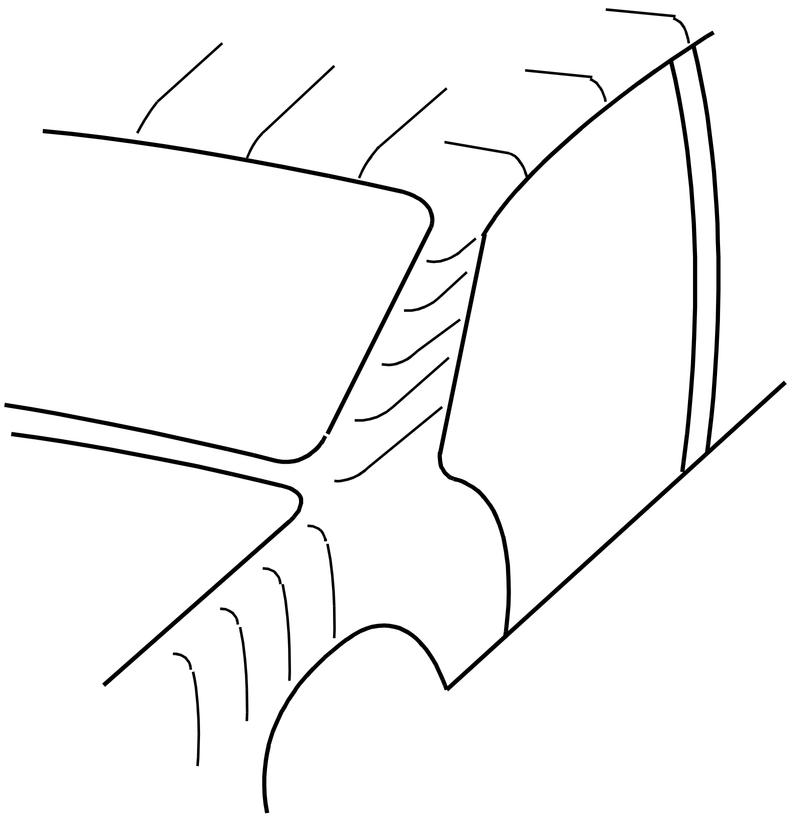
KAM

Car Body Measurement



Operating Instructions

ZEISS

Carl Zeiss
Industrial Metrology
Business Group
D-73446 Oberkochen

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Foreword

These operating instructions describe the performance and handling of **KAM** software for car body measurement.

It is here assumed that the operator is familiar with the CMM and the **UMESS** basic software. Please keep all of the documents included in the scope of delivery available at all times.

We reserve the right to modify the version and scope of delivery of the CMM and revise the software packages and the corresponding documentation.

Conventions in these operating instructions

Before beginning work with these operating instructions you should first familiarize yourself with the conventions used here.

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 reference to a **reference element** ."
  - File and directory names
    Example: **/home/zeiss/UB**
- *italics*
  - A highlighted text whose contents are especially important
    Example: "Click with the *right* mouse button ..."
  - Cross reference
    Example: "..., see also ➤*„Characters and symbols“ on page -4“*
- **`Courier bold`**
  Text in dialog boxes and protocols (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 or the workpiece.

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

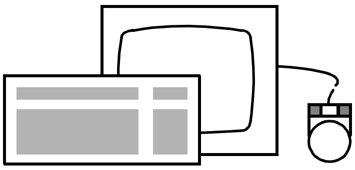
Symbol for function call-in

Several possibilities exist:

– Direct selection via a DI number

– Function selection via a softkey

Example:



```
DI 3800
<MACRO>
<S MACRO>
```

TERMIN

Symbol for softkey

References to softkeys in dialogs are displayed as follows.

Chapter overview

These operating instructions describe the function, handling and possible applications of the KAM measuring program.

The following topics are covered:

➤*„Introduction“ on page 1-1*

➤*„Point measurements“ on page 2-15*

➤*„Fast Contour Control (FCC)“ on page 3-45*

Contents

Chapter 3 Fast Contour Control (FCC)

Chapter 1

Introduction

KAM Car Body Measurement Software is a program for the automatic measurement of points and contours on car bodies.

This chapter contains:

Possibilities

– Measurement of points on curved surfaces with calculation of surface normals, including the determination of virtual points as they occur in car bodies with rounded edges.

– Fast Contour Control (FCC) with output of best-fit results (as a substitute for multiposition measuring gages).

