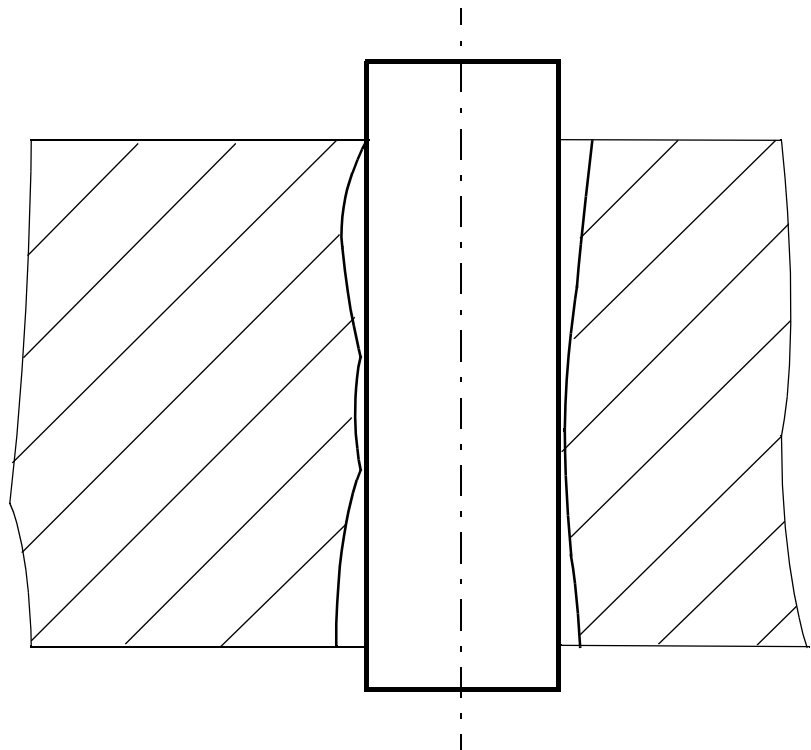


UMESS

Option 3 Extended Best Fit Functions for UNIX and LINUX



Operating Instructions



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Document type: . . . Operating Instructions
Version: 8.x
Date: 04/2000
Order no.: 61212-1040102

Preface

These operating instructions are based on the assumption that you are already familiar with the operation of the corresponding coordinate measuring machine and its components. Please always keep all of the documents included in delivery within easy reach.

Conventions in these operating instructions

Before beginning work with these operating instructions you should first familiarize yourself with the conventions they employ.

The following text will provide you with information on the fonts, characters and symbols used in this manual.

Typographical conventions

The fonts and type-faces used in these operating instructions have the following significance:

- **bold**
 - A dialog element displayed on the screen
Example: "... the <**TERMIN**> button"
 - A term
Example: "during the calculation the spatial position of a **part feature** is determined in relation to a **reference element**."
 - File and directory names
Example: **/home/zeiss/UB**
- *italics*
 - A highlighted text containing information of special importance
Example: "Click with the *right* mouse button ..."
 - Cross reference
Example: "..., see also ➤ „Circle best fit“ on page 2-17"
- **Courier bold**
Text in dialog boxes and records

Characters and symbols

Special characters and symbols are used in these operating instructions.

Symbols for warnings and notes



Danger!

Special caution is required in this case. The warning triangle on the left indicates a danger of injury. If you do not observe this warning you may possibly be injured.



Important!

This symbol is used to warn the reader of situations involving a possible data loss, measuring errors, faults during a measuring run, collisions, or damage to the CMM and/or the workpiece.



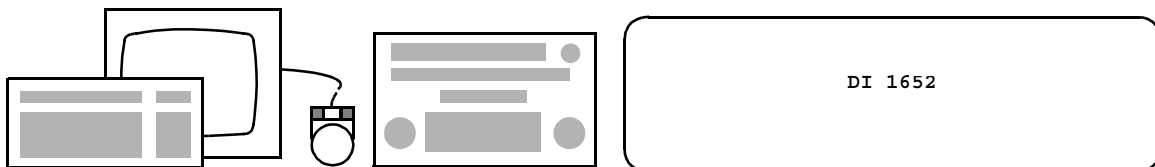
The **NOTE** symbol is placed next to important text passages and helpful additional information.

Symbol for function call

Several possibilities exist:

- Direct selection via a DI number
- Function selection via the pull-down menu
- Selection via a pictograph display

Example:



Symbol for softkey

References to softkeys are displayed in dialogs as follows.

Chapter overview

These operating instructions describe the function, handling and possible applications of the UMESS Opt.3 measuring program.

