFF** soft key to <u>ON</u> to send the current position over the serial port when the switch is closed.

▶ While in the ZERO field, press the appropriate axis keys to enable or disable zeroing of the axis display positions when the switch is closed.

▶ While in the (NEXT HOLE) field, press the **ON/OFF** soft key to <u>ON</u> to move to the next hole within a pattern.

Console Adjustment

The LCD's brightness and contrast can be adjusted for this console. When in either Actual Value or Distance-To-Go mode, the Up/Down arrow keys can also be used to adjust the contrast of the LCD. This form is also used to set the display saver's idle time-out.

The display saver setting is the amount of time the system is idle before the LCD is turned off. The idle time may be set from 30 to 120 minutes. The display saver can be disabled during the current power cycle.

Language

The ND 780 supports multiple languages. To change the language selection:

▶ Press the **LANGUAGE** soft key until the desired language selection appears on the soft key and the form.

▶ Press ENTER to confirm your selection.

Import/Export
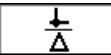
Operating parameter information can be imported or exported over the serial port. (See "Serial port" on page 75.)

▶ Press the **IMPORT/EXPORT** soft key in the Setup screen.

▶ Press **IMPORT** to download operating parameters from a PC.

▶ Press **EXPORT** to upload the current operating parameters to a PC.

▶ To exit, press the C key.

General Operation's Soft Key Function Overview

There are three pages of soft key functions to select from. Use the LEFT/RIGHT ARROW keys to cursor through each page. The page indicator in the Status bar will show the page orientation. The darkened page indicates the page you are currently on. Each key has a reference page for added information.

Fig. I.17 Page Indicator and Set Zero Indicator

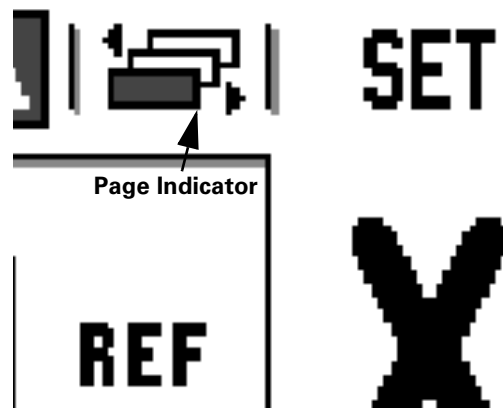| Soft Key Page 1	Soft Key function	Soft key Symbol
HELP	Opens on-screen help instructions. (Page 18)	HELP
TOOL	Opens the Tool Table. (Page 31 for Milling. Page 54 for Turning)	TOOL
ACTUAL VALUE/ DISTANCE-TO-GO	Switches display between operating modes Actual Value/ Distance-To-Go. (Page 17)	⊥ ∆
SET/ZERO	Toggles between Set Zero functions. Used with individual axis keys. (Page 27)	SET ZERO
Soft Key Page 2	**Soft Key function**	**Soft key Symbol**
DATUM	Opens the *DATUM* form to set the datum for each axis. (Page 35)	DATUM
PRESET	Opens the *PRESET* form. This form is used to set a nominal position. (This is a Distance-To-Go function) (Page 42)	PRESET
1/2 (Mill Function Only)	Used to divide the current position by two. (Page 48)	1/2
PATTERN (Mill Function Only)	Opens the *CIRCLE* and *LINEAR PATTERN* forms. (This is a Distance-To-Go function) (Page 49)	PATTERN
R$_X$ (Lathe Function Only)	This soft key toggles between radius and diameter displays. (Page 59)	R$_x$

Soft Key Page 3	Soft Key function	Soft key Symbol
SETUP	Opens the Job Setup menu and provides access to the **INSTALLATION SETUP** soft key. (Page 22)	SETUP
ENABLE REF	Press when ready to identify a reference mark. (Page 21)	ENABLE REF
CALC	Opens the Calculator functions. (Page 28)	CALC
INCH/MM	Toggles between inch and millimeter units. (Page 22)	INCH MM

General Operation's Soft Key Functions Detailed

This section details the soft key functions that are the same, whether the ND 780 is configured for Mill or Turn applications.

Set Zero Soft Key

The **SET/ZERO** soft key is a key that determines the effect of pressing an Axis key. This key is a toggle key, switching the functionality between Set and Zero. The current state is indicated in the Status Bar.

When the state is Set, and the ND 780 is in Actual Value mode, selecting an Axis key opens the *DATUM* form for the selected axis. If the ND 780 is in Distance-To-Go mode, a *PRESET* form opens.

When the state is zero, and the ND 780 is in Actual Value mode, selecting an Axis key sets the datum for that axis to zero at the current position. If it is in Distance-To-Go mode, the current Distance-To-Go value is set to zero.

> ⚠ If the ND 780 is in Actual Value mode and the state of **SET/ ZERO** is zero, pressing any Axis key resets the current datum to zero at the current location for that axis.
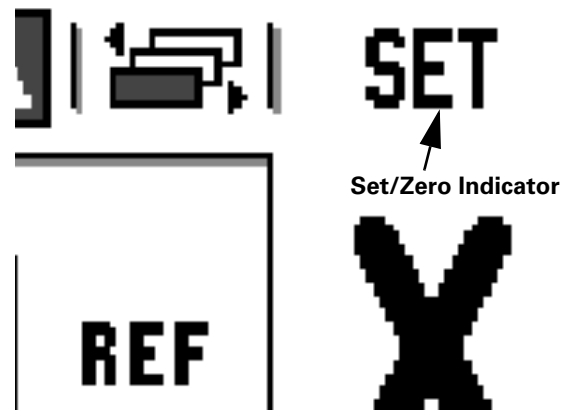
Set/Zero Indicator

Fig. I.18 Page Indicator and Set Zero Indicator

Calc Soft Key

ND 780's calculator is capable of handling everything from simple arithmetic to complex trigonometry and RPM calculations.

Press the **CALC** soft key to access the **STANDARD/TRIG** and **RPM** soft keys. See Fig. I.19 & Fig. I.20.

☞ When you need to enter more than one calculation into a numeric field, the calculator will perform multiplication and division before it performs addition and subtraction. If you were to enter 3 + 1 ÷ 8, ND 780 will divide one by eight, then add three for an answer of 3.125.

Trig functions contain all trig operators as well as, square and square root. Whenever you're calculating the SIN, COS or TAN of an angle, enter the angle first and then press the appropriate soft key.

☞ Angle values use the current angle format selection of decimal degrees, DMS, or radians.
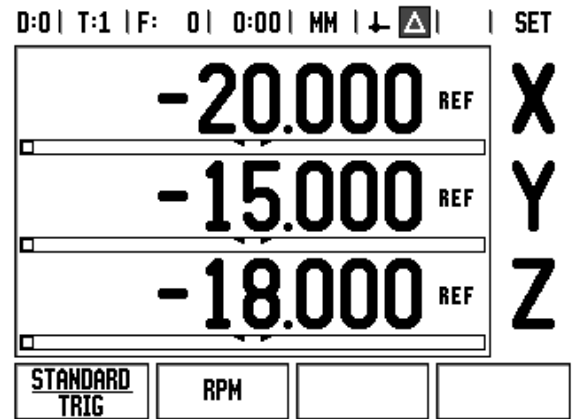
Fig. I.19 Calculator soft keys
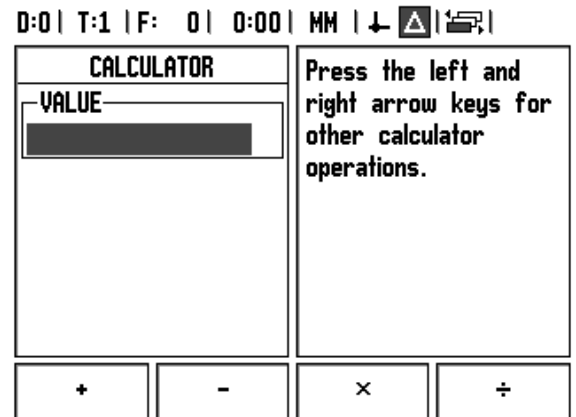
Fig. I.20 Standard/Trig function soft keys

The RPM calculator is used to determine the RPM (or surface cutting speed) based on a specified tool (part, for turning applications) diameter. See Fig. I.21. The values shown in this Figure are only an example. Consult your tool manufacturer's manual to verify spindle speed ranges per tool.

▶ Press **CALC**.

▶ Press the **RPM** soft key to open the *RPM CALCULATOR* form.

▶ The RPM calculator requires a tool diameter. Use the numeric hard keys to enter a diameter value. The diameter value will default to the current tool's diameter. If there is no last value entered in this power cycle, the default value is 0.

▶ If a surface speed value is required, enter the value using the numeric hard keys. When a surface speed value is entered, the associated RPM value will be calculated.

When in the SURFACE SPEED field, a soft key is available for opening on-line help. The table may be consulted for a recommended range of surface speeds for the material being machined.

▶ Press the **UNITS** soft key to show the units as inch or millimeter.

▶ The *RPM CALCULATOR* form is closed by pressing the C key.

Fig. I.21 RPM Calculator form

Taper Calculator Soft Key (Turning Applications only)

Use the taper calculator to calculate taper angle. See Fig. I.22.

Entry values:

For the taper ratio, calculation requires:

- Change in the radius of the taper
- Length of the taper

For taper calculations using both diameters (D1, D2) and length requires:

- Starting diameter
- End diameter
- Length of the taper


```
D:0 | T:1 | F:  0 | 0:00 | MM | ⏚ ◬ |      |
```

TAPER CALCULATOR	Enter first diameter.
┌DIAMETER───────	
D1 5.0000	
D2 10.0000	
┌LENGTH────────	
25.0000	
┌ANGLE─────────	
5.7106°	

			HELP

Fig. I.22   Taper Calculator form

CALC	Press the **CALC** soft key.
	You will notice the soft key selection has changed and now includes the taper calculator functions.

D1/D2 LENGTH

TAPER: D1/D2/L	To calculate the angle using two diameters and length between, press the **TAPER: D1/D2/L** soft key.
	Using the numeric keys, enter data into DIAMETER 1 and DIAMETER 2 fields. Press ENTER after each selection.
	Enter data into the LENGTH field, and the angle, based on the calculations entered, will appear in the ANGLE field.

TAPER RATIO

TAPER: RATIO	To calculate angles using the ratio of the diameter change to length, press the **TAPER: RATIO** soft key.
	Using the numeric keys, enter data into the ENTRY 1 and ENTRY 2 fields. Press ENTER after each selection.
	The calculated ratio and the angle will appear in their respective fields.

I – 3 Milling Specific Operations

This section discusses operations and soft key functions specific to milling applications only. Soft key functions that are the same, whether the ND 780 is configured for Mill or Turn applications, are detailed starting on Page 27.

Soft Key Functions Detailed

Tool Soft Key

This soft key opens the tool table and provides access to the *TOOL* form for entering a tool's parameters. The ND 780 can store up to 16 tools within the tool table.

Tool Radius Compensation feature

ND 780 has a tool radius compensation feature. This allows you to enter workpiece dimensions directly from the drawing. The displayed distance to go is then automatically lengthened (R+) or shortened (R–) by the value of the tool radius. See Fig. I.23. (For more information see "Preset Soft Key" on page 42)

Tool Table

The ND 780's tool table provides a convenient way to store diameter and length offset information for each of the tools you commonly use. You can enter up to 16 tools. See Fig. I.24.

The length offset may be entered as a known value or the ND 780 may determine the offset automatically. See the following Tool Table Usage example for more information regarding the **TEACH LENGTH** soft key.

The following soft keys are also available while in the *TOOL TABLE* form or in the individual tool data form:

| Function	Soft key
This key allows the operator to select which axis all the tool length offsets will effect. The tool's diameter values will subsequently be used to offset the remaining two axes.	TOOL AXIS [Z]
Press to automatically enter the tool offset length. Only available in TOOL LENGTH field.	TEACH LENGTH
This will open the *TOOL TYPES* form for selection. Only available in TYPE field.	TOOL TYPES
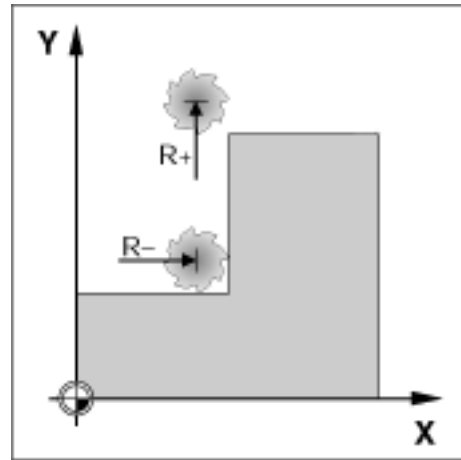
Fig. I.23   Tool radius compensation

Sign for the length difference ∆L
If the tool is **longer** than the reference tool: ∆L > 0 (+)
If the tool is **shorter** than the reference tool: ∆L < 0 (–)

☞ The tool length is the difference in length ∆L between the tool and the reference tool. The reference tool is indicated by T1 in Fig. I.25.

Entering tool data (Fig. I.25)

▶ Choose **TOOL** soft key.

▶ Cursor to the desired tool and press ENTER. The *TOOL DESCRIPTION* form will appear.

▶ Enter the tool diameter.

▶ Enter the tool length or press **TEACH LENGTH**.

▶ Enter the tool units.

▶ Enter the tool type and press ENTER to return to the tool table. Press C to exit.

Tool Table Usage

Example: Entering the tool length and diameter into the tool table. See Fig. I.26 & Fig. I.27.

Tool diameter 2.00

Tool length: 20.000

Tool unit: mm

Tool type: flat end mill

☞ It is also possible to have ND 780 determine the length of an offset. See alternative example below.

D:0 | T:1 | F: 0 | 0:00 | MM | 🔲 ∆ | 🖴 |

TOOL TABLE (DIA/LENGTH)		
1	2.000/	20.000 MM ENGRAVE
2	5.000/	14.000 MM PILOT DRL
3	25.000/	50.000 MM CTR-BORE
4	6.000/	12.000 MM CARB ML
5	10.000/	25.000 MM BROACH
6	2.000/	0.000 MM FL END ML
7	2.500/	0.000 MM FL END ML
8	3.000/	5.000 MM

| TOOL AXIS [Z] | CLEAR TOOL | | HELP |

Fig. I.24 Tool Table in Milling
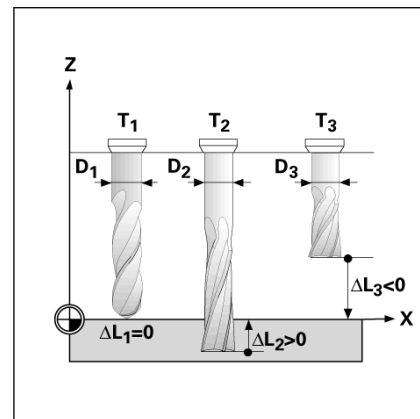
Fig. I.25 Tool length and diameter

D:0 | T:1 | F: 0 | 0:00 | MM | 🔲 ∆ | 🖴

TOOL		X	−20.000
DIAMETER		Y	0.000
	2.000	Z	0.000
LENGTH			
	20.000	Enter the tool diameter.	
UNITS			
	MM		
			HELP

Fig. I.26 Tool length and diameter entry

| TOOL | Press the **TOOL** soft key. |

The cursor will default to the *TOOL TABLE* form.