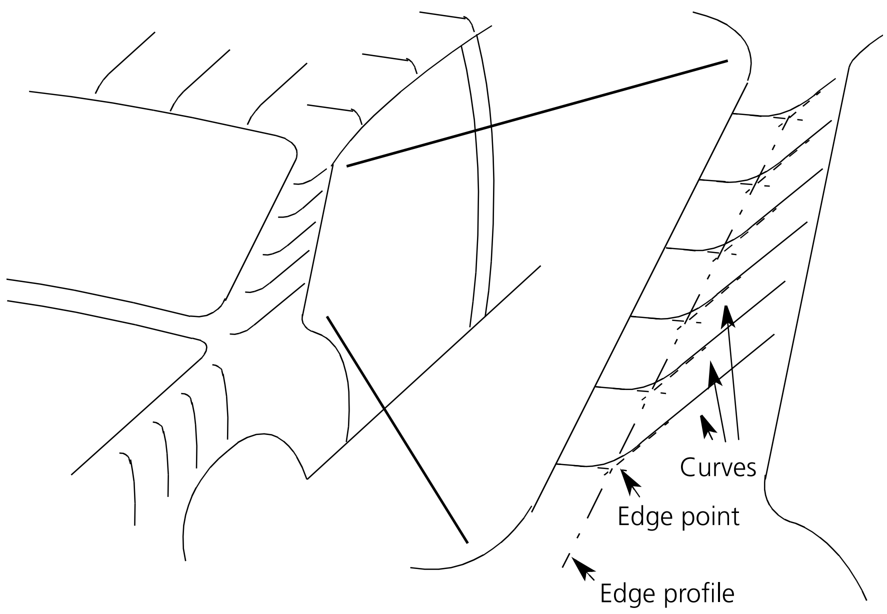
In principle this program can be used for all workpieces where similar measuring tasks are involved.

The prerequisite for using KAM is nominal data which can be produced or transferred in different ways, e.g. generated from a KUM or VDA file or transferred via a VDA interface.

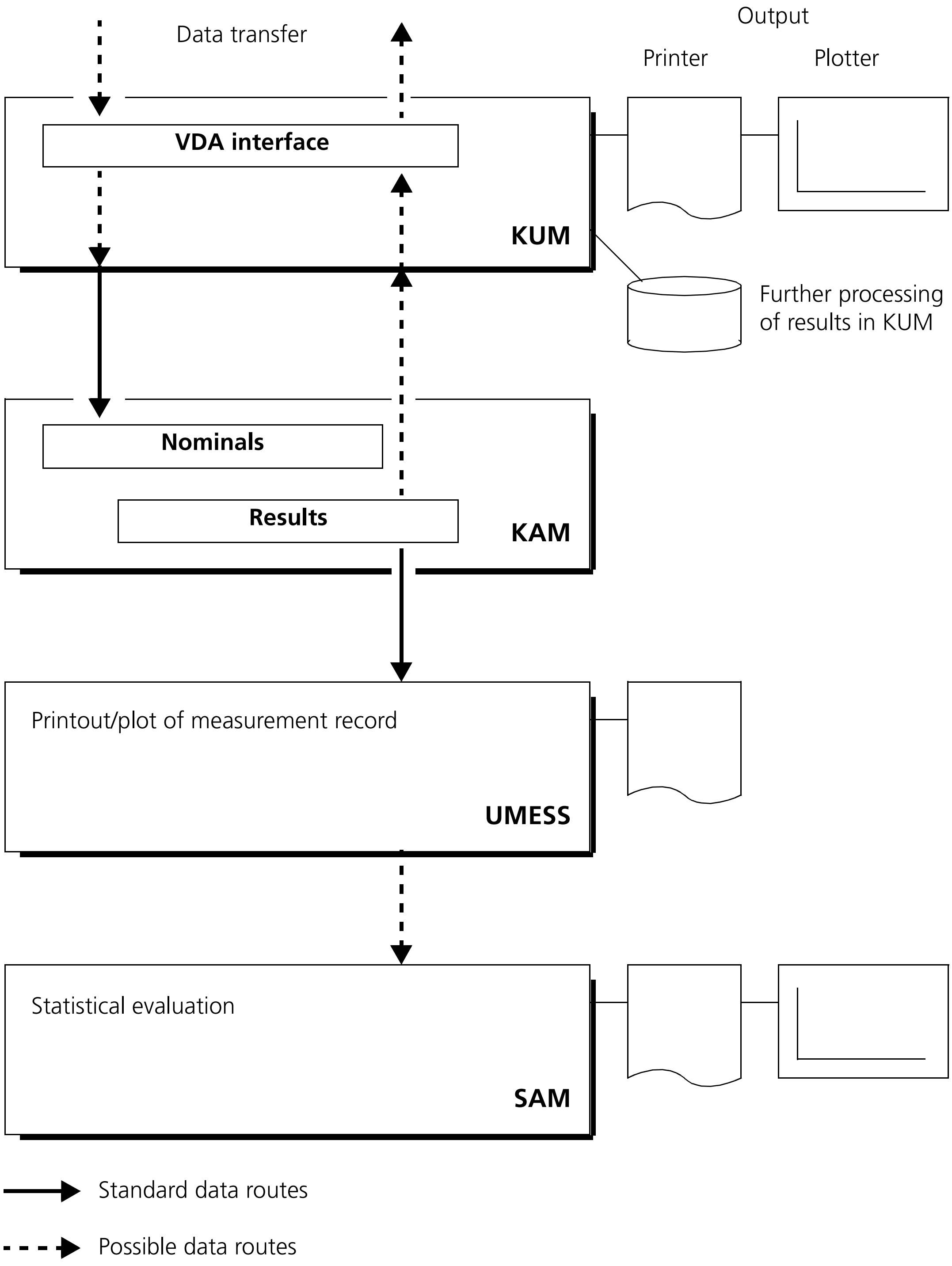
The program executes an automatic or a semi-automatic run based on the nominal data. If required, the data acquired can be stored in a data file. Further processing, e.g. plotting, printing and conversion, is also possible.