The following topics are covered:

- „3D point-to-point best fit“ on page 1-3
- „Calculation of geometric elements“ on page 2-9

Direct input functions

DI Number	Input Abbrev.	Function	Description
1164		Assign nominal and actual values for best fit	► <i>Page 1-5</i>
1663		Switch name allocation on/off	► <i>Page 1-7</i>
1180		Best fit of geometric elements	► <i>Page 2-13</i>
1168		Best fit of circle into curve	► <i>Page 2-21</i>

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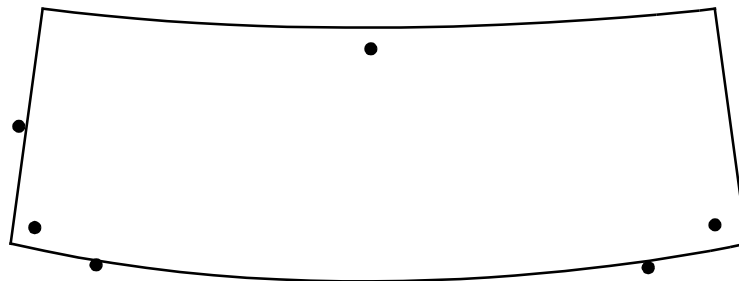
Chapter



3D point-to-point best fit

This program extends the best fit possibilities, i.e. the points measured for workpiece alignment are optimally fit to a nominal geometry (according to Gauss).

Application example: Optimization of the coordinate system of a windshield via a best fit using reference points.



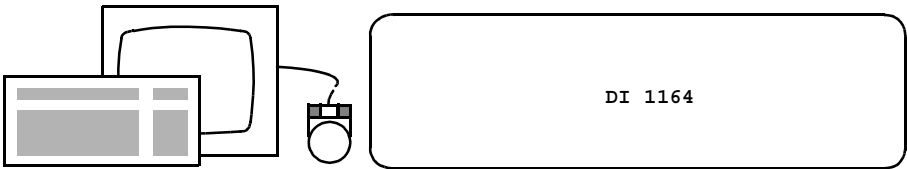
This chapter contains:

Procedure	1-4
Specifying nominals and actuals for the best fit	1-5
Best fit	1-7

Procedure

- Mathematically align workpiece to be best fit in a temporary coordinate system.
- Probe all of the elements (features) to be used for the best fit.
- Select **Nom-Act-Value input** with **<DI 1164>** in the **3D Best fit** dialog window to enter the elements for the best fit.
- Select **3D Best fit** dialog window with **<TERMIN>** to define the best fit conditions.
- Close previous dialog window with **<TERMIN>** and start the best fit procedure.

Specifying nominals and actuals for the best fit



Dialog window

Dialog

3D Best fit: Nom-Act-Value input

Best fit of ADR/Name

to

Step

Best fit of ADR/Name

to

Step

ADR/Name of meas. element

Symbol

Nominal

X

Y

Z

Table input: Conclude TAB TERMIN

Display/Change: TAB NEXT, TAB PREV

* YES

NO

*

TAB NEXT

TAB TERM

TERMIN

BACK

TAB PREV

INFO

Softkeys

TAB NEXT

Scroll table forwards.

TAB PREV

Scroll table backwards.

TAB TERM

Jump to next input field.

Input fields

Best fit of ADR/Name .. to .. Step

Input of the result name or address (absolute or relative address) of the element to be fitted. The start address, end address and step width (address block) must be entered for consecutive elements or elements arranged at regular intervals.

Always enter data in the lower line: When a line (address block) has been completed, the data automatically jumps up one line (address block). New data can then be entered in the lower line. Terminate the input with **<TAB TERM>**.

Up to 10 lines can be entered.

All geometric elements are allowed for the best fit (point, space point, circle, surface, intersection or symmetry elements, etc.). Note that with geometric elements it is not the individual points but the results printed in the measurement record, e.g. the piecing point of the coordinate axis through the surface, which are best fitted.

ADR/Name of meas. element

The nominals for the displayed measured element must be entered in the next input fields.

Symbol, X, Y, Z nominal

Fields for tabular input of the nominals of the measured element displayed at the top. The nominals are preassigned with rounded off values. You can scroll through the table using the **<TAB NEXT>** and **<TAB PREV>** softkeys.

Terminate your input with **<TAB TERM>**.

Best fit



Dialog window

Dialog									
3D Best fit									
Result name:		<input type="text"/>							
Best fit mode Rotation around and/or shift in axes:									
Rot. around X		<input type="checkbox"/>							
Rot. around Y		<input type="checkbox"/>							
Rot. around Z		<input type="checkbox"/>							
Shift in X		<input type="checkbox"/>							
Shift in Y		<input type="checkbox"/>							
Shift in Z		<input type="checkbox"/>							
<input type="button" value="YES"/>				<input type="button" value="NO"/>					
								<input type="button" value="TERMIN"/>	
<input type="button" value="BACK"/>									
								<input type="button" value="INFO"/>	

Input fields

Result name

A name can be entered here if the name allocation is activated (<DI 1663>).

Best fit mode Rotation around and/or shift in axes:

Rotation around ..axis, shift in ..

Select the best fit mode by specifying the direction of rotation and/or shift.

NOTE

Measured values must also be available for the axes and directions selected.