TOOL TABLE

▼ Cursor to the tool you want to define or enter the tool number. Press ENTER.

TOOL DIAMETER

2 Enter the tool diameter (2) cursor down to the LENGTH field.

▼ Press the DOWN ARROW key.

TOOL LENGTH

2 **0** Enter the tool length for example, (20 mm) and cursor down to the UNITS field.
▼

– ALTERNATIVE METHOD –

It is also possible to have ND 780 determine an offset. This method involves touching the tip of each tool to a common reference surface. This allows ND 780 to determine the difference between the length of each tool.

Move the tool until its tip is touching the reference surface.

| TEACH LENGTH | Press the **TEACH LENGTH** soft key. ND 780 will calculate an offset relative to this surface. |

Repeat the procedure for each additional tool using the same reference surface.

☝ Only the tools set using the same reference surface may be changed without having to reset the datum.

👆 If the tool table already contains tools in which the length has been set, the reference surface should first be established using one of them. If not, you will not be able to switch between the new tools and the existing tools without having to re-establish the datum. Before adding the new tools, select one of the tools from the tool table. Touch the tool to a reference surface and set the datum to 0.

TOOL UNIT

| INCH MM | ▶ Enter the TOOL UNIT (inch/mm) and |

| ▼ | ▶ cursor to the TOOL TYPE field. |

TOOL TYPE

| TOOL TYPES | ▶ Press **TOOL TYPES** soft key. Select from list of tools and press ENTER. |

Calling the Tool Table

Before you start machining, select the tool you are using from the tool table. ND 780 then takes into account the stored tool data when you work with tool compensation.

Tool call

| TOOL | Press the **TOOL** soft key. |

TOOL NUMBER

| ▼ ▲ | Use the UP/DOWN ARROW keys to cursor through the selection of tools (1-16). Highlight the tool you want. |
| C | Verify the proper tool has been called, and press the C key to exit. |

D:0 | T:1 | F: 0 | 0:00 | MM | 🕐 Δ | 🖨 |

TOOL TYPES	Select the desired
BALL END MILL	tool type then press
BORING HEAD	ENTER.
BROACH	
CARBIDE MILL	
COUNTER-BORE	
COUNTER-SINK	
DRILL	
ENGRAVING TIP	
	HELP

Fig. I.27 TOOL TYPE field

Datum Soft Key

Datum settings define the relationships between the axis positions and the display values.

The easiest way to set datum points is to use the ND 780's probing functions – regardless of whether you probe the workpiece with an edge finder or a tool.

Of course, you can also set datum points in the conventional manner by touching the edges of the workpiece, one after the other with a tool and manually entering the tool positions as datum points (see examples following this page).

The datum table can hold up to 10 datum points. In most cases this will free you from having to calculate the axis travel when working with complicated workpiece drawings containing several datums.

Example: Setting a workpiece datum without using the probing function. See Fig. I.28 & Fig. I.29.

Tool diameter: D = 3 mm

Axis sequence in this example: X - Y - Z

Preparation: Set the active tool to the tool that will be used to set the datum

| DATUM | Press the **DATUM** soft key. |

Cursor will be in the DATUM NUMBER field.

| ▼ | Enter the datum number and press the DOWN ARROW key to go to the X axis field. |

Touch the workpiece at edge **1**.

DATUM SETTING X

| − 1 · 5 | Enter the position of the tool center (X = – 1.5 mm) and |

| ▼ | press the DOWN ARROW key to advance to the Y-axis. |

Touch the workpiece at edge **2**.

DATUM SETTING Y

| − 1 · 5 | Enter the position of the tool center (Y = – 1.5 mm) and |

| ▼ | press the DOWN ARROW key. |

Touch the workpiece surface.

DATUM SETTING Z = + 0

| 0 | Enter the position of the tool tip (Z = 0 mm) for the Z-coordinate of the datum. Press ENTER. |

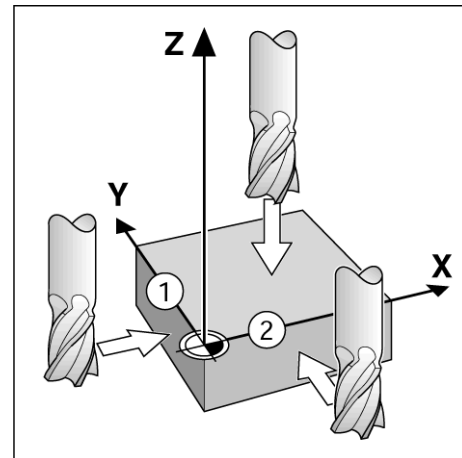Fig. I.28 SET DATUM form

Fig. I.29

Probing Functions for Datum Setting

It is particularly easy with a **HEIDENHAIN** Electronic 3D, KT 130 Edge Finder (Fig. I.30) connected through X10. The ND 780 also supports a grounding type edge finder connected via the 3.5 mm Phono Jack on the back of the unit. Both types of edge finders operate the same way.

☞ During probe functions, the display freezes with the location of the edge, centerline, or circle center.

The following probing soft key functions are available:

- Workpiece edge as datum: **EDGE**
- Centerline between two workpiece edges: **CENTER LINE**
- Center of a hole or cylinder: **CIRCLE CENTER**

In all probing functions, ND 780 takes into account the entered stylus diameter.

To abort the probing function while it is active, press the C key.

Datum setting with the edge finder

☞ To perform probing, the probe's dimensional characteristics must first be entered into Job Setup (see "Job Setup Parameters" on page 22). Probe characteristics are retained after a power interruption

Fig. I.30 The **HEIDENHAIN** KT 130 Edge Finder

Example: Probe workpiece edges, and set the corner as a datum. See Fig. I.31 & Fig. I.32.

Datum axis:	X = 0 mm
	Y = 0 mm

The coordinates of the datum can be set by probing edges or surfaces and capturing them as datums.

DATUM	Press **DATUM.**

▼	Select a new datum or press the DOWN ARROW key to move to the X AXIS field.

PROBE	Press the **PROBE** soft key.

EDGE	Press **EDGE** soft key.

PROBE IN X AXIS

Move the edge finder toward the workpiece until the LEDs on the edge finder light up.

Retract the edge finder from the workpiece.

ENTER VALUE FOR X + 0

0 ▼	0 is offered as a default value for the coordinate. Enter the desired coordinate for the workpiece edge, for this example X = 0 mm and
	press the DOWN ARROW key.
EDGE	Press **EDGE** soft key.

PROBE IN Y AXIS

Move the edge finder toward the workpiece until the LEDs on the edge finder light up.

Retract the edge finder from the workpiece.
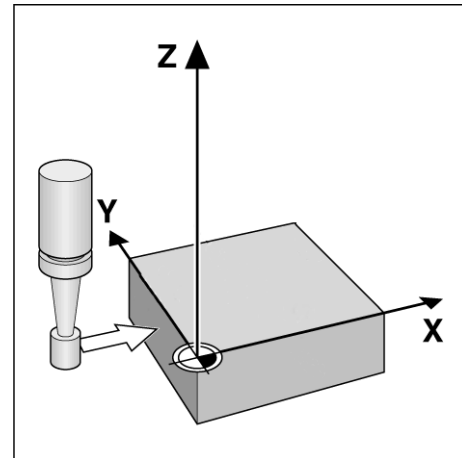
Fig. I.31   Setting datum using an edge finder

D:0 | T:1 | F: 0 | 0:00 | MM | 🔲 △ | | SET

SET DATUM	X	0.000
DATUM NUMBER	Y	0.000
0	Z	−20.000

DATUM	Move to the edge or press NOTE.
X	
Y	
Z	

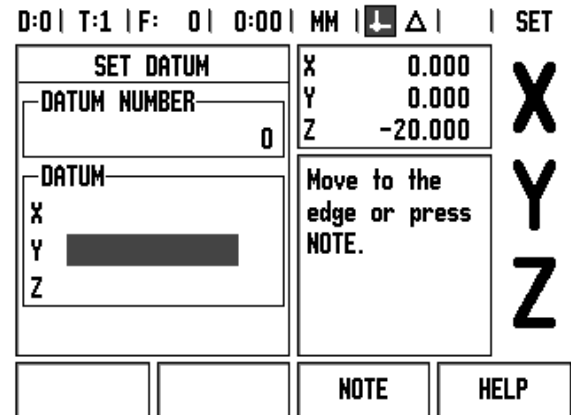|		NOTE	HELP

Fig. I.32

ENTER VALUE FOR Y + 0

0

0 is offered as a default value for the coordinate. Enter the desired coordinate for the workpiece edge, for this example Y = 0 mm and

set the coordinate as a datum for this workpiece.

ENTER

Press ENTER.

Example: Set centerline between two workpiece edges as datum. See Fig. I.33 & Fig. I.34.

The position of the centerline **M** is determined by probing the edges **1** and **2**.

The centerline is parallel to the Y axis.

Desired coordinate of the centerline: X =0 mm

👆 Spacing between edges is displayed on the message box when using the probe centerline feature.

DATUM

Press **DATUM.**

▼

Press the DOWN ARROW key.

PROBE

Press **PROBE**.

CENTER LINE

Press **CENTER LINE**.

PROBE 1ST EDGE IN X

Move the edge finder toward workpiece edge **1** until the LEDs in the edge finder light up.

PROBE 2ND EDGE IN X

Move the edge finder toward workpiece edge **2** until the LEDs in the edge finder light up. The distance between the edges is displayed on the message box.

Retract the edge finder from the workpiece.

Fig. I.33   Setting centerline between two edges

Fig. I.34

ENTER VALUE FOR X

0   Enter coordinate (X = 0 mm) and transfer coordinate as datum for the centerline and press ENTER.

Example: Probe the center of a hole with an edge finder and set the datum, 50 mm from the circle's center. See Fig. I.35 & Fig. I.36.

X coordinate of the circle center: X = 50 mm

Y coordinate of the circle center: Y = 0 mm
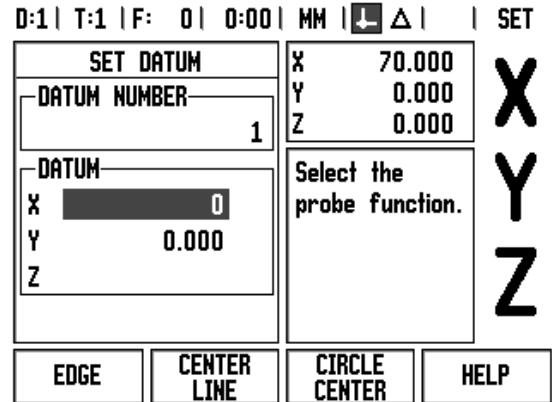
DATUM   Press **DATUM.**

▼   Press the DOWN ARROW key.

PROBE   Press **PROBE**.

CIRCLE CENTER   Press **CIRCLE CENTER.**

Move edge finder towards first point **1** on the circumference until the LEDs on the edge finder light up.

Probe two additional points on the circumference in the same manner. Further instructions appear on the screen. See Instruction Box for measured diameter.

ENTER CENTER POINT X   X = 50

5 0   Enter the first coordinate (X = 50 mm) and

▼   press the DOWN ARROW key.

ENTER CENTER POINT Y   Y = 0
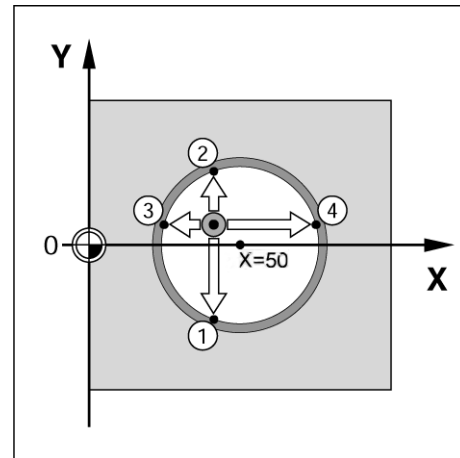
0   Accept default entry Y = 0 mm. Press ENTER.

Fig. I.35   Setting the center of a hole

Fig. I.36

Probing with a Tool

Even if you use a tool or non-electrical edge finder to set datum points, you can still use ND 780's probing functions. See Fig. I.37 & Fig. I.38.

Preparation: Set the active tool to the tool that will be used to set the datum

Example: Probe workpiece edge and set edge as datum

Datum axis: X =0 mm

Tool diameter D = 3 mm
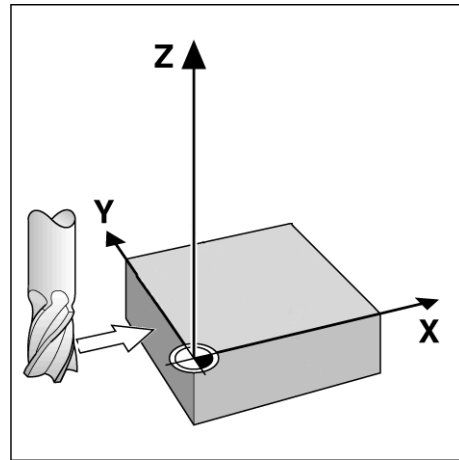
Fig. I.37 Setting datum using an edge

DATUM	Press **DATUM.**
▼	Press the DOWN ARROW key until the X AXIS field is highlighted.
PROBE	Press **PROBE** soft key.
EDGE	Press **EDGE** soft key.

PROBE IN X

⊕	Touch workpiece edge.
NOTE	Store the position of the edge by pressing the **NOTE** soft key. The **NOTE** soft key is useful when determining tool data by touching the workpiece in the absence of an edge finder with feedback. To avoid losing the position value when the tool is retracted, press the **NOTE** soft key to store the value while it is in contact with the workpiece edge. The location for the touched edge will take into account the diameter of the tool in use (T:1, 2...) and **the last direction the tool was moved** prior to pressing the **NOTE** soft key.
⊕	Retract the tool from the workpiece.

Fig. I.38

ND 780

ENTER VALUE FOR X

0

ENTER

Enter coordinate of the edge

and

press ENTER.