Example

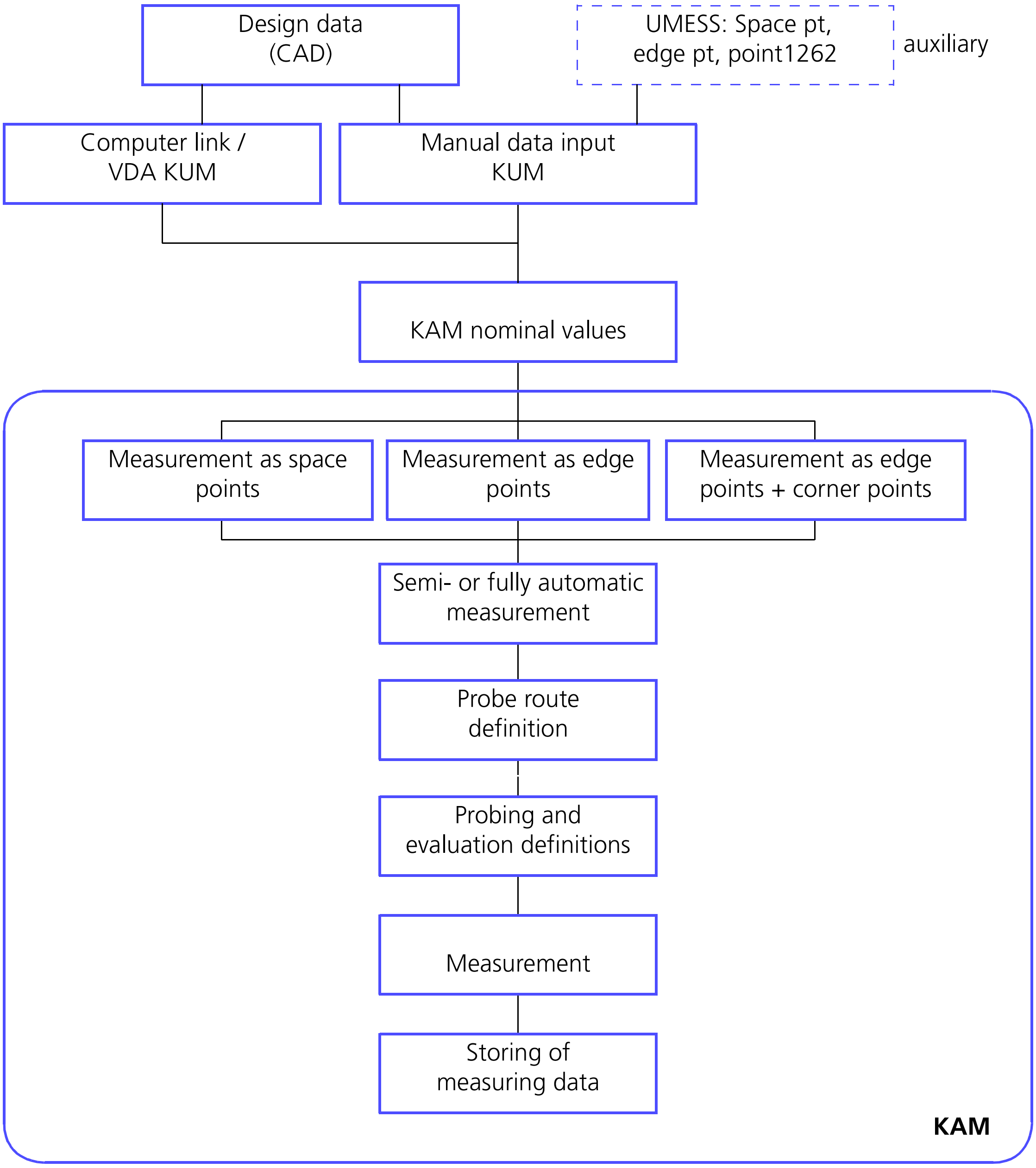
Use of edge points in car body measurement