Procedure

Enter the required data and determine the best fit procedure. The best fit result will be output after you press <TERMIN>.

Example

```
Best fit method: Gauss
Best fit mode Shift in XYZ
Best fit mode Rotation around XYZ
3D Best fit Start

11      3D FIT      X      0.1359
                        Y      0.0602
                        Z     -0.0012
      SPACE      W     -0.0029
      PLANE      W      0.2104  AROUND SPACE AXIS  Z
13P S/MIN/MAX      .3548      (2) -0.4022      (9) 0.3815

3D Best fit end
```

Chapter

2

Calculation of geometric elements

This chapter contains:

Basic principles and application examples.	2-10
Best fit of geometric elements (DI 1180)	2-13
Best fit of circle into curve (DI 1168).	2-21

Basic principles and application examples

UMESS calculates geometric elements using the Gaussian best fit method as the standard procedure. The option 3 extends the best fit calculating methods to include:

- the Chebyshev best fit (minimum criterion),
- the minimum circumscribed (outer tangential) element,
- the maximum inscribed (inner tangential) element.

Gaussian best fit

The standard method used by UMESS, the Gaussian best fit, determines the mean best fit element. Calculation is performed so that the sum of the distances squared between the calculated (ideal) contour and the actual (probed) contour is kept to a minimum.

This method is insensitive to outliers and provides a clear result with a minimum calculation effort.

Chebyshev best fit (minimum criterion)

The Chebyshev minimum criterion best fit can be selected with **<DI 1180>** to determine the smallest possible form deviation (e.g. as required by DIN ISO 1101). This method calculates the geometric element so that the smallest possible maximum deviation between the calculated and the probed contour results (the X distances shown in the drawing on the next page).

With this calculation method, the extreme values determine the measurement result. Outliers have a strong influence. For form tests you should determine the elements with a high number of points and carry out the calculation according to the Chebyshev method.

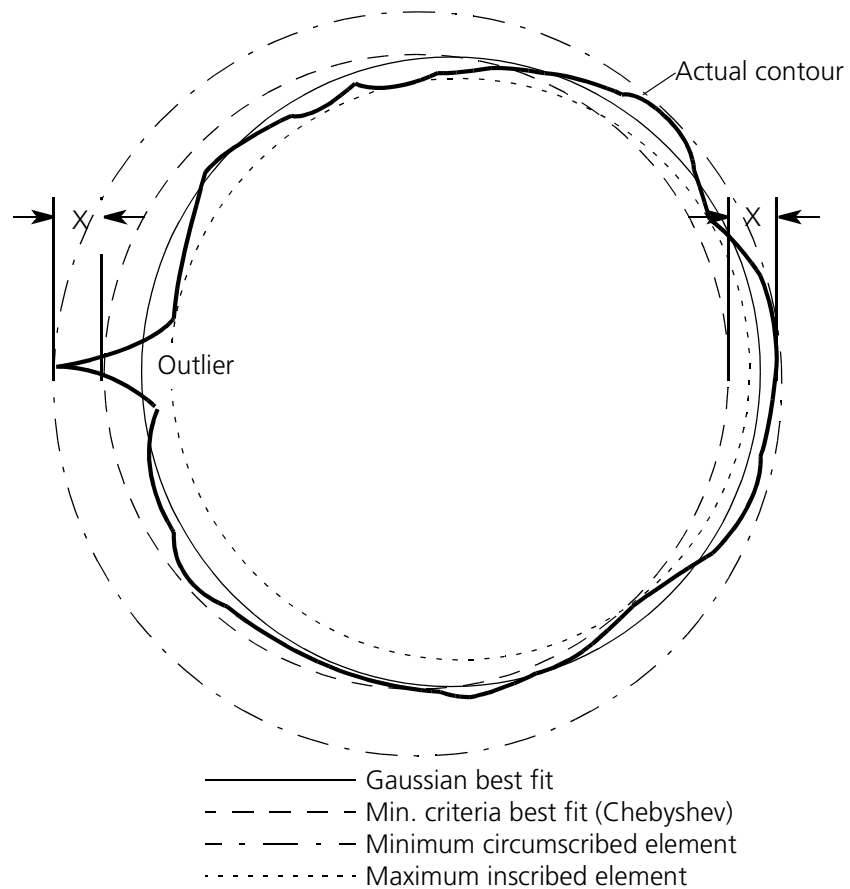
Calculation as minimum circumscribed and maximum inscribed (tangential) elements

Instead of the mean best fit element (Gauss), the (minimum circumscribed or maximum inscribed) element bordering on the respective extreme points can be requested with **<DI 1180>**. This application is recommended for determination of the mating size and (alternatively to the Gaussian method) for determining the reference element with position tolerances.

With surfaces, the terms "outer/inner tangential surface" are used instead of "minimum circumscribed/maximum inscribed element" (➤ „Surface best fit“ on page 2-15).