Preset Soft Key

The Preset function allows the operator to indicate the nominal (target) position for the next move. Once the new nominal position information is entered the display will switch to Distance-To-Go mode and show the distance between the current position and the nominal position. The operator now only needs to move the table until the display is zero and he will be at the required nominal position. The information for the location of the nominal position can be entered as an absolute move from the current datum zero or as an incremental (I) move from the current position.

Presetting also allows the operator to indicate which side of the tool will be doing the machining at the nominal position. The **R+/-** soft key in the *PRESET* form defines the offset that will be in effect during the move. R+ indicates that the center line of the current tool is in a more positive direction than the edge of the tool. R- indicates that the center line is in a more negative direction than the edge of the current tool. Using R+/- offsets automatically adjusts the distance-to-go value to account for the diameter of the tool.

Fig. I.39   Tool radius compensation

Absolute Distance Preset

Example: Milling a shoulder by traversing to display value zero using absolute position

The coordinates are entered as absolute dimensions; the datum is the workpiece zero. See Fig. I.40 & Fig. I.41.

Corner 1: X = 0 mm / Y = 20 mm
Corner 2: X = 30 mm / Y = 20 mm
Corner 3: X = 30 mm / Y = 50 mm
Corner 4: X = 60 mm / Y = 50 mm

> 👆 If you would like to recall the last entered preset for a particular axis, press the **PRESET** soft key and then the axis key.
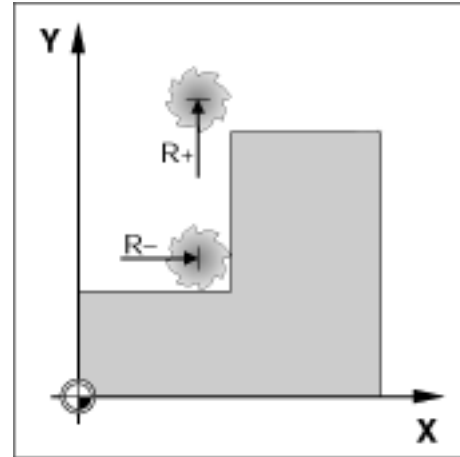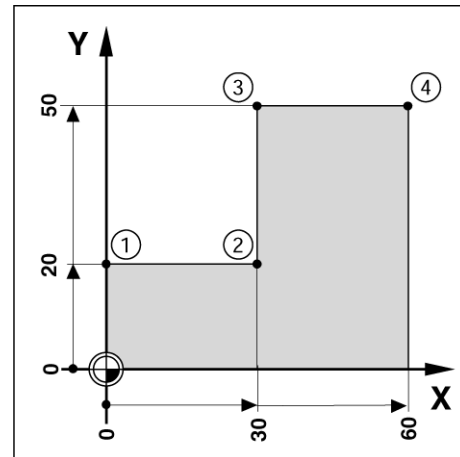

Fig. I.40   Single cycle preset

Preparation:

▶ Select the tool with the appropriate tool data.
▶ Pre-position the tool to an appropriate location (such as X = Y = -20 mm).
▶ Move the tool to milling depth.

D:1	T:1	F: 0	0:00	MM	⟁ Δ		SET

```
        PRESET            X      0.000
 ┌PRESET─────────         Y      0.000
 X         20.000 R+      Z    -20.000
 Y            10 R-      ┌──────────────┐
 Z                      │ Enter the    │
                        │ nominal      │
                        │ position, select │
                        │ the type and │
                        │ tool offset. │
                        └──────────────┘
 ┌────┬──────┬──────┬──────┐
 │ I  │ R +/-│      │ HELP │
 └────┴──────┴──────┴──────┘
```

Fig. I.41

PRESET Press the **PRESET** soft key.

[ ] Press the Y axis key

- ALTERNATIVE METHOD -

SET ZERO Press the **SET/ZERO** soft key so that you are in Set mode.

[ ] Press the Y axis key.

NOMINAL POSITION VALUE

2 0 Enter nominal position value for corner point 1: Y = 20 mm and

R +/- select tool radius compensation R + with **R+/-** soft key. Press until R+ is shown next to axis form.

ENTER Press ENTER.

⊕ Traverse the Y axis until the display value is zero. The square in the graphic positioning aid is now centered between the two triangular marks.

PRESET Press the **PRESET** soft key.

[ ] Press the X axis key

- ALTERNATIVE METHOD -

SET ZERO Press the **SET/ZERO** soft key so that you are in Set mode.

[ ] Press the X axis key.

3 0

Enter nominal position value for corner point **2**:
X = +30 mm,

R +/-

select tool radius compensation R – with **R+/-** soft key. Press twice until <u>R-</u> is shown next to axis form.

ENTER

Press ENTER.

Traverse the X axis until the display value is zero. The square in the graphic positioning aid is now centered between the two triangular marks.

PRESET

Press the **PRESET** soft key.

Press the Y axis key

- ALTERNATIVE METHOD -

SET ZERO

Press the **SET/ZERO** soft key so that you are in Set mode.

Press the Y axis key.

NOMINAL POSITION VALUE

5 0
Enter nominal position value for corner point **3**:
Y = +50 mm,

R +/-
select tool radius compensation R + with **R+/-** soft key and Press until <u>R+</u> is shown next to axis form.

ENTER
Press ENTER.

Traverse the Y axis until the display value is zero. The square in the graphic positioning aid is now centered between the two triangular marks.

PRESET
Press the **PRESET** soft key.

Press the X axis key

- ALTERNATIVE METHOD -

SET ZERO
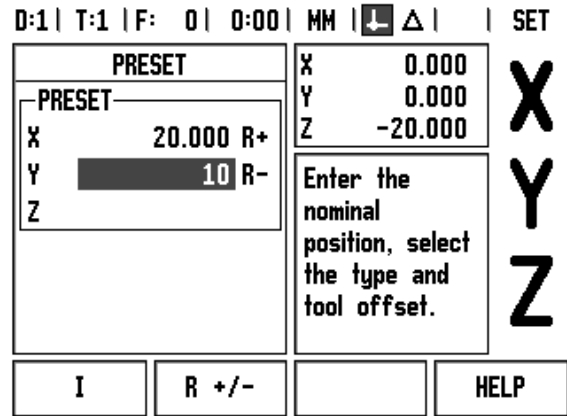Press the **SET/ZERO** soft key so that you are in Set mode.

Press the X axis key.

NOMINAL POSITION VALUE

6 0
Enter nominal position value for corner point **4**:
X = +60 mm,

R +/-
select tool radius compensation R + and press ENTER.

Traverse the X axis until the display value is zero. The square in the graphic positioning aid is now centered between the two triangular marks.

Incremental Distance Preset

Example: Drilling by traversing to display value zero with incremental positioning

Enter the coordinates in incremental dimensions. These are indicated in the following (and on the screen) with a preceding **I**. The datum is the workpiece zero. See Fig. I.42 & Fig. I.43.

Hole **1** at: X = 20 mm / Y = 20 mm

Distance from hole **2** to hole **1**: X**I** = 30 mm / Y**I** = 30 mm

Hole depth: Z = –12 mm

Operating mode: **DISTANCE-TO-GO**

NOMINAL POSITION VALUE

PRESET — Press the **PRESET** soft key.

Press the X axis key.

- ALTERNATIVE METHOD -

SET ZERO — Press the **SET/ZERO** soft key so that you are in Set mode.

Press the X axis key.

2 0 — Enter nominal position value for hole **1**: X = 20 mm and ensure no tool radius compensation is active.

▼ Press the DOWN ARROW key.

NOMINAL POSITION VALUE

2 0 — Enter nominal position value for hole **1**: Y = 20 mm. Ensure no tool radius compensation is showing.

▼ Press the DOWN ARROW key.

NOMINAL POSITION VALUE

– 1 2 — Enter the nominal position value for the hole depth: Z = –12 mm. Press ENTER.

Drill hole **1**: Traverse the X, Y and Z axis until the display value is zero. The square in the graphic positioning aid is now centered between the two triangular marks.

Retract the drill.

Fig. I.42 Drilling example

Fig. I.43

NOMINAL POSITION VALUE

PRESET   Press the **PRESET** soft key.

    Press the X axis key

- ALTERNATIVE METHOD -

SET ZERO   Press the **SET/ZERO** soft key so that you are in Set mode.

    Press the X axis key.

3 0   Enter nominal position value for hole **2**: X = 30 mm,

I   mark your input as an incremental dimension, press **I** soft key.

ENTER   Press ENTER.

    Press the Y axis key.

NOMINAL POSITION VALUE

3 0   Enter nominal position value for hole **2**: Y = 30 mm,

I   mark your input as an incremental dimension, press **I** soft key.

ENTER   Press ENTER.

    Traverse the X and Y axes until the display value is zero. The square in the graphic positioning aid is now centered between the two triangular marks.

PRESET   Press the **PRESET** soft key.

    Press the Z axis key.

NOMINAL POSITION VALUE

ENTER	Press ENTER (uses last entered preset).

Drill hole **2**: Traverse Z axis until the display value is zero. The square in the graphic positioning aid is now centered between the two triangular marks. Retract the drill.
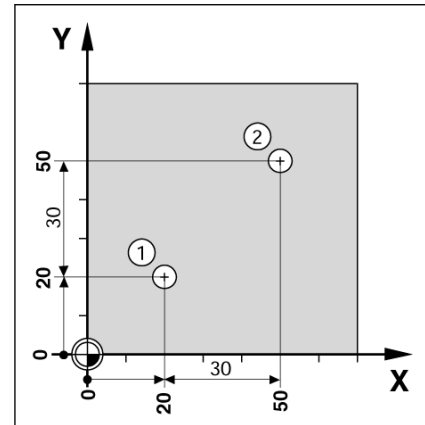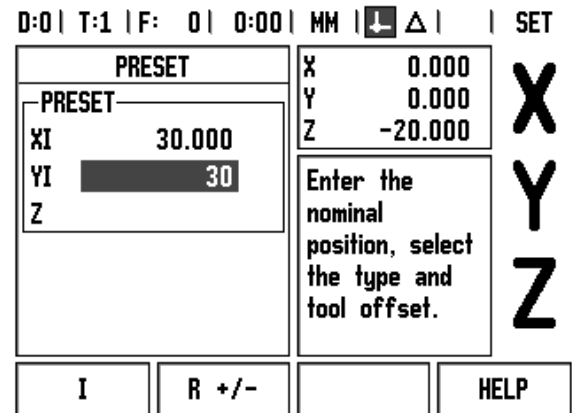
1/2 Soft Key

The **1/2** soft key is used to find the half-way (or midpoint) between two locations along a selected axis of a workpiece. This can be performed in either Actual Value or Distance-To-Go mode.

☞ This feature will change datum locations when in Actual Value mode.

Example: Finding the midpoint along a selected axis

X dimension: X = 100 mm

Midpoint: 50 mm

MOVE TO 1ST POINT

Move tool to first point.

ZERO/SET soft key must be set to Zero.

ZERO AXIS AND MOVE TO 2ND POINT

Select the X axis key and

move to second point.

PRESS 1/2 AND MOVE TO ZERO

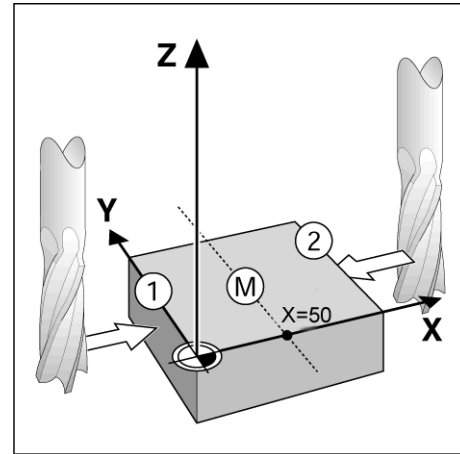|	
1/2	Press **1/2** soft key, then press the X axis key and move until you reach zero. This is the midpoint location.

Fig. I.44 Example of finding the midpoint

I Operating Instructions

Patterns Soft Key (Milling)

This section describes the hole pattern functions for Circle and Linear patterns.

In the Distance-To-Go mode, use the soft keys to select the desired hole pattern function and enter the required data. This data can usually be taken from the workpiece drawing (e.g. hole depth, number of holes, etc.).

With hole patterns, the ND 780 then calculates the positions of all the holes and displays the pattern graphically on the screen.

The View Graphic enables verification of the hole pattern before you start machining. It is also useful when: selecting holes directly, executing holes separately, and skipping holes.

Functions for milling patterns

Function	Soft key
Press this to see the lay out of the current pattern.	VIEW
Press to go to previous hole.	PREVIOUS HOLE
Press to manually advance to the next hole.	NEXT HOLE
Press to end drilling.	END

Circle Pattern Soft Key

Information required:

■ Pattern type (full or segment)

■ Holes (number of)

■ Center (center of circle pattern in pattern plane)

■ Radius (defines radius of the circle pattern)

■ Start angle (angle of 1st hole in the pattern) - The start angle is between the zero angle reference axis and the first hole (for added information see "Zero Angle Reference Axis" on page 14).

■ Step angle (optional: this only applies if creating a circle segment.) - The step angle is the angle between holes.

■ Depth (the target depth for drilling in the tool axis)

ND 780 calculates the coordinates of the holes which you then move to simply by traversing to display value zero.

Example: Enter data and execute a circle pattern. See Fig. I.45, Fig. I.46 & Fig. I.47.