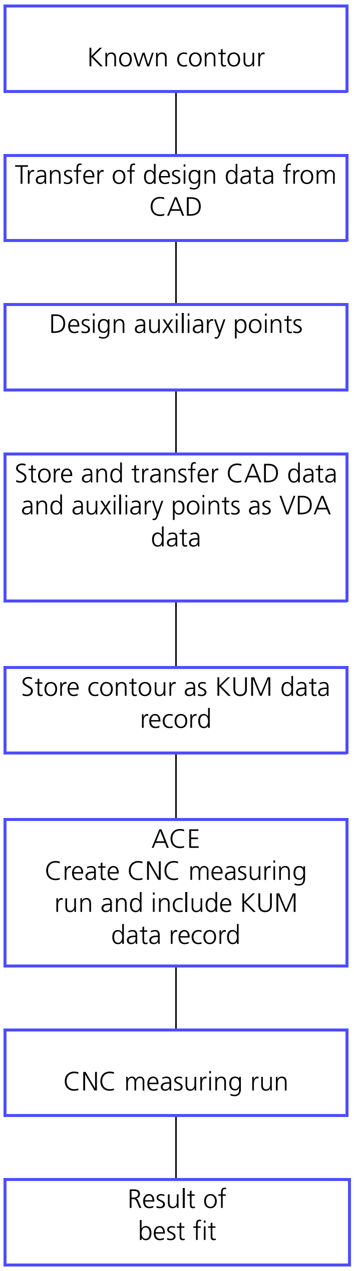
Interaction of KAM (only 3D, edge and corner points) with other programs



Flow chart for 3D, edge and corner points



Flow chart for Fast Contour Control (FCC)



Chapter 2

Point measurements

This chapter contains:

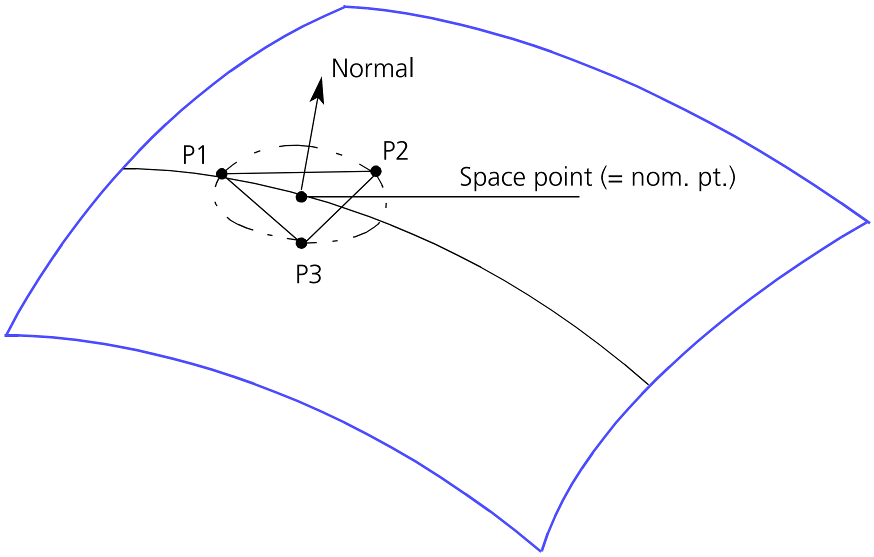
Definitions

Space point

A space point is a point on any surface. It is clearly defined by three coordinates (X, Y, Z) and the normal direction of the surface at this point (A1, A2 or Nx, Ny, Nz) see Option 6 in the UMESS Operating Instructions.