Example

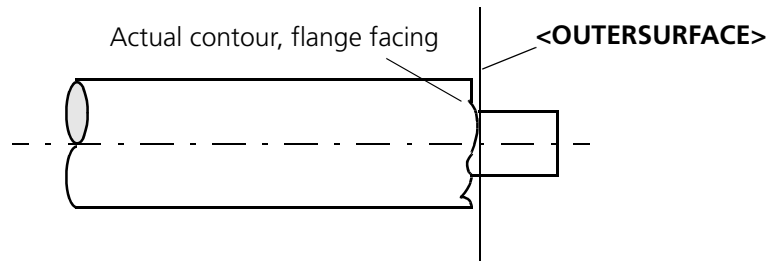
Using a scanned circle (with a magnified outlier for clarification):



The above illustration shows the actual contour and the ideal geometric contours of the circle according to the different methods. The individual best fit methods yield varying results with regard to size (e.g. diameter), form deviation and position (e.g. center).

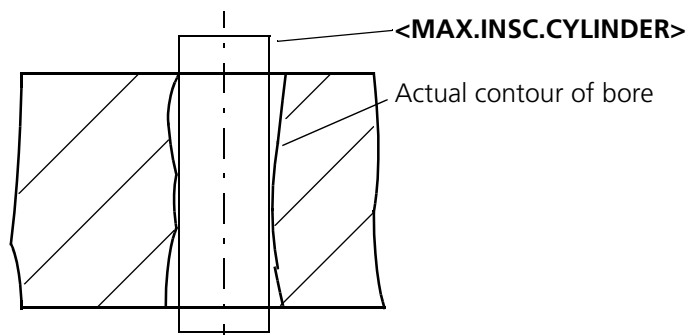
Application examples

- Fixed shafts: You require the data from the surface which contacts the flange facing at its highest point.



Measure shaft as **<CYLINDER>** and align mathematically as usual, measure (scan) flange as **<SURFACE>** and then calculate as **<OUTERSURFACE>**, if necessary with preset alignment angle (► „Surface best fit“ on page 2-15).

- You want to determine the largest ideal geometric pin which fits into an aligned bore (e.g. to place the zero point there).



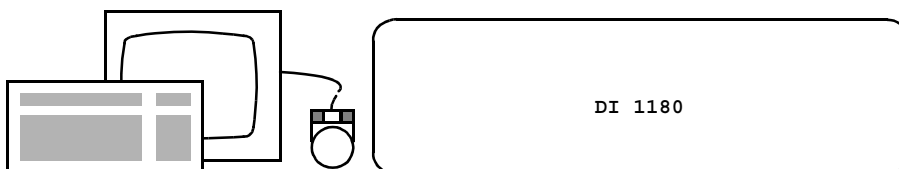
- Mathematically align testpiece and measure (scan) bore as **<CYLINDER>**. Then calculate the untilted **<MAX.INSC.CYLINDER>** (► „Cylinder best fit“ on page 2-19).

Best fit of geometric elements (DI 1180)

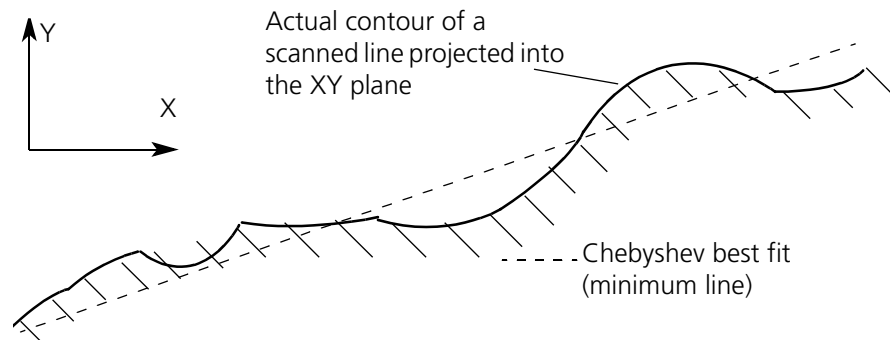
<DI 1180> enables the calculation of geometric elements, e.g. <CIRCLE>, <SURFACE>, <LINE>, <CYLINDER> according to the Chebyshev best fit method or as a minimum circumscribed/maximum inscribed or tangential element (➤ „Basic principles and application examples“ on page 2-10).

Procedure

- Measure the element by scanning or individually probing a large number of points. Outliers can be eliminated by using filters.
- Request result (acc. to the Gaussian method) with <TERMIN>.
- Call up <DI 1180> and preselect the required evaluation via the conversational mode:
- After line measurement: ➤ „Line best fit“ on page 2-14.
- After surface measurement: ➤ „Procedure“ on page 2-13.
- After circle measurement: ➤ „Circle best fit“ on page 2-17.
- After cylinder measurement: ➤ „Cylinder best fit“ on page 2-19.
- Then continue editing the best fit element (e.g. form and position inspection).



Line best fit



Procedure: ➤ „Procedure“ on page 2-13.