Holes (no. of): 4

Coordinates of center: X = 10 mm / Y = 15 mm

Bolt circle radius: 5 mm

Start angle: (Angle between X axis and 1st hole): 25°

Hole depth: Z = -5mm

1st step: Enter data

|	
PATTERN	Press **PATTERN** soft key.
CIRCLE PATTERN	Press **CIRCLE PATTERN** soft key.
PATTERN TYPE	Enter the type of circle pattern (full). Cursor to the next field.
HOLES	
4	Enter the number of holes (4).
CIRCLE CENTER	
1 0 **1 5**	Enter the X and Y coordinates of the circle center (**X** = 10), (**Y** = 15). Cursor to the next field.
RADIUS	
5	Enter the radius of the circle pattern (5).
START ANGLE	
2 5	Enter the start angle (25°).
STEP ANGLE	
9 0	Enter the step angle (90°) (this can only be changed if entering a "segment").
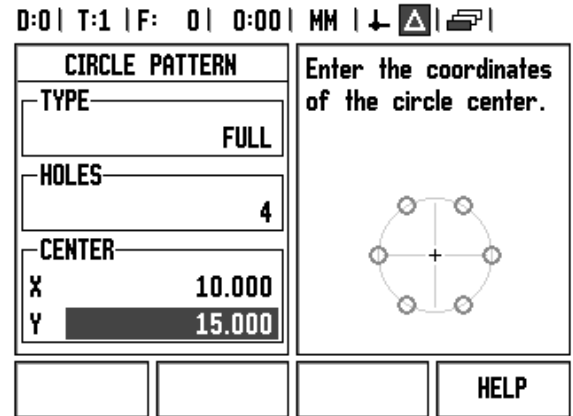
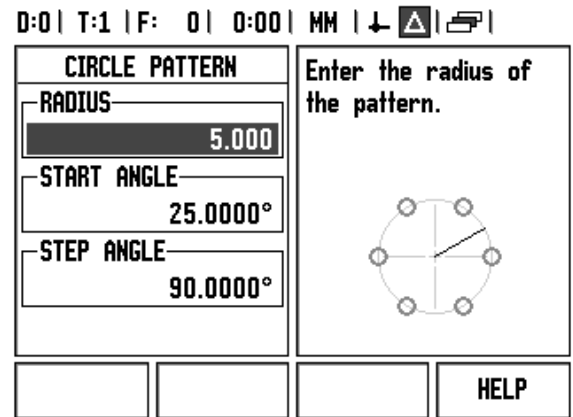Fig. I.45 Beginning of Circle Pattern form

Fig. I.46 Page 2 of Circle Pattern Form
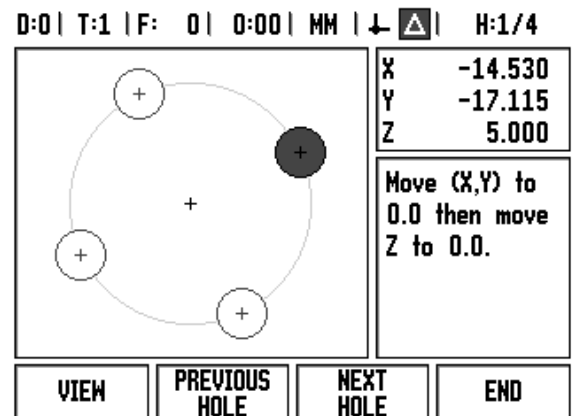
Fig. I.47 View of Circle Pattern Graphic

DEPTH

– 5

ENTER

Enter the depth when needed. The depth of the hole is optional and may be left blank. If it is not required, press ENTER.

VIEW

Pressing the **VIEW** soft key will toggle between the two views of the pattern (the Graphic and DRO).

2nd step: Drill

Move to hole:
Traverse the X and Y axes until display value zero.

Drill:
Traverse to display value zero in the tool axis.

After drilling, **retract** the drill in tool axis.

NEXT HOLE

Press the **NEXT HOLE** soft key.

END

Continue to drill the remaining holes in the same way.

When pattern is complete, press the **END** soft key.

Linear Pattern

Information required:

- Linear pattern type (array or frame)
- First hole (1st hole of the pattern)
- Holes per row (number of holes in each row of pattern)
- Hole spacing (the spacing or offset between each hole in the row)
- Angle (the angle or rotation of the pattern)
- Depth (the target depth for drilling in the tool axis)
- Number of rows (number of rows in the pattern)
- Row spacing (the spacing between each row of the pattern)

Example: Enter data and execute a linear pattern. See Fig. I.48, Fig. I.49 & Fig. I.50.

Type of pattern: Array

First X coordinate of hole: X = 20 mm

First Y coordinate of hole: Y = 15 mm

Number of holes per row: 4

Hole spacing: 10 mm

Tilt angle: 18°

Hole depth: -2

Number of rows: 3

Row spacing: 12 mm

1st step: Enter data

PATTERN	Press **PATTERN** soft key.
LINEAR PATTERN	Press **LINEAR PATTERN** soft key.

PATTERN TYPE

ARRAY FRAME	Enter the type of pattern (Array). Cursor to the next field.

FIRST HOLE X AND Y

2 0 **1 5**	Enter the X and Y coordinates (**X** = 20), (**Y** = 15). Cursor to the next field.

HOLES PER ROW

4	Enter the number of holes per row (4).Cursor to the next field.

HOLE SPACING

1 0	Enter the hole spacing (10).

ANGLE

1 8	Enter the tilt angle (18°).

Fig. I.48   Linear Pattern Example

Fig. I.49   Linear Pattern Form

Fig. I.50   View of Linear Pattern Graphic

DEPTH

[−] [2]   Enter the depth when needed (-2). The depth of the hole is optional and may be left blank.

NUMBER OF ROWS

[3]   Enter the number of rows (3).

ROW SPACING

[1] [2]   Enter the spacing between rows,

ENTER   press ENTER.

VIEW   Pressing the **VIEW** soft key to see the graphic.

2nd step: Drill

Move to hole:
Traverse the X and Y axes until display value zero.

Drill:
Traverse to display value zero in the tool axis.

After drilling, **retract** the drill in tool axis.

NEXT HOLE   Press the **NEXT HOLE** soft key.

END   Continue to drill the remaining holes in the same way.

When pattern is complete, press the **END** soft key.

I – 4 Turning Specific Operations

This section discusses operations and soft key functions specific to turning applications only. Soft key functions that are the same, whether the ND 780 is configured for Mill or Turn applications, are detailed starting on Page 27.

Soft Keys Functions Detailed

Turning Specific Display Icons

Function	Display Icon
This is used to indicate that the displayed value is a diameter value. No icon visible indicates that the display is a radius value.	Ø

Tool Soft Key

The ND 780 can store the dimensional offsets for up to 16 tools. When you change a workpiece and establish a new datum, all tools are automatically referenced from the new datum.

Before you can use a tool, you must enter its offset (the cutting edge position). Tool offsets can be set using the TOOL/SET or NOTE/SET features.

If you have measured your tools using a tool presetter, the offsets may be entered directly. See Fig. I.51.

To access the Tool Table menu:

TOOL	Press the **TOOL** soft key.

The cursor will default to the TOOL TABLE field.

TOOL TABLE

▼ ▲	Scroll to the tool you want to define. Press ENTER.

D:0 | T:1 | F: 0 | 0:00 | MM | ⊥ 🔺 | 🖅 |

TOOL TABLE (X/Z)	
1	19.082Ø	0.000
2	0.000Ø	0.000
3	0.000Ø	0.000
4	0.000Ø	0.000
5	19.451Ø	0.000
6	0.000Ø	0.000
7	0.000Ø	0.000
8	0.000Ø	0.000

| | CLEAR TOOL | | HELP |

Fig. I.51 Tool table in turning

Tool Table Usage

Example: Entering offsets into the tool table

Setting tool offsets using TOOL/SET

The TOOL/SET operation can be used to set a tool's offset using a tool when the diameter of the workpiece is known.

|	
	Touch the known diameter in the X axis.
TOOL	Press the **TOOL** soft key. Scroll to the desired tool.
ENTER	Press the ENTER key.
	Select the axis (X) key.
2 0	Enter the position of the tool tip, for example, X=Ø 20 mm. Remember to ensure the ND 780 is in diameter display mode (Ø) if you input a diameter value.
	Touch the workpiece face with the tool.
▼	Cursor to the Z axis.
0	Set the position display for the tool tip to zero, Z=0. Press ENTER.
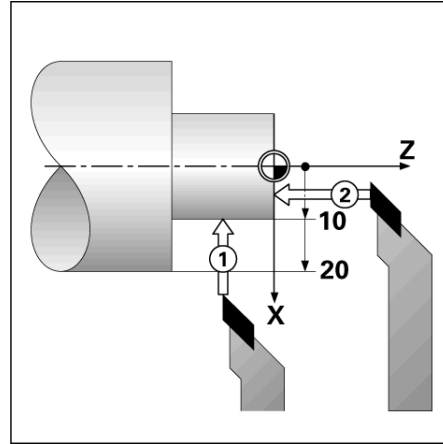
Fig. I.52

Setting Tool Offset using NOTE/SET Function

The NOTE/SET function can be used to set a tool's offset when a tool is under load and the diameter of the workpiece is not known. See Fig. I.53.

The NOTE/SET function is useful when determining tool data by touching the workpiece. To avoid losing the position value when the tool is retracted to measure the workpiece, this value can be stored by pressing **NOTE**.

To use the NOTE/SET function:

| TOOL | Press the **TOOL** soft key. Select the desired tool and press ENTER key. |

| | Select the X axis key. |

| | Turn a diameter in the X axis. |

| NOTE | Press the **NOTE** soft key while the tool is still cutting. |

| | Retract from the current position. |

| | Turn the spindle off and measure the workpiece diameter. |

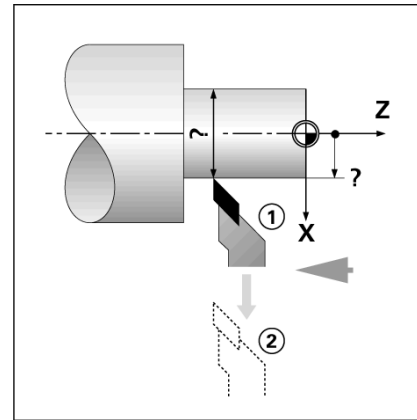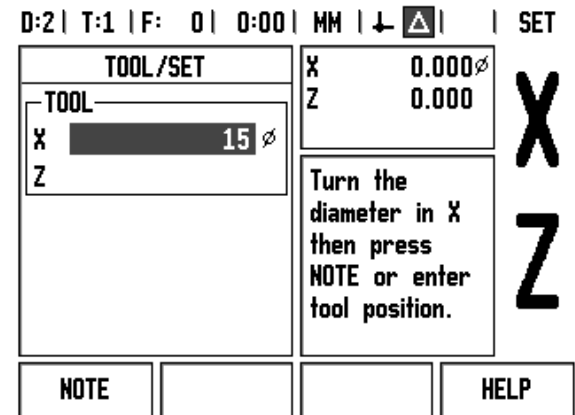| 1 5 | Enter the measured diameter or radius, for example, 15 mm and press ENTER. Remember to ensure the ND 780 is in diameter display mode (Ø) if you input a diameter value. |

Fig. I.53 Setting Tool Offset

Fig. I.54 TOOL/SET Form

Datum Soft Key

See "Datum Soft Key" on page 35 for basic information. Datum settings define the relationships between the axis positions and the display values. For most lathe operations there is only one X-axis datum, the center of the chuck, but it may be helpful to define additional datums for the Z-axis. The table can hold up to 10 datum points. The easiest way to set datum points is to touch a workpiece at a known diameter or location, then enter that dimension as the value that the display should be showing

Example: Setting a workpiece datum. See Fig. I.55 & Fig. I.56.

Axis sequence in this example: X - Z

Preparation:

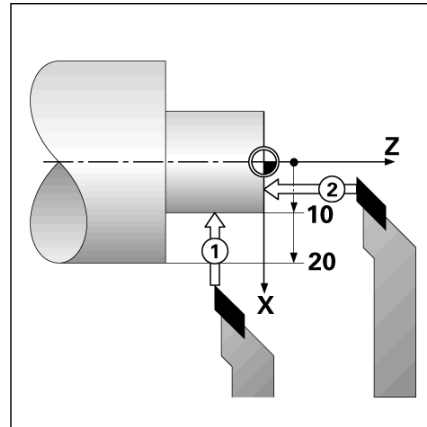Call the tool data by selecting the tool which you are using to touch the workpiece.

DATUM	Press the **DATUM** soft key.
▼	The cursor will be in the DATUM NUMBER field.
▼	Enter the datum number and press the DOWN ARROW key to go to the X AXIS field.
⊕	Touch the workpiece at point **1**.

DATUM SETTING X

2 **0**	Enter the diameter of the workpiece at that point.
▼	Remember to ensure the ND 780 is in diameter display mode (Ø) if you input a diameter value.
	Press the DOWN ARROW key to advance to the Z-axis.
⊕	Touch the workpiece surface at point **2**.

DATUM SETTING Z

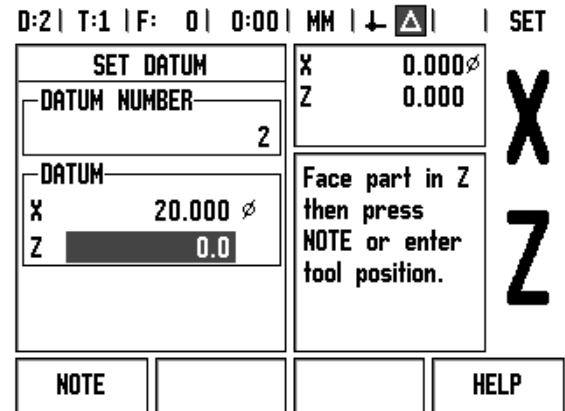|	
0	Enter the position of the tool tip (Z = 0 mm) for the Z-coordinate of the datum.
ENTER	Press ENTER.

Fig. I.55   Setting a workpiece datum

Fig. I.56

Setting Datums using NOTE/SET Function

The NOTE/SET function is useful for setting a datum when a tool is under load and the diameter of the workpiece is not known. See Fig. I.57.

To use the NOTE/SET function:

DATUM	Press the **DATUM** soft key.

The cursor will be in the DATUM NUMBER field.

| ▼ | Enter the datum number and press the DOWN ARROW key to go to the X AXIS field.

Turn a diameter in the X axis. |
|---|---|

NOTE	Press the **NOTE** soft key while the tool is still cutting.

Retract from the current position.

Turn the spindle off and measure the workpiece diameter.

| 1 5 | Enter the measured diameter, for example, 15 mm and press ENTER.

Remember to ensure the ND 780 is in diameter display mode (Ø) if you input a diameter value. |
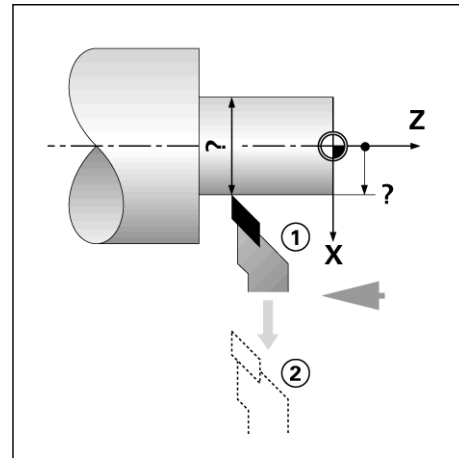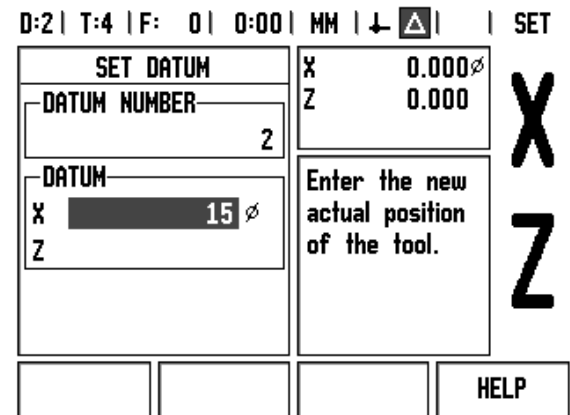|---|---|

Fig. I.57

Fig. I.58 Setting Datum using NOTE/SET

Preset Soft Key

The functionality of the **PRESET** soft key has been explained previously in this manual (See "Preset Soft Key" on page 42). The explanation and examples on those pages are based on a mill application. The basics of those explanations are the same for turning applications with two exceptions; Tool Diameter Offsets (R+/-), and Radius vs. Diameter inputs.