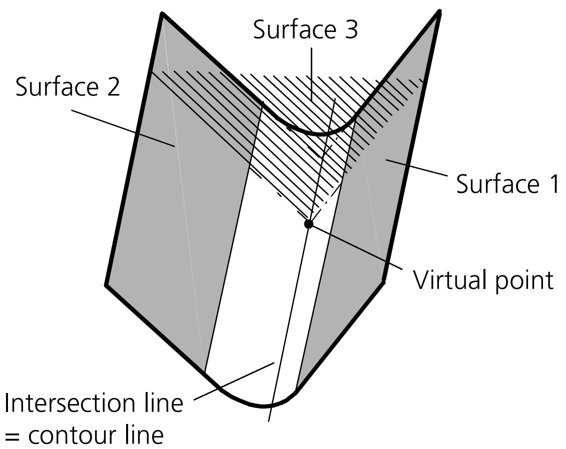
Probing procedure

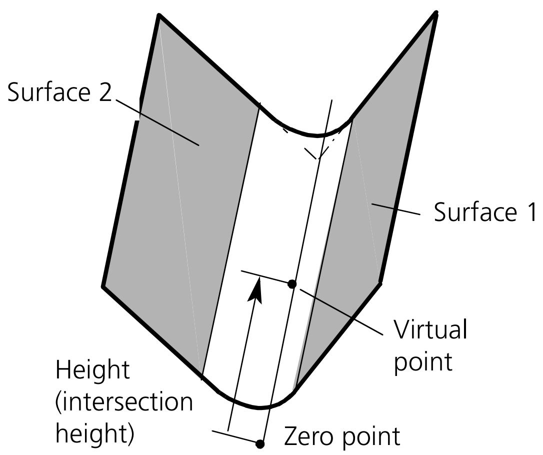
If the normal is not known, three points are probed automatically on the circle around the given point. The radius and start angle of this circle can be preselected. The normal is calculated from these three probings. Using the auxiliary normal, the nominal point is probed in the normal direction and a normal is again defined with three probings. If the difference between the two normals falls below a limit value, the determination of the space point will be terminated. The result is output. Otherwise an iteration will be executed (up to max. 5 times).



Edge point

An edge point is a virtual (imaginary) point resulting from the intersection of three surfaces or two surfaces and a specified height.





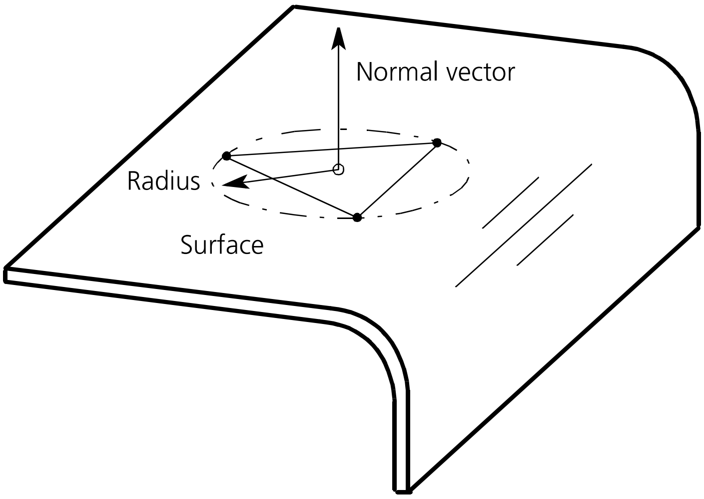
In contrast to physical points, edge points can not be probed directly.

Determination of edge points

Determination of two surfaces and their intersection line. Points located on this **edge profile** are the edge points wanted. They are determined by the relevant **intersection height**. The two surfaces are represented by two space points.

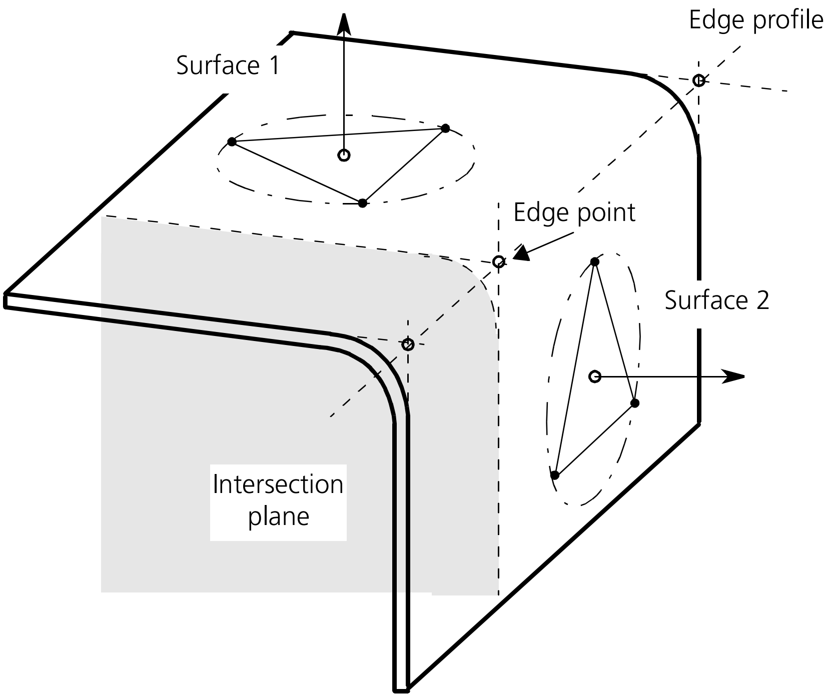
Probing procedure

To determine the surface or its normal, three points on a circle are automatically probed around the given point. The radius and start angle of this circle can be preselected. The surface and its normal vector are determined by these three probings.