Prerequisite

The last record address must contain a line calculation according to the Gaussian method.

Dialog window

Dialog	
Line calculation	
Element name	
Minimum line	*

Input fields

Element name

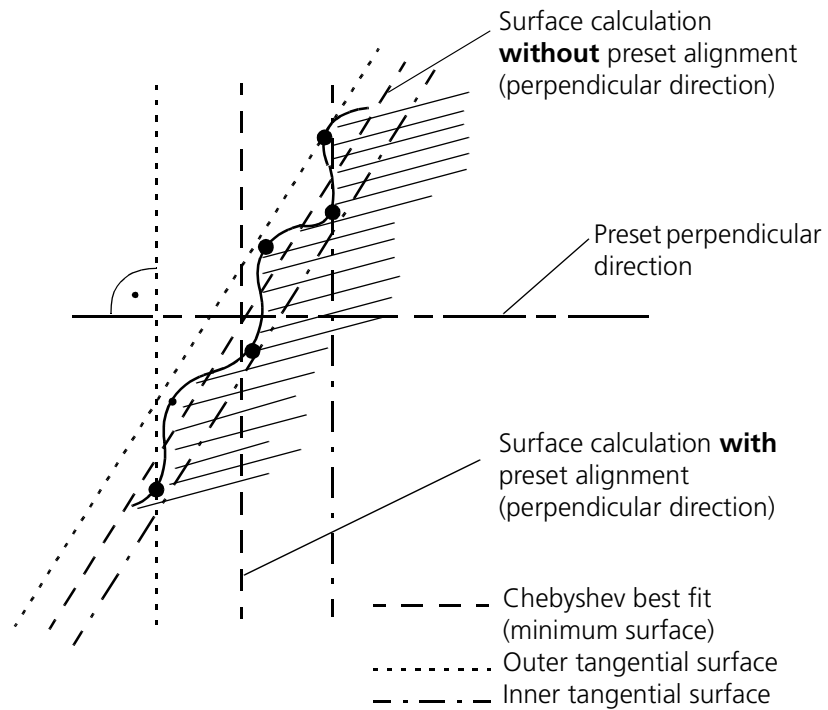
If the name allocation has been activated with **<DI 1663>**, a default name is offered here which can either be accepted or overwritten.

Minimum line

<YES>

Chebyshev best fit

Surface best fit



Calculation method

Outer tangential surface

The surface calculated lies on the highest probing.

Inner tangential surface

The surface calculated runs through the lowest probing (in the material).

Minimum surface

Chebyshev surface (minimization of maximum distance).

Procedure: ➤ „Procedure“ on page 2-13.

Prerequisite

The last record address must contain a Gaussian surface calculation.

Dialog window

Surface calculation

Element name
Outer tangential surface
or inner tangential surface
or minimum surface

Surface with specified alignment
Normal as for address
or projected angles
nor normal

Surface perpend. to another surf.
Address of the other surface
or proj. angle to axis
or normal