Tool diameter offsets have no applications with turning tools, so this functionality is not available while doing turning presets.

While doing turning, input values can be either radius or diameter values. It is important to be sure the units you are entering for the preset agree with the state that the display is currently using. A diameter value is shown with a Ø symbol. The state of the display can be changed using the **R$_X$** soft key (see below).

R_X (Radius/Diameter) Soft Key

Drawings for lathe parts usually give diameter values. ND 780 can display either the radius or the diameter for you. When the diameter is being displayed, the diameter symbol (Ø) is shown next to the position value. See Fig. I.59.

Example: Radius display, position 1 X = 20 mm

Diameter display, position 1 X = Ø 40 mm

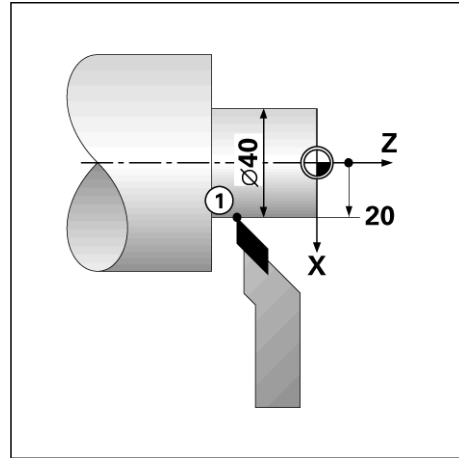| R_X	Press the R_X soft key to switch between radius display and diameter display.

Fig. I.59 Workpiece for radius/diameter display

II

Technical Information

II – 1 Installation and Electrical Connection

Items Supplied

■ ND 780 Display Unit
■ Power connector
■ User's Manual

Accessories

■ Tilting base
■ Tilting Bracket Assembly
■ Universal Mounting Arm
■ KT 130 Edge Finder
■ Handle

ND 780 Display Unit

Mounting Location

Locate the unit in a well ventilated area such that it may be easily accessed during normal operation.

Installation

M4 screws are used to secure ND 780 from below. For the hole locations: See "Dimensions" on page 85.

Electrical connection

There are no serviceable items within this unit. Therefore, the ND 780 must never be opened.

The length of the power cord is not to exceed 3 meters.

Connect a protective ground to the protective conductor terminal on the rear of the unit. This connection must never be interrupted.

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

Use only original replacement fuses.

Electrical requirements

Voltage   100 - 240 Vac

Power   30 VA max.

Frequency   50/60 Hz

Fuse   630 mA/250 Vac, 5 mm x 20 mm, Slo-Blo (line and neutral fused)

Environmental

Protection (EN 60529)   IP 40 back panel

                            IP 54 front panel

Operating temperature   0° to 45°C (32° to 113°F)

Storage temperature   -20° to 70°C (-22° to 158°F)

Mechanical weight   2.6 kg (5.8 lb.)

Wiring the power connector, see Fig. II.1

Hot leads: L and N

Ground: ⏚

Minimum diameter of power connection cable: 0.75 mm^2.

Protective earthing (grounding)

> ⚠ It is necessary to connect the protective conductor terminal on the rear panel to the star point of machine ground. Minimum cross-section of the connecting wire: 6 mm^2, see Fig. II.2.

Preventative maintenance

No special preventative maintenance is necessary. For cleaning, wipe lightly with a dry lint-free cloth.
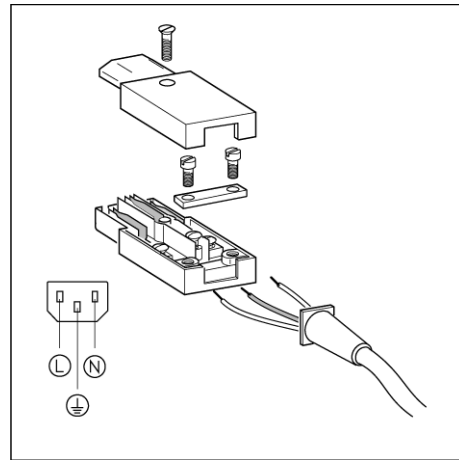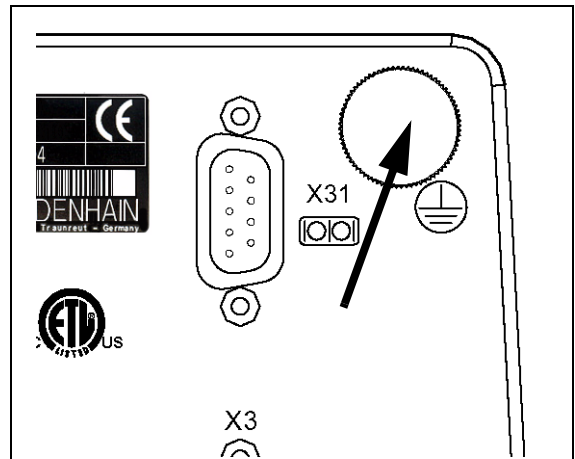

Fig. II.1   Wiring the power connector

Fig. II.2   The protective conductor terminal on the rear panel.

Connecting the Encoders

ND 780 can be used with **HEIDENHAIN** linear and rotary encoders that provide sinusoidal output ($11\mu A_{PP}$ or $1V_{PP}$). The encoder inputs on the rear panel are designated X1, X2 and X3. See Fig. II.3 & Fig. II.4.

The **connecting cable** must not exceed 30 m (100 ft.) in length.

⚠ Do not engage or disengage any connections while the unit is under power.

Fig. II.3   15 pin header X1 - X3 plug pinout for encoder signal input on rear panel.

The operator can setup any encoder input to go to any axis.

Default configuration:

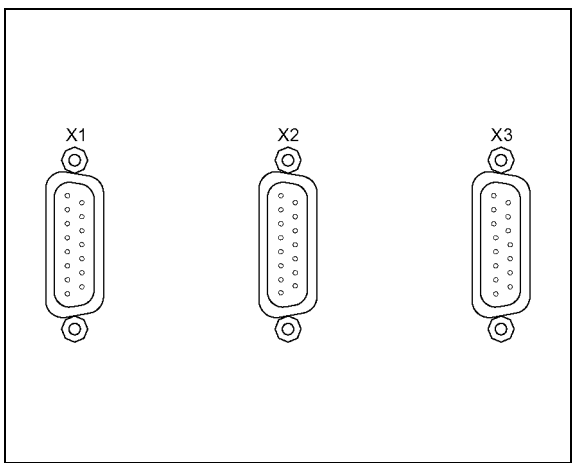| Encoder input	Mill	Turn
X1	X	X
X2	Y	Z_0
X3	Z	Z

Fig. II.4   Encoder inputs on rear panel.

Connecting Edge Finder Output and Input Signals

Connect the **HEIDENHAIN** Edge Finder to the D-sub input X10 on the rear panel.

Adapt ND 780 for use with the Edge Finder through the following operating parameters:

- Stylus length
- Stylus diameter

For description of operating parameters, see "Job Setup Parameters" on page 22.

☞ The operator must enter new edge finder settings.

Pin layout for Edge Finder and Measured Value Output input (see Fig. II.5 for pinout)

Pin	Assignment
1	0V (Inner shield)
2	KTS Ready
3	Reserved for future use
6	+5V
7	0V
8	0V
9	Reserved for future use
12	Value Output Contact
13	KTS
14	Value Output Pulse

Pins 12 and 14 are used in conjunction with the Measured Value Output feature. When either of these contacts are shorted to Pin 8 (0V) the measured values as defined in Job Setup (see "Measured Value Output" on page 24) are output over the TXD line of the RS-232 interface. A commercially available switch can be used to provide the contact between pin 12 and 8. The pulse input between pin 14 and pin 8 can be initiated with a TTL logic device (i.e. SN74LSXX).
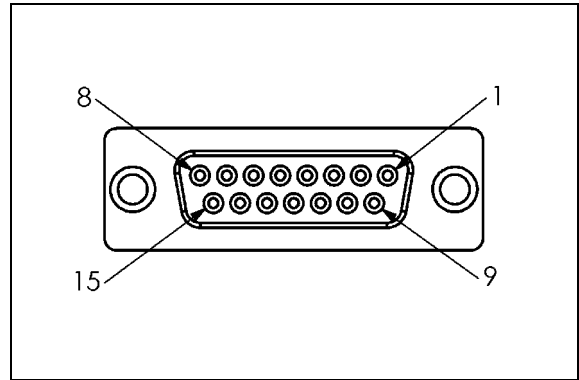

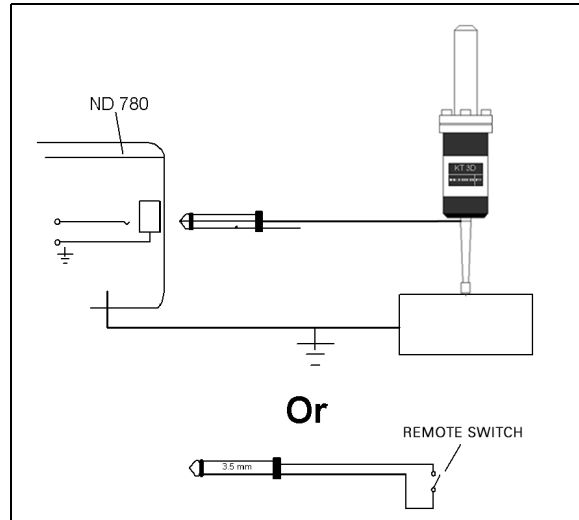Fig. II.5   15 pin receptacle connector for Edge Finder
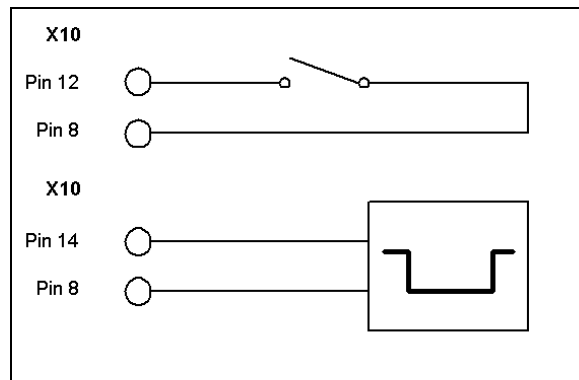

Fig. II.6   Grounding Edge Finder

Fig. II.7   Pin connection; 12 and 8, 14 and 8

II – 2 Installation Setup

Installation Setup Parameters

Installation setup is accessed by pressing the **SETUP** soft key, which brings up **INSTALLATION SETUP** soft key. See Fig. II.8.

Installation Setup parameters are established during the initial installation and, most likely, will not often change. For this reason, the installation setup parameters are protected by a passcode: **(95148)** type these digits in using the numeric key pad and then press ENTER.

```
D:1 | T:3 | F:  0 | 0:00 | MM | ⌐ △ |    |
┌─────────────────────┬───────────────────┐
│  INSTALLATION SETUP  │ Set the counter   │
│ ENCODER SETUP        │ application (MILL or│
│ DISPLAY CFG.         │ TURN) and number of│
│ ERROR COMPENSATION   │ axes (2 or 3).    │
│ BACKLASH COMP.       │                   │
│ SERIAL PORT          │                   │
│ COUNTER SETTINGS     │                   │
│ DIAGNOSTICS          │                   │
│                      │                   │
├──────────┬──────────┼─────────┬─────────┤
│   JOB    │ IMPORT   │         │  HELP   │
│  SETUP   │ EXPORT   │         │         │
└──────────┴──────────┴─────────┴─────────┘
```
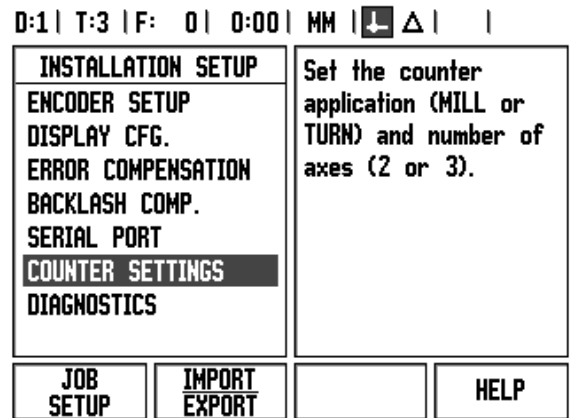
Fig. II.8 Installation screen

Encoder Setup

Encoder Setup is used to set the encoder resolution and type (linear, rotary), count direction, reference mark type. See Fig. II.9.

▶ The cursor will default to the ENCODER SETUP field upon opening Installation Setup. Press ENTER. This opens a list of 3 possible encoders, labeled INPUT X1 X2 or X3.

▶ Scroll to the encoder you want to change and press ENTER.

▶ The ENCODER SIGNAL field will automatically be determined.

▶ Cursor will be in the ENCODER TYPE field, select the encoder type by pressing the **LINEAR/ROTARY** soft key.

▶ For linear encoders, cursor to the SIGNAL PERIOD field and use **COARSER** or **FINER** soft keys to select the encoder's signal period in μm (2, 4, 10, 20, 40, 100, 200, 10 240, 12 800) or type in the exact signal period desired. For rotary encoders, enter the signal period directly. See "Encoder Parameters" on page 73 for values.

▶ In the REFERENCE MARK field, press the **REF MARK** soft key, then select either the **NONE, SINGLE,** or **CODED** soft key for the reference signal.

▶ For coded reference marks, press the **SPACING** soft key to select 500, 1000, 2000 or 5000.

▶ In the COUNT DIRECTION field, select the count direction by pressing the **POSITIVE** or **NEGATIVE** soft key. If the encoder's count direction matches the user's count direction, select positive. If the directions do not match, select negative.

▶ In the ERROR MONITOR field, select whether the system will monitor and display encoder counting and signal errors by selecting ON or OFF. This monitors Counting errors. The types of Counting errors are contamination errors (when the signal to the encoder falls below a set limit) and frequency error (when the signal frequency exceeds the set limit). When an error message occurs, press the C key to remove it.

Fig. II.9   ENCODER SETUP form

Display Configuration

The *DISPLAY CONFIGURATION* form is where the operator determines which axes are displayed and in what order.

▶ Scroll to the desired display and press ENTER.