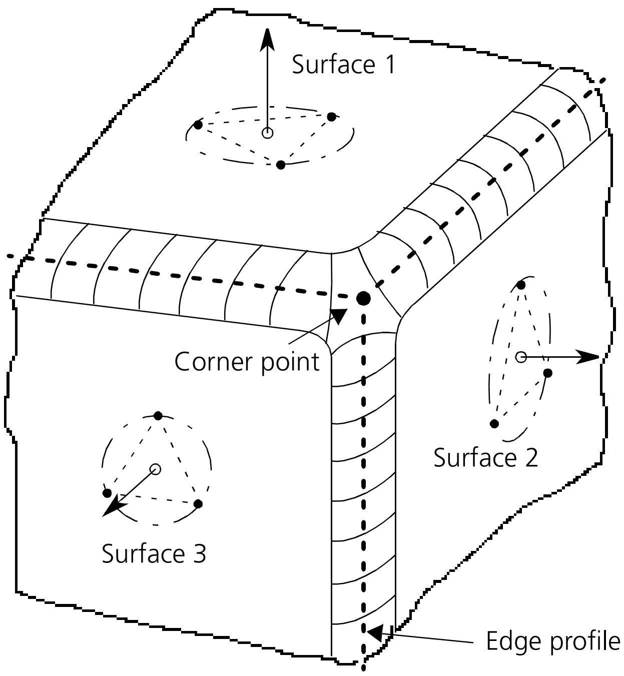
A second surface is determined in the same way. The intersecting line of the two surfaces is called the edge profile.

The edge point forms the piercing or penetration point of the edge line through the intersection plane determined at a specified height.



Corner point

A corner point is the intersecting point of three surfaces, each of which is determined by a space point. A corner point can also be generated manually by recalling three space points.

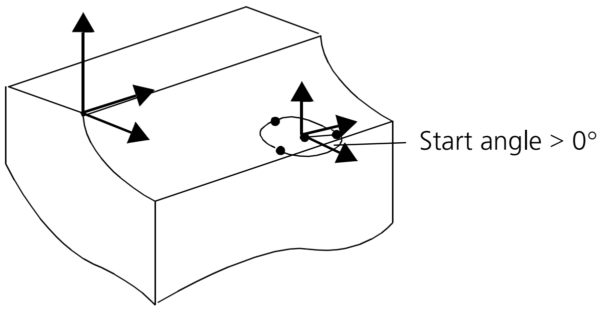


Start angle

Probing direct.	EBKZ	START ANGLE counts from
+X, -X	1	+Y counterclockwise (mathematically
+Y, -Y	2	+Z positive); for **START ANGLE = 0,** the first
+Z, -Z	3	+X auxiliary point is located on the axis

Application example

Space point located very close to an edge.



Semi-automatic or fully automatic measurement

If fully automatic measurement is selected, the machine travels via the nominal point and executes probings automatically.

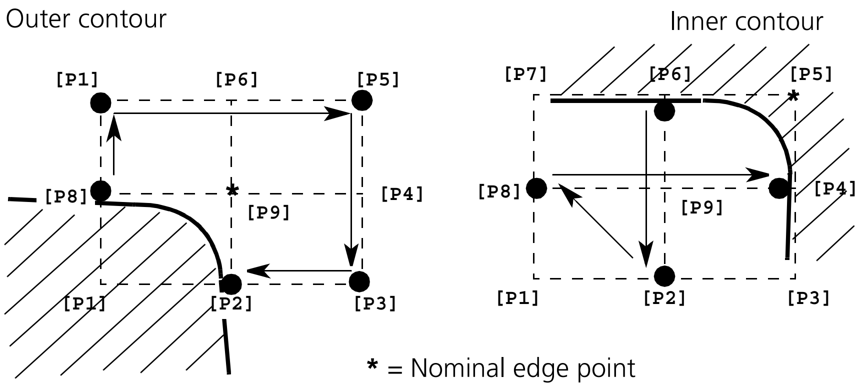
If semi-automatic measurement is used, the machine travels via the nominal point and waits for a manual probing after an acoustic signal sounds. Then the normal is defined automatically.

Semi-automatic measurement is therefore advisable in confined probing spaces and when measuring workpieces with coarse tolerances.

Travel path

When measuring edge points, the automatic run is generated with minimum programming effort: The position where the probing is to take place and the intermediate positions via which the probing points can be reached without collision are determined for each curve.

The position and sequence of the probings and intermediate positions are determined in the travel path rectangle. With an outer contour, **P9** of the rectangle must be placed in the nominal edge point. With an inner contour, one of the corners of the rectangle (**P1**, **P3**, **P5**, **P7**) must be placed in the nominal edge point.