W1
Nx

W2
Ny

Nz

Y
Nx

or z

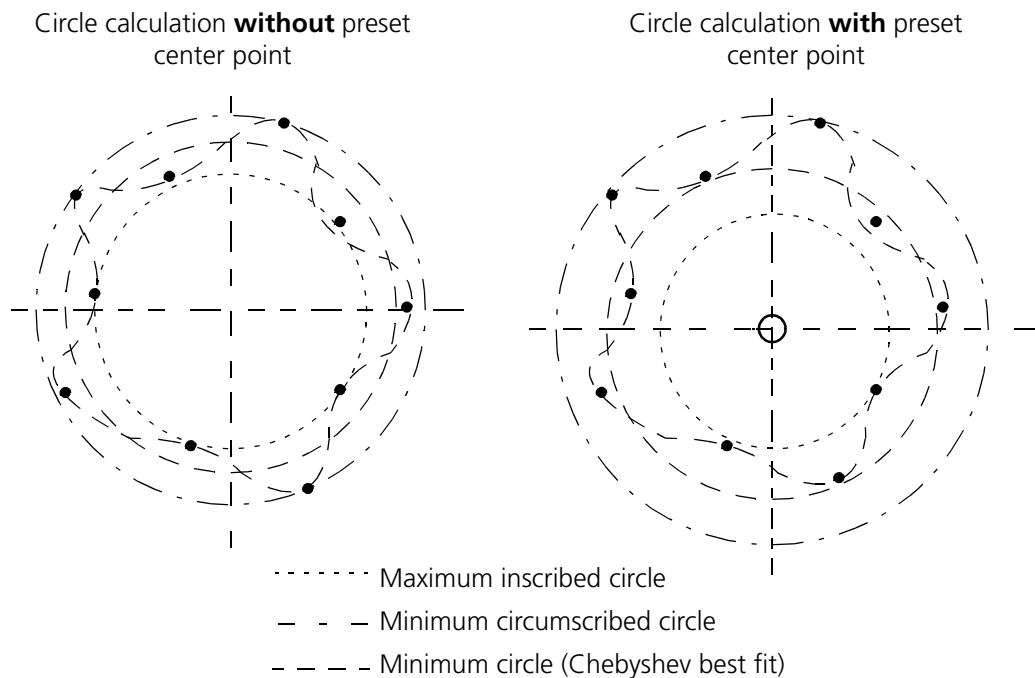
W1
Ny

W2
Nz

Input fields

Element name	If the name allocation is activated <DI 1663> a default name is offered which can either be accepted or overwritten.
Outer tangential surface	<YES> The surface calculated lies on the highest probing.
or inner tangential surface	<YES> The surface calculated runs through the lowest probing (in the material).
or minimum surface	<YES> Chebyshev surface (minimization of the maximum distances).
Surface with specified alignment (perpendicular direction)	<YES> The surface normal is specified by the address of a geometric element through 2 projected angles or by Nx, Ny and Nz of the normal.
Surface perpendicular to another surface	<YES> The current surface is to be perpendicular to another surface. The normal direction of the other surface is specified by the address of a geometric element, by 2 projected angles or by Nx, Ny and Nz of the normal.

Circle best fit



Calculation methods without specifying the center point

Maximum inscribed circle

All points probed lie outside of the contour of the calculated circle.

Minimum circumscribed circle

All points probed lie within the contour of the calculated circle.

Minimum circle

Chebyshev best fit of circle.

Calculation methods specifying the center point

Maximum inscribed circle

The radius of the circle is determined by the probing point with the shortest distance from the specified center point.

Minimum circumscribed circle

The radius of the circle is determined by the probing point with the greatest distance from the specified center point.

Minimum circle

The radius of the circle corresponds to the mean value from the radii of the maximum inscribed and minimum circumscribed circles.

Procedure: ➤ „Procedure“ on page 2-13.

Prerequisite

The last record address must contain a Gaussian circle calculation (may also be a minimum circumscribed or maximum inscribed circle with multiple calls)

At least 180° must be measured for the minimum circumscribed and maximum inscribed circles.

Dialog window

Dialog

Circle calculation

Element name

Maximum inscribed circle
or minimum circumscribed circle
or minimum circle

Specify center point
Address
or coordinates

x

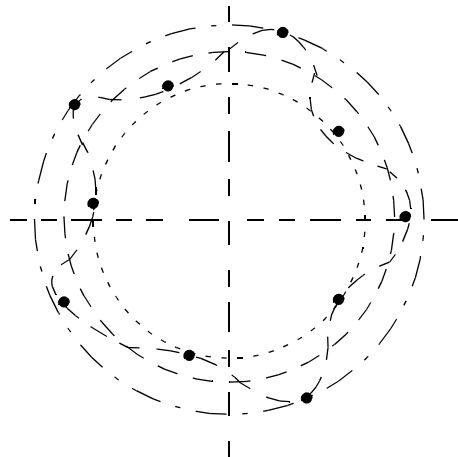
y

Input fields

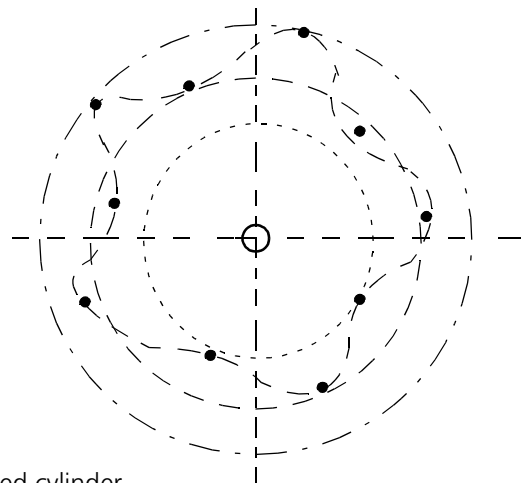
Element name	If the name allocation is activated <DI 1663> , a standard name is offered here which can be accepted or overwritten.
Max. inscribed circle	<YES> All points probed lie outside of the contour of the calculated circle.
Min. circumscribed circle	<YES> All points probed lie inside of the contour of the calculated circle.
Minimum circle	<YES> Chebyshev best fit.
Specify center point	<YES> The center point for the nominal position of the circle can be specified by the address of a geometric element or by coordinates.

Cylinder best fit

Cylinder calculation **without** preset direction and position of the cylinder axis



Cylinder calculation **with** preset direction and position of the cylinder axis



- Max. inscribed cylinder
- - - Min. circumscribed cylinder
- - - Min. cylinder (Chebyshev best fit)

Calculation methods without preset direction and position of cylinder axis

Max. inscribed cylinder

All points probed lie outside of the contour of the calculated cylinder.

Min. circumsr. cylinder

All points probed lie inside of the contour of the calculated cylinder.

Minimum cylinder

Chebyshev best fit.