▶ Press the **ON/OFF** soft key to turn the display on or off. Press the LEFT or RIGHT ARROW key to select the axis label.

▶ Scroll to the INPUT field.

▶ Press the numeric keys associated with the encoder input on the back of the unit. Press the **+** or **-** soft keys to couple a second input with the first.

▶ Scroll to the DISPLAY RESOLUTION field. Press the **COARSER** or **FINER** soft keys to select the display resolution.

Error Compensation

The distance a cutting tool travels, measured by an encoder, can in certain cases, differ from the actual tool travel. This error can occur due to ball screw pitch error or deflection and tilting of axes. This error can either be linear or non-linear. You can determine these errors with a reference measurement system, e.g. the VM 101 from **HEIDENHAIN** or with gauge blocks. From an analysis of the error it can be determined which form of compensation is required, linear or non-linear error.

The ND 780 provides the opportunity to compensate for these errors and each axis can be programmed separately with the appropriate compensation.

> Error compensation is only available when using linear encoders.

Linear Error Compensation

Linear error compensation can be applied, if the results of the comparison with a reference standard show a linear deviation over the whole measuring length. In this case the error can be compensated by the calculation of a single correction factor. See Fig. II.10 & Fig. II.11

▶ Once determined, the encoder's error information is entered directly. Press the **TYPE** soft key to select **LINEAR** compensation.

▶ Enter the compensation factor in parts per million (ppm) and press the ENTER key.

To calculate the linear error compensation use this formula:

Correction factor $LEC = \left(\dfrac{S - M}{M}\right) \times 10^6$ ppm

with $\quad$ S = measured length with reference standard

$\qquad$ M = measured length with device at axis

Example
If the length of the standard you used is 500 mm and the measured length along the X-axis is 499.95, then the LEC for the X-axis is 500 parts per million (ppm).

$$LEC = \left(\frac{500 - 499.95}{499.95}\right) \times 10^6 \text{ ppm}$$

LEC = 500 ppm
(rounded to the nearest whole number)

Fig. II.10 Linear error comp., calculation formula

Non-Linear Error Compensation

Non-linear error compensation should be applied, if the results of the comparison with a reference standard show an alternating or oscillating deviation. The required correction values are calculated and entered in a table. ND 780 supports up to 200 points per axis. The error value between two entered adjacent correction points is calculated with linear interpolation.

☝ Non-linear error compensation is only available on scales with reference marks. If non-linear error compensation has been defined, no error compensation will be applied until the reference marks have been crossed.

Starting a Non-linear Error Compensation Table

▶ Select Non-linear by pressing the **TYPE** soft key.

▶ To start a new error compensation table, first press the **NEW TABLE** soft key.

▶ All correction points (up to 200) are equally spaced from the start point. Enter the distance between each of the correction points. Press the DOWN ARROW key.

▶ Enter the table's start point. The start point is measured from the scale's reference point. If this distance is not known, you can move to the location of the start point and press **TEACH POSITION**. Press ENTER.

☝ Pressing ENTER will save the spacing and start point information. Any previous data in the table will be erased.

Configuring the Compensation Table

▶ Press the **EDIT TABLE** soft key to view the table entries.

▶ Use the UP or DOWN ARROW keys or the numeric keys to move the cursor to the correction point to be added or changed. Press ENTER.

▶ Enter the known error which exists at this point. Press ENTER.

▶ When completed, press C key to exit the table and return to the *ERROR COMPENSATION* form.

Reading the Graph

The error compensation table may be viewed in table or graphical formats. The graph shows a plot of a translation error vs. measured value. The graph has a fixed scale. As the cursor is moved through the form, the location of the point on the graph is indicated with a vertical line.
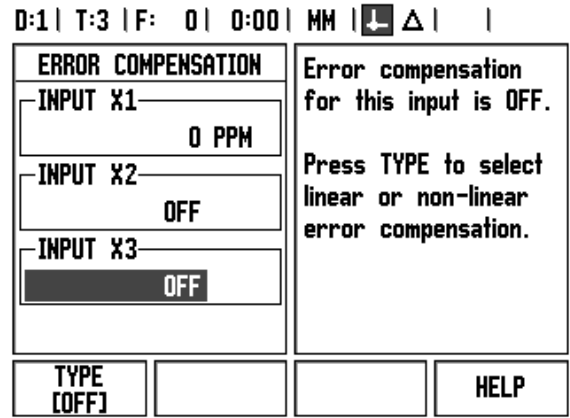

Fig. II.11 Linear error compensation form

Viewing the Compensation Table

▶ Press the **EDIT TABLE** soft key.

▶ To switch between the table and graph views, press the **VIEW** soft key.

▶ Press the UP or DOWN ARROW keys or the numeric keys to move the cursor within the table.

The error compensation table data may be saved to or loaded from a PC via the serial port.

Exporting the Current Compensation Table

▶ Press the **EDIT TABLE** soft key.

▶ Press the **EXPORT TABLE** soft key.

Importing a New Compensation Table

▶ Press the **NEW TABLE** soft key.

▶ Press the **IMPORT TABLE** soft key.

Backlash Compensation

When using a rotary encoder with a lead screw, a change in direction of the table might cause an error in the displayed position due to clearances within the lead screw assembly. This clearance is referred to as backlash. This error can be compensated for by inputting the amount of backlash within the lead screw into the Backlash Compensation feature. See Fig. II.12.

If the rotary encoder is ahead of the table (displayed value is greater than the table's true position), this is called positive backlash and the value entered should be the positive value of the amount of error.

If the rotary encoder follows the table (displayed value is less than the table's true position), this is called negative backlash and the value entered should be the negative value of the amount of the error.

No Backlash Compensation is 0.000.

Fig. II.12 Backlash compensation form

Serial Port (X31)

A printer or computer may be connected to the serial port. Part programs and configuration files may be sent to a printer or computer. Remote commands, remote key codes, part programs and configuration files may be received from a computer. See Fig. II.13.

▶ The BAUD field can be set to 300, 600, 1 200, 2 400, 9 600, 19 200, 38 400, 57 600 or 115 200 by using the **LOWER** and **HIGHER** soft keys.

▶ The parity can be set to NONE, EVEN, or ODD using the soft keys provided.

▶ Data Bits in the FORMAT field can be set to 7 or 8 using the soft keys provided.

▶ The STOP BITS field can be set to 1 or 2 using soft keys.

▶ LINE FEED field can be set to YES if the external device needs a line feed to follow a carriage return.

▶ Output tail is the number of carriage returns that will be sent at the end of the measured value output transmission. The output tail is initially 0 and can be set to a positive integer value (0 - 9) by using the numeric hard keys.

The serial port settings will be retained on a power cycle. There is no parameter to enable or disable the serial port. Data will only be sent to the serial port if the external device is ready. Refer to Data Interface section for cable connection and pin assignments.

Fig. II.13 SERIAL PORT form

Counter Settings

The *COUNTER SETTINGS* form is the parameter where the operator defines the user application for the readout. The choices are for milling or turning applications. See Fig. II.14.

A **FACTORY DEFAULT** soft key appears in the *COUNTER SETTINGS* choice of options. When pressed, the configuration parameters (based on either mill or turn) will be reset to factory defaults. The operator will be prompted to press **YES** to set parameters to factory default settings or **NO** to cancel and return to previous menu screen.

The NUMBER OF AXES field sets the number of axes needed. A **2/3** soft key will appear to choose between either 2 or 3 axes.

Fig. II.14 COUNTER SETTINGS form

Diagnostics

The *DIAGNOSTICS* form provides access for testing the keypad, edge finders and encoders. See Fig. II.15.

Keypad Test

An image of the keypad provides an indication when a switch is pressed and released.

▶ Press each hard and soft key to test. A dot will appear on each key when it has been pressed indicating that it is operating properly.

▶ Press the C key two times to exit the keypad test.

Edge Finder Test

▶ To test the edge finder, touch the edge finder to a part and EF 1 will appear on the display screen when a grounding type edge finder is used. EF 2 will appear when an electronic edge finder is used.

D:1 | T:3 | F: 0 | 0:00 | MM | ⏛ △ |

Use the graphic to verify a key's press and release.

To exit, press the clear key (C) twice.

Fig. II.15 DIAGNOSTICS form

Encoder signal plot

This parameter allows the operator to plot the signal of each encoder. See Fig. II.16.

▶ Select which encoder you want to observe.

▶ Cursor to the desired input and press ENTER.

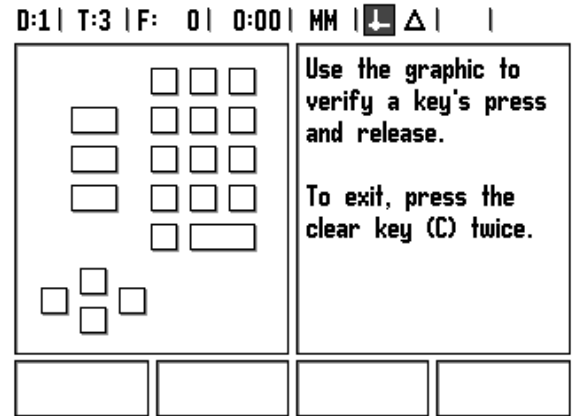▶ As the encoder is moved you will see the signals of the A & B channels.

D:0 | T:1 | F: 0 | 0:00 | MM | ⏛ △ |

INPUT X2

SIGNAL (Vpp)
A   1.31
B   1.29
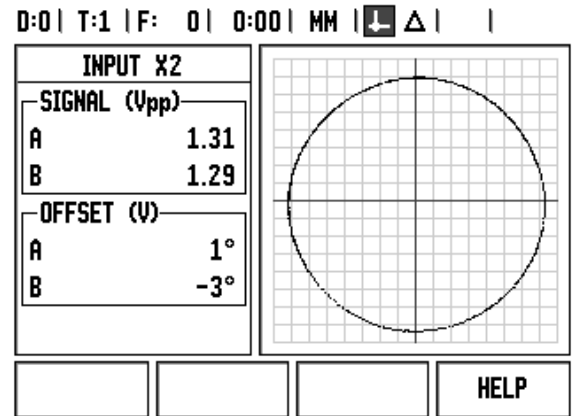
OFFSET (V)
A   1°
B   -3°

HELP

Fig. II.16 Example of a signal plot

II – 3 Encoder Parameters

The following tables represent a partial list of encoders. These tables describe all operating parameters which you must set for the encoders. Most entries can be found in the operating instructions for your encoder.

Example settings for HEIDENHAIN linear encoders with 11-µA$_{PP}$ signals

Encoder	Signal period	Reference marks
CT MT xx01	2	Single
LS 303/303C LS 603/603C	20	Single/ 1000
LS 106/106C LS 406/406C	20	Single/1000
LB 302/302C	40	Single/2000
LIM 501	10 240	Single

Example settings for HEIDENHAIN linear encoders with 1-V$_{PP}$ signals

Encoder	Signal period	Reference marks
LIP 382	0.128	–
MT xx81 LIP 481A/481R	2	Single
LIP 481X	2	Single
LF 183/183C LF 481/481C LIF 181/181C LIP 581/581C	4	Single/5000
LS 186/186C	20	Single/1000
LB 382/382C LIDA 18x/18xC	40	Single/ 2000
VM 182	4	–
LIDA 10x/10xC	100	Single/1000
LIM 581	10 240	Single

Example settings for HEIDENHAIN rotary encoders

Encoder	Line count	Reference marks
ROD 250, RON 255	9 000/18 000	1
ROD 250C, RON 255C	9 000	500
ROD 250C, ROD 255C ROD 700C, RON 705C RON 706C	18 000	1 000
ROD 700C, ROD 800C	36 000	1 000

II – 4 Data Interface

The ND 780's data interface includes the RS-232 serial port (X31). The serial port supports both bi-directional data communications which allows data to be exported to or imported from an external device and external operations via the data interface.

Data which can be exported from the ND 780 to an external serial device includes:

◼ Job and installation configuration parameters

◼ Non-linear error compensation tables

◼ Measured value output (display values or probing functions)

Data which can be imported into ND 780 from an external device includes:

◼ Remote key commands from an external device

◼ Job and installation configuration parameters

◼ Non-linear error compensation tables

This chapter covers what you need to know about setting up the data interface:

◼ Pin layout of data interface

◼ Signal level

◼ Wiring of the connecting cable and connectors

◼ Data format

Serial port

The RS-232-C/V.24 serial port is located on the rear panel (see Fig. II.17 for pin layout). The following devices can be connected to this port:

◼ Printer with serial data interface

◼ Personal computer with serial data interface

For operations that support data transfer, an **IMPORT/EXPORT** soft key will be available. (See "Serial Port (X31)" on page 71.)

To export data to a serial port printer, press the **IMPORT/EXPORT** soft key. The data is exported in an ASCII text format which can be printed directly.

To export or import data between the ND 780 and a personal computer, the PC must use terminal communications software such as TNC Remo. (TNC Remo is available for free at: http://filebase.heidenhain.de/doku/english/serv_0.htm. Contact your Heidenhain distributor for further details.) This software processes the data being sent or received over the serial cable link. All data transferred between ND 780 and the PC is in ASCII text format.

To export data from the ND 780 to a PC, the PC must first be made ready to receive the data to save it to a file. Setup the terminal communication program to capture ASCII text data from the COM port to a file on the PC. After the PC is ready to receive, start the data transfer by pressing the ND 780's **IMPORT/EXPORT** soft key.
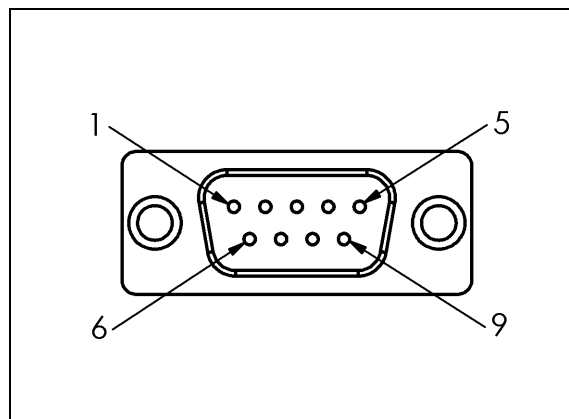

Fig. II.17 Pin layout of RS-232-C/V.24 data interface

To import data into the ND 780 from a PC, the ND 780 must first be made ready to receive the data. Press the ND 780's **IMPORT/EXPORT** soft key. After the ND 780 is ready, setup the terminal communications program on the PC to send the desired file in ASCII text format.

☞ The ND 780 does not support communication protocols such as Kermit or Xmodem.

Wiring the connecting cable

The wiring of the connecting cable depends on the device being connected (see technical documentation for external device).

Full wiring

Before the ND 780 and your PC can communicate, they need to be connected to each other with a serial cable. See Fig. II.18 & Fig. II.19.