You can define the travel path in one of two ways:

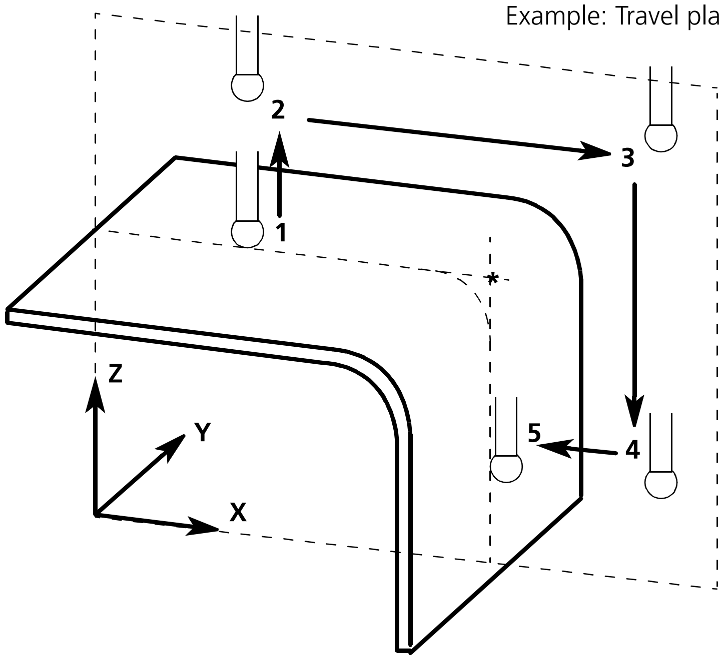
– Place the travel path rectangle in the applicable travel plane and define the probings and intermediate positions required or

– Determine the applicable travel plane so that you can then take the applicable code from the travel path definition tables. Then enter this code in the KAM travel path definition input mask with **<DEF STOR>**.

Important:
The following rules must be strictly observed to prevent collisions.

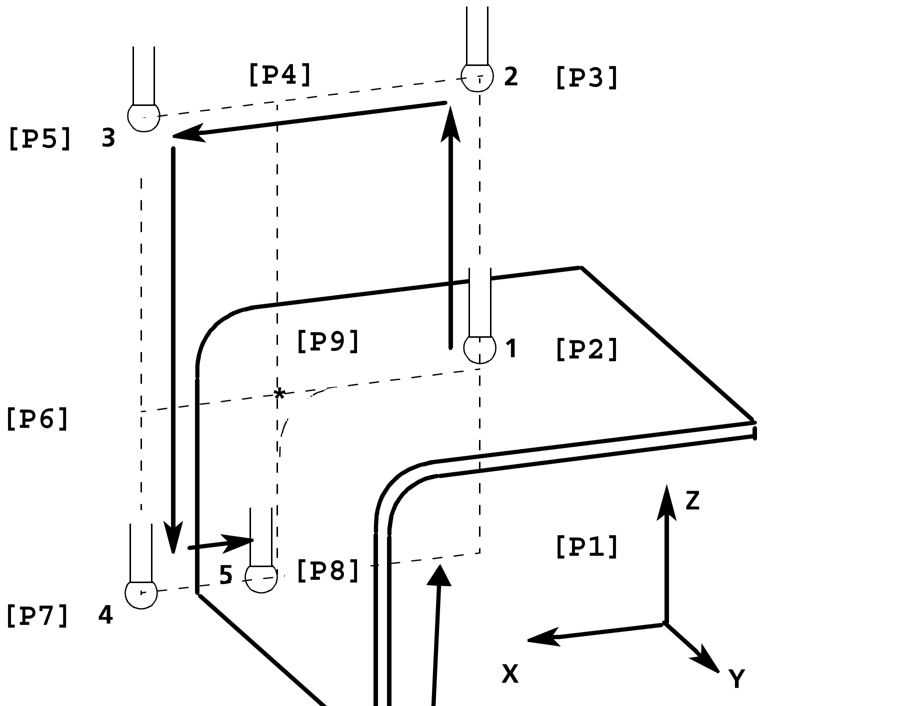
1 Define the travel plane (see drawing)
2 Assign the travel path rectangle to the travel plane.
3 Enter the sequence of the probings and intermediate positions in fields **P1 - P9** of the KAM travel path definition input mask (input mask ➤*„Defining travel paths for edge points“ on page 2-34*).
   or:
   Determine the applicable code using the tables for travel path definition and enter it in the KAM travel path definition input mask with **<DEF STOR>**.