Calculation methods with preset direction and position of cylinder axis

Max. inscribed cylinder

The radius of the calculated cylinder results from the smallest vertical distance of a probed point from the specified cylinder axis.

Min. circumsr. cylinder

The radius of the calculated cylinder results from the largest vertical distance of a probed point from the specified cylinder axis.

Minimum cylinder

The radius of the minimum cylinder is calculated from the mean value of the maximum inscribed and the minimum circumscribed cylinder.

Procedure: ➤ „Procedure“ on page 2-13.

Prerequisite

The last record address must contain a cylinder calculation.

At least 180° must be probed for maximum inscribed and minimum circumscribed cylinders.

Dialog window

Dialog			
Cylinder calculation			
Element name	<input type="text"/>		
Maximum inscribed cylinder	<input type="text"/>	<input type="text"/>	<input type="text"/>
or minimum circumscribed cylinder	<input type="text"/>	<input type="text"/>	<input type="text"/>
or minimum cylinder	<input type="text"/>	<input type="text"/>	<input type="text"/>
Axis direction specified	<input type="text"/>	<input type="text"/>	<input type="text"/>
Direction as for address	<input type="text"/>	<input type="text"/>	<input type="text"/>
or projected angle	W1 <input type="text"/>	W2 <input type="text"/>	<input type="text"/>
or direction vector	Rx <input type="text"/>	Ry <input type="text"/>	Rz <input type="text"/>
Point on cylinder axis specified	<input type="text"/>	<input type="text"/>	<input type="text"/>
Point as for address	<input type="text"/>	<input type="text"/>	<input type="text"/>
or coordinates	x <input type="text"/>	y <input type="text"/>	z <input type="text"/>
<div> <div>* YES</div> <div>NO</div> <div></div> <div></div> </div> <div> <div>*</div> <div></div> <div></div> <div></div> <div>TERMIN</div> </div>			
<div> <div>BACK</div> <div></div> <div></div> <div></div> </div> <div> <div></div> <div></div> <div></div> <div>INFO</div> </div>			

Input fields

Element name

If the name allocation has been activated via **<DI 1663>**, a default name will be offered here which can also be overwritten.

Max. inscribed cylinder

<YES>

All points probed lie outside the contour of the calculated cylinder.

Min. circumsc. cylinder

<YES>

All points probed lie within the contour of the calculated cylinder.

Minimum cylinder

<YES>

Chebyshev best fit.

Axis direction specified

<YES>

The axis direction can be specified by the address of a geometric element, by the projected angle of an axis or by the direction vector of an axis.

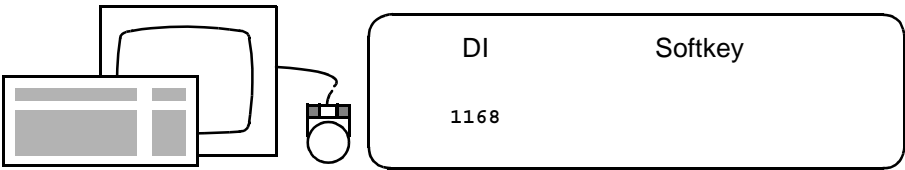
Point on cylinder axis specified

<YES>

The position of the cylinder axis can be specified by the address of a geometric element or by a point on the cylinder axis. A point on the cylinder axis can be specified only if the axis direction has also given.

Best fit of circle into curve (DI 1168)

When fitting a circle into a curve, the two contact points connecting the circle and curve are measured. Both contact points are output with the corresponding angle to the alignment line and the circle which has been fit.



A circle with a specified diameter is fit into a scanned contour. Since the best fit of a circle with a specified diameter into an ellipse-shaped contour already exists, the inputs and outputs have been adapted accordingly. Both types of best fit are called up with the same direct input. The type of calculation must then be selected on the screen page. The outputs differ only regarding the additional text specifying the type of calculation used.

Input

Direct input **<DI 1168>** results in display of the following screen page. The new feature offered here is the possibility of selecting the method of calculation. **Fit circle to ellipse-shaped curve part** corresponds to the previous function of **<DI 1168>**. **Fit circle to any curve part** is the new method of calculation. The previous method is automatically selected after power-up. Following each subsequent invocation, the type of calculation last selected is preallocated.