Pin assignment

Pin	Assignment	Function
1	No assignment	
3	TXD	- Transmitted data
2	RXD	- Received data
7	RTS	- Request to send
8	CTS	- Clear to send
6	DSR	- Data set ready
5	SIGNAL GND	- Signal ground
4	DTR	- Data terminal ready
9	No assignment	

Signal

Signal	Signal level "1"= "active"	Signal level "0"= "inactive"
TXD, RXD	-3 V to -15 V	+ 3 V to + 15 V
RTS, CTS DSR, DTR	+ 3 V to + 15 V	-3 V to -15 V
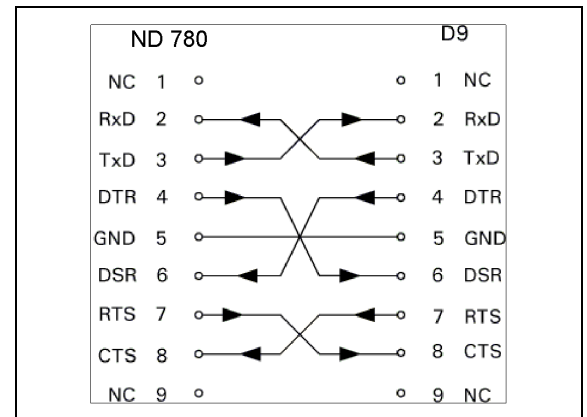
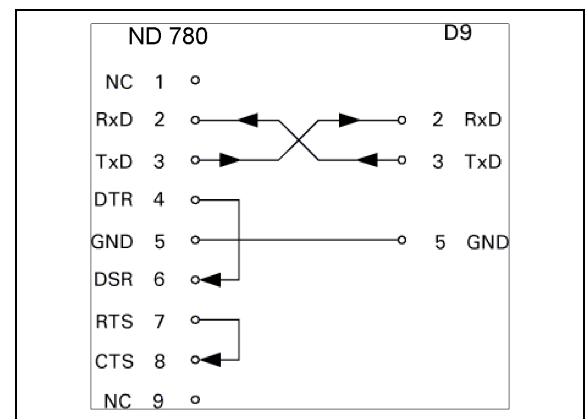Fig. II.18 Pin connection for serial port with handshaking

Fig. II.19 Pin connection for serial port without handshaking

External Operations via RS-232 Data Interface

You can operate the display unit over the RS-232 data interface using an external device. The following key commands are available:

Format	
<ESC>TXXXX<CR>	Key is pressed
<ESC>AXXXX<CR>	Output of screen contents
<ESC>SXXXX<CR>	Special functions

Sequence of commands	Function
<ESC>T0000<CR>	Key '0'
<ESC>T0001<CR>	Key '1'
<ESC>T0002<CR>	Key '2'
<ESC>T0003<CR>	Key '3'
<ESC>T0004<CR>	Key '4'
<ESC>T0005<CR>	Key '5'
<ESC>T0006<CR>	Key '6'
<ESC>T0007<CR>	Key '7'
<ESC>T0008<CR>	Key '8'
<ESC>T0009<CR>	Key '9'
<ESC>T0100<CR>	Key 'CE' or 'CL'
<ESC>T0101<CR>	Key '-'
<ESC>T0102<CR>	Key '.'
<ESC>T0104<CR>	Key 'ENT'
<ESC>T0109<CR>	Key 'X'
<ESC>T0110<CR>	Key 'Y'/'Z'/'Z$_0$'
<ESC>T0111<CR>	Key 'Z'
<ESC>T0114<CR>	Key 'Soft key 1'
<ESC>T0115<CR>	Key 'Soft key 2'
<ESC>T0116<CR>	Key 'Soft key 3'
<ESC>T0117<CR>	Key 'Soft key 4'
<ESC>T0135<CR>	Key 'Cursor Left'
<ESC>T0136<CR>	Key 'Cursor Right'
<ESC>T0137<CR>	Key 'Cursor Up'
<ESC>T0138<CR>	Key 'Cursor Down'
<ESC>A0000<CR>	Send device identification
<ESC>A0200<CR>	Send actual position
<ESC>S0000<CR>	Reset device
<ESC>S0001<CR>	Lock keyboard
<ESC>S0002<CR>	Release keyboard

II – 5 Measured Value Output

Examples of character output at the data interface

If you have a PC you can retrieve values from ND 780. In all three examples, measured value output is started with **Ctrl B** (sent over serial interface) or a **switching signal at the EXT input** (within optional Auxiliary Machine Interface). **Ctrl B** will transmit the currently displayed values in either Actual Value or Distance-To-Go mode, whichever is currently visible (see "Measured Value Output" on page 24).

Data output using external signals

Example 1: Linear axis with radius display X = + 41.29 mm

X	=	+	4 1	.	2 9		R	<CR>	<LF>
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

1 Coordinate axis

2 Equal sign

3 +/– sign

4 2 to 7 places before the decimal point

5 Decimal point

6 1 to 6 places after the decimal point

7 Unit: blank space for mm, **"** for inches

8 Actual value display:
   R for radius, **D** for diameter
   Distance-to-go display:
   r for radius, **d** for diameter

9 Carriage return

10 Blank line (Line Feed)

Example 2: Rotary axis with degrees decimal display
C = + 1260.0000°

C	=	+	1 2 6 0	.	0 0 0 0		W	\<CR>	\<LF>
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**

1 Coordinate axis

2 Equal sign

3 +/– sign

4 4 to 8 places before the decimal point

5 Decimal point

6 0 to 4 places after the decimal point

7 Blank space

8 `W` for angle (in distance-to-go display: `w`)

9 Carriage return

10 Blank line (Line Feed)

Example 3: Rotary axis with degrees/minutes/seconds display
C = + 360° 23' 45'' '

C	=	+	3 6 0	:	2 3	:	4 5		W	\<CR>	\<LF>
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**

1 Coordinate axis

2 Equal sign

3 +/– sign

4 3 to 8 places degrees

5 Colon

6 0 to 2 places minutes

7 Colon

8 0 to 2 places seconds

9 Blank space

10 `W` for angle (in distance-to-go display: `w`)

11 Carriage return

12 Blank line (Line Feed)

Data output using Edge Finder

In the next three examples, measured value output is started with a **switching signal from the edge finder.** Printing capability can be turned on or off in the Job Setup parameter Measured Value Output. Information from here is transmitted from the selected axis.

Example 4: Probing function Edge Y = –3674.4498 mm

Y		:	-	3 6 7 4	.	4 4 9 8		R	<CR>	<LF>
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**

1 Coordinate axis

2 2 blank spaces

3 Colon

4 +/– sign or blank space

5 2 to 7 places before the decimal point

6 Decimal point

7 1 to 6 places after the decimal point

8 Unit: blank space for mm, **"** for inches

9 **R** for radius display, **D** for diameter display

10 Carriage return

11 Blank line (Line Feed)

Example 5: Probing function Centerline

Coordinate of centerline on X axis CLX = + 3476.9963 mm (**C**enter **L**ine **X** axis)

Distance between the probed edges DST = 2853.0012 mm (**Dist**ance)

CLX	:	+	3 4 7 6	.	9 9 6 3		R	<CR>	<LF>
DST	:		2 8 5 3	.	0 0 1 2		R	<CR>	<LF>
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

1 Colon

2 +/– sign or blank space

3 2 to 7 places before the decimal point

4 Decimal point

5 1 to 6 places after the decimal point

6 Unit: blank space for mm, **"** for inches

7 R for radius display, D for diameter display

8 Carriage return

9 Blank line (Line Feed)

Example 6: Probing function Circle Center

First center point coordinate, e.g. CCX = –1616.3429 mm, Second center point coordinate, e.g. CCY = +4362.9876 mm, (**C**ircle **C**enter **X** axis, **C**ircle **C**enter **Y** axis; coordinates depend on working plane) Circle diameter DIA = 1250.0500 mm

	:	-	1 6 1 6	.	3 4 2 9		R	<CR>	<LF>
CCX	:	-	1 6 1 6	.	3 4 2 9		R	<CR>	<LF>
CCY	:	+	4 3 6 2	.	9 8 7 6		R	<CR>	<LF>
DIA	:		1 2 5 0	.	0 5 0 0		R	<CR>	<LF>
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**

1 Colon

2 +/– sign or blank space

3 2 to 7 places before the decimal point

4 Decimal point

5 1 to 6 places after the decimal point

6 Unit: blank space for mm, **"** for inches

7 R for radius display, D for diameter display

8 Carriage return

9 Blank line (Line Feed)

II – 6 Specifications for Milling

ND 780 Data	
Axes	Up to 3 axes from A - Z
Encoder inputs	Sinusoidal signals 11 µA$_{PP}$, 1 V$_{PP}$; input frequency max. 100 kHz for incremental HEIDENHAIN encoders ■ *Signal period:* 2 µm, 4 µm, 10 µm, 20 µm, 40 µm, 100 µm, 10240 µm, 12800 µm ■ *Line count:* 9000/18000/36000
Subdivision factor	Max. 1024-fold
Display step	Linear axes: 1 mm to 0.1 µm Rotary axes: 1° to 0.0001° (00°00′01″)
Display	Monochrome display for position values, dialog and input display, graphic functions, graphic positioning aid ■ *Status display:* Operating mode, REF, inch/mm, scaling factor, feed rate, stop watch Datum number Tool number Tool compensation R–, R+
Functions	■ REF reference-mark evaluation for distance-coded or single reference marks ■ Distance-to-go mode, nominal position input (absolute or incremental) ■ Scaling factor ■ Edge Finder input for both 3D and Grounding types ■ **HELP:** On-screen operating instructions ■ **INFO:** Calculator, cutting data calculator, user and operating parameters ■ 10 datum points and 16 tools ■ Probing functions for datum acquisition, preferably with the KT Edge Finder: Edge, Center Line and Circle Center ■ Tool radius compensation ■ Calculation of positions for bolt hole circles and linear hole patterns
Error compensation	Linear and non-linear, up to 200 measuring points
Backlash compensation	Rotary encoder applications with ballscrews
Data interface	■ *Serial:* **RS-232-C/V.24** 300 to 115200 baud For output of measured values and parameters; For input of parameters, remote keys and commands

ND 780 Data	
Accessories	■ Tilting Base ■ Universal Mounting Arm ■ KT 130 Edge Finder ■ Tilting Bracket Assembly ■ Handle
Main power input	100 V to 240 V; 50 Hz to 60 Hz; power consumption 30 VA max.
Operating temperature	0°C to 45°C (32 °F to 113 °F)
Storage temperature	-20°C to 70°C (-22°F to 158°F)
Degree of protection (EN 60529)	IP 40 (IP 54 front panel)
Weight	2.6 kg

II – 7 Specifications for Turning

ND 780 Data	
Axes	Up to 3 axes from A to Z, Z_0, Z_S
Encoder inputs	Sinusoidal signals 11 μA_{PP}, 1 V_{PP}; input frequency max. 100 kHz for incremental HEIDENHAIN encoders ■ *Signal period:* 2 µm, 4 µm, 10 µm, 20 µm, 40 µm, 100 µm, 10 240 µm, 12 800 µm ■ *Line count:* 9 000/18 000/36 000
Subdivision factor	Max. 1 024-fold
Display step	Linear axes: 1 mm to 0.1 µm Rotary axes: 1° to 0.0001° (00°00'01")
Display	Monochrome display for position values, dialog and input display, graphic functions, graphic positioning aid ■ *Status display:* tool number, operating mode, REF, inch/mm, scaling factor, feed rate, diameter display Ø, stop watch, datum
Functions	■ REF reference-mark evaluation for distance-coded or single reference marks ■ Distance-to-go mode, nominal position input (absolute or incremental) ■ Scaling factor ■ **HELP:** On-screen operating instructions ■ **INFO:** Calculator, taper calculator, user and operating parameters ■ 10 datum point, 16 tools ■ Freezing tool position for back-off
Backlash Compensation	Rotary encoder applications with ballscrews
Error Compensation	Linear and non-linear, up to 200 measuring points
Data interface	■ *Serial:* **RS-232-C/V.24** 300 to 115 200 baud For output of measured values and parameters; For input of parameters, remote keys and commands
Accessories	■ Tilting Base, Tilting Bracket Assembly, Handle
Main power input	100 V to 240 V; 50 Hz to 60 Hz; power consumption 30 VA max.
Operating temperature	0°C to 45°C (32 °F to 113 °F)
Storage temperature	-20°C to 70°C (-22°F to 158°F)
Degree of protection (EN 60 529)	IP 40 (IP 54 front panel)
Weight	2.6 kg

II – 8 Dimensions

Dimensions mm/inches
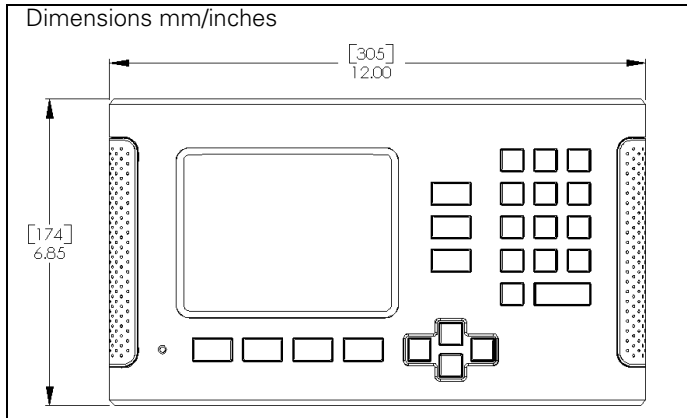
Front view with Dimensions

Back view
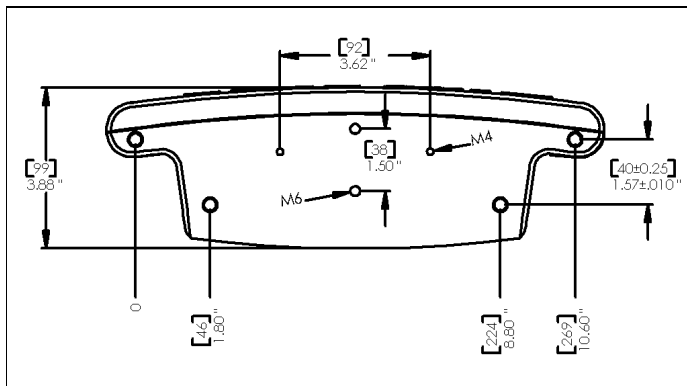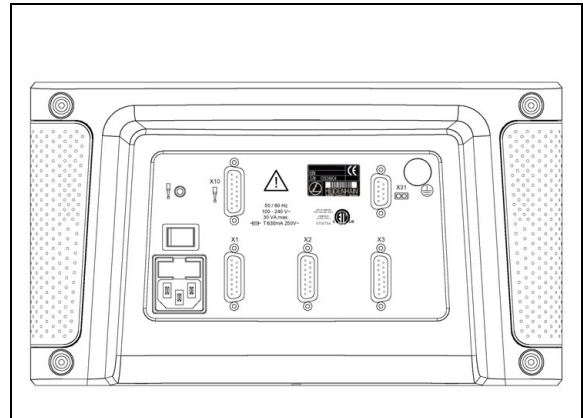
Bottom view with Dimensions

II – 9 Accessories

Accessory ID Numbers

ID Number	Accessories
520010-01	Pkgd, ND 780
382929-01	Pkgd, Universal Mounting Arm, ND 780
281619-01	Pkgd, Tilting Base ND 780
520011-01	Pkgd, Tilting Bracket Assembly ND 780
520012-01	Pkgd, Handle ND 780
285067-01	Pkgd, KT-130 Edge Finder

ND 780 Handle
Id. Nr. 520 012-01
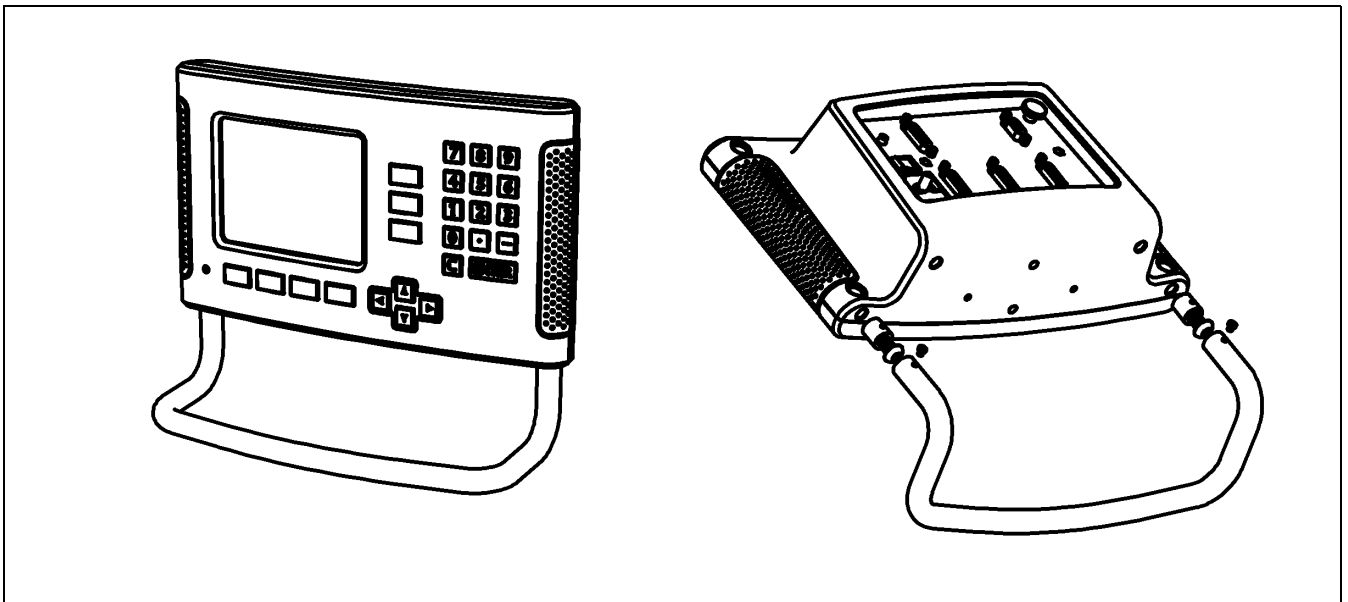
ND 780 Mounting Instructions
Universal Mounting Arm
Id. Nr. 382 929-01

HHCS 5/8-11 x 3"
SCSS 5/8-2" x 1/2-13 x .8"
HHCS m16 x 75 mm
HHCS m14 x 75 mm

5/8" Flat Washer (2)

M6 x 12 mm SHSS (4)

Yoke

Mounting Base

M6 x 12 mm SHSS (4)

Arm

M8 x 70 mm HHCS

Flat Washer

M6 x 30 mm SHCS (2)
or
1/4-20 x 1-1/4" SHCS (2)

M8 Locking Hex Nut

Tilt/Bracket
Assembly
Id. Nr. 520011-01

End Cap (2)

44.45
1.75

Arm

Front View of Yoke

End Cap (2)
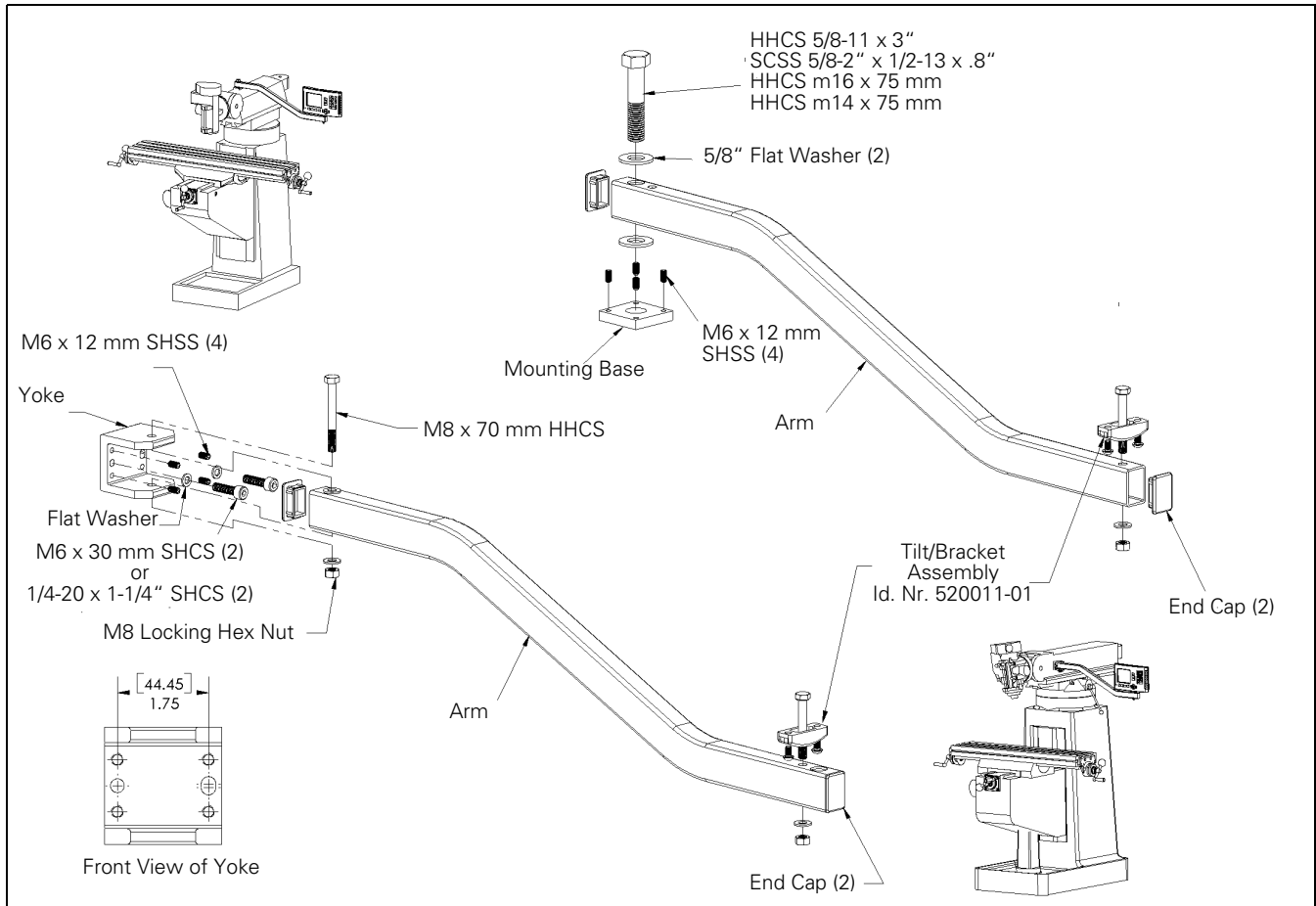
ND 780 Mounting Instructions
Tilting Base
Id. Nr. 281 619-01

M4 x 12 SHCS

Tilting Base

20°

38±0.5
1.5±.02

20±0.5
4.73±.02"

8
.31"

92
3.622"

56
2.205"

210±0.20
8.268±.008"

240
9.45"
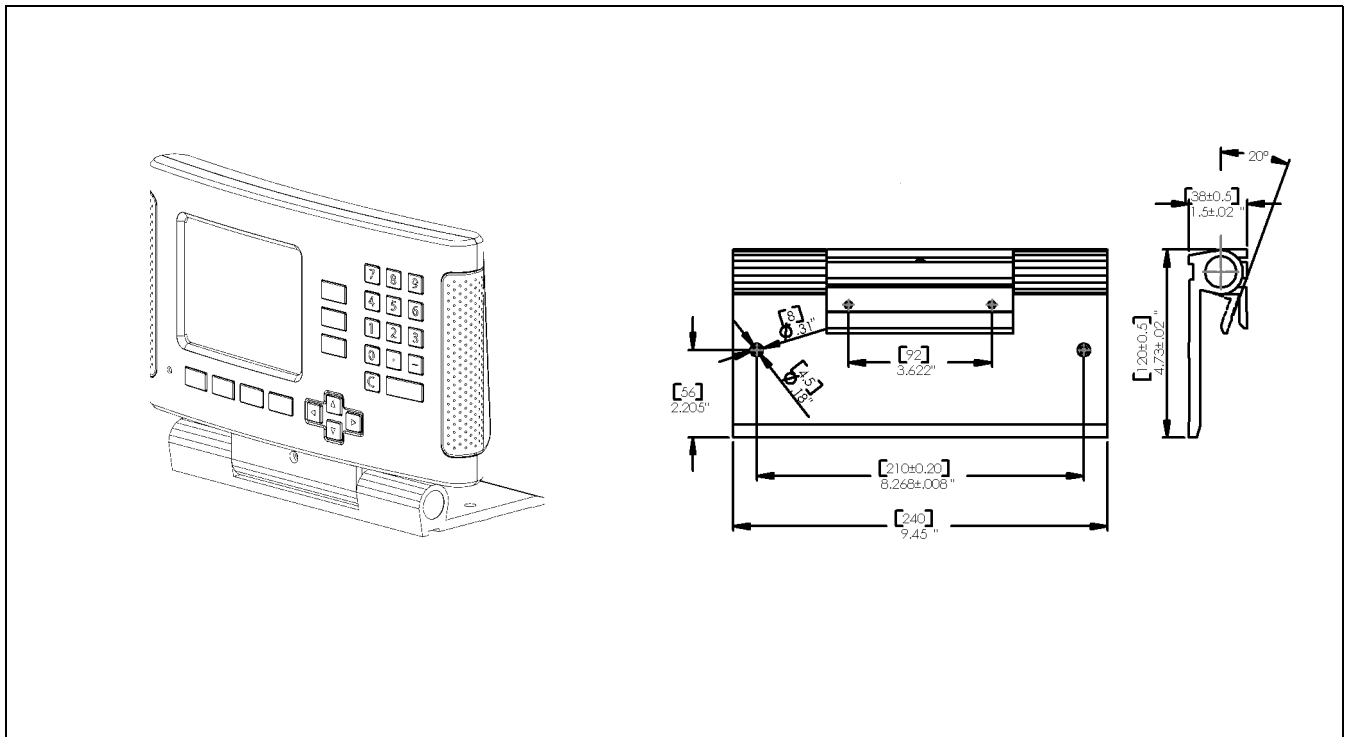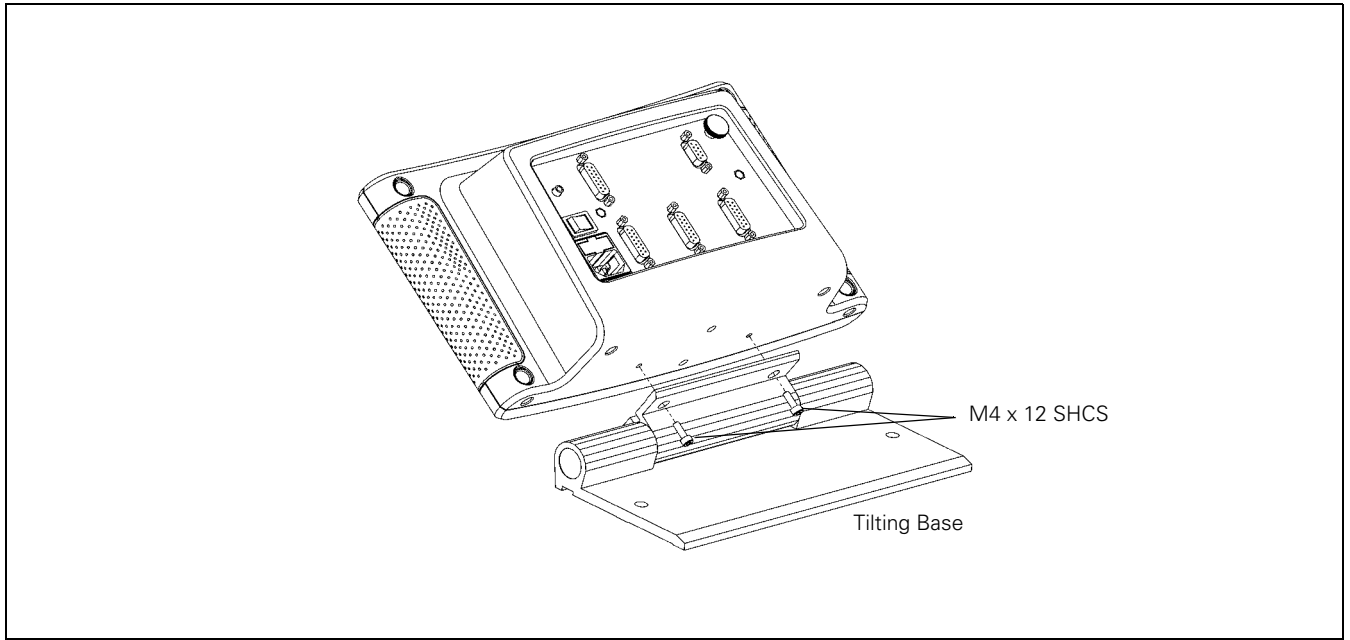
ND 780 Mounting Instructions
Tilting Bracket
Id. Nr. 520011-01

M8 x 60 HHCS

Tilting bracket

M6 BHCS

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[i]

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