Dialog

Fit circle to curve

Result name

Measuring plane

yz

or

zx

or xy

Circle diameter

Calculation method

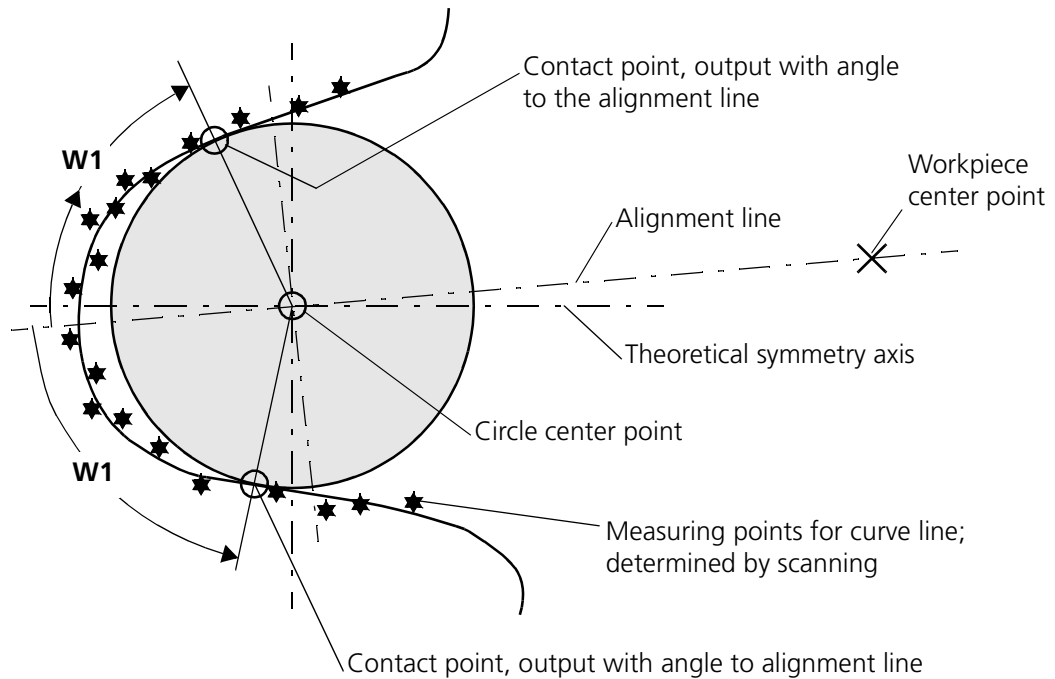
☐ Fit circle to ellipse-shaped curve part
 ☐ Fit circle to any curve part

The screen page for geometric elements then branches.

Output

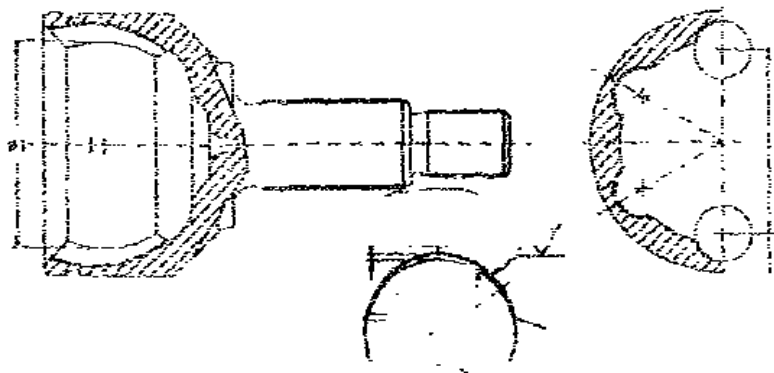
The method of calculation used, the best fit circle with specified diameter and calculated center point, the two contact points of the circle and contour and the best fit circle as an ellipse are output.

The ellipse is output only because an ellipse was calculated and output acc. to the method previously used.



Example

Measuring record for best fit of circle into curve



```

1      Alignment
      DISPLACEMENT
      X      0.0000
      Y      0.0000
      Z      0.0000

2      SURFACE
      Z      -273.9922
      X/Y W1  -0.2574
      Y/Z W1   0.4242
      4P S/MIN/MAX      0.153      (3)  -.0084      (1)  .0077

3      ROTATE SPACE
      W      -.4961

4      ZERO POINT
      Z      -273.9820

5      CIRCLE A
      X      406.0349
      Y      -283.8044
      D      91.7606

6      ZERO POINT
      X      406.0349
      Y      -283.8044

7      CIRCLE I
      X      0.1785
      Y      28.4949
      D      21.4098
      249P S/MIN/MAX      .0172      (196)  -.0320      (249)  .0401

8      CIRCLE A RECALL ( 5) WITH TRANSFORMATION
      X      0.0000
      Y      0.0000
      D      91.7606

9      CIRCLE I RECALL ( 7) WITHOUT TRANSFORMATION
      X      0.1785
      Y      28.4949
      D      21.4098
      S      0.172      FORM .0721

10     ROTATE PLANE AROUND SPACE AXIS Z
      W      .3589

11     ZERO POINT
      X      0.0000
      Y      28.4955

      Fit of circle in ellipse-shaped curve

12     CIRCLE
      X      0.2190
      Y      -0.0997
      D      19.0500

13     POINT
      X      -8.1199
      Y      4.2528
      Y/X W1  -28.8989

14     POINT
      X      8.6914
      Y      4.2528
      Y/X W1  27.1903

15     ELLIPSE
      X      0.2093
      Y      -0.7525
      D1      19.3545
      Y/X W1  179.1457
      D2      20.7173
      228P S/MIN/MAX      .0026      (1)  -.0096      (25)  .0065

```

=====

CNC - END

=====

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