Example: Travel plane = X-Z



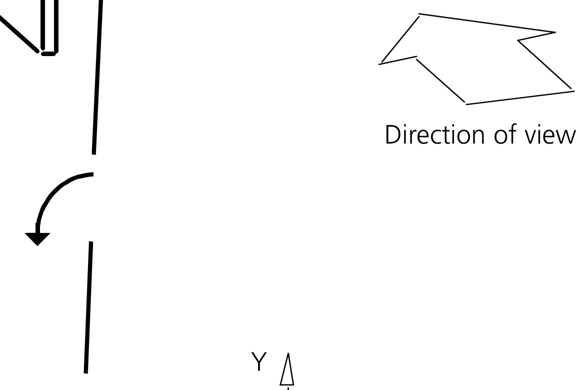
In special cases, you can deviate from the point plane specified in the tables for travel path definition. A minimum of 3 travel path positions must be designated.

Points **P1 - P9** are always assigned from a perspective looking from the positive direction of the 3rd axis onto the travel plane:

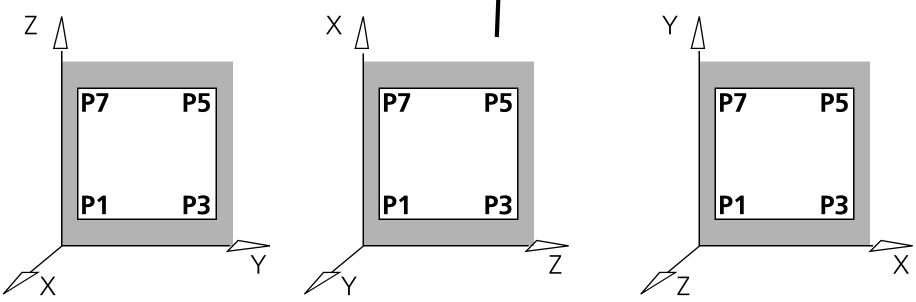


Note:

The orientation of the travel path rectangle must correspond to the workpiece coordinates.



Therefore for correct assignment of **P1**-**P9** the travel path rectangle must be rotated 90° in the XZ travel plane.

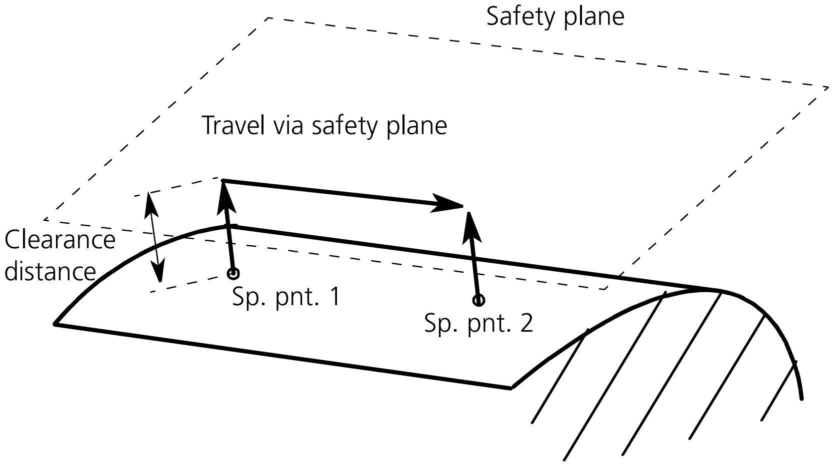


PCN = 1 PCN = 2 PCN = 3

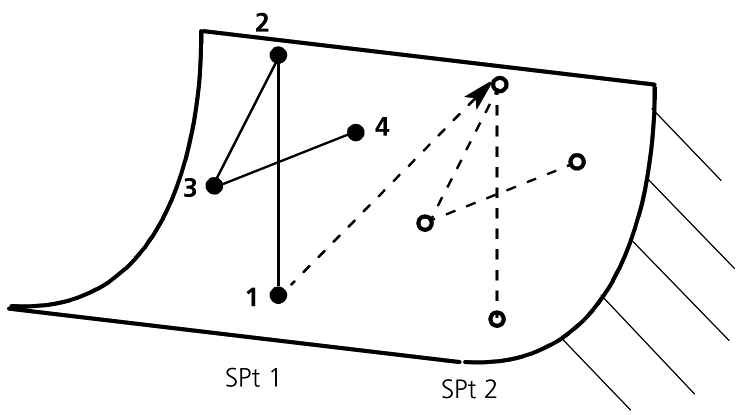
Safety (clearance) plane

With outer contours, a safety plane is specified to enable collision-free travel around the workpiece.

After measuring a space point (edge point), the probe is positioned in the safety plane (preselectable) in front of the next space point. The next space point is probed starting from this point. Probing is performed automatically or manually, depending on the given mode of measurement.



With inner contours, travel over the safety plane would lead to collisions. In such cases a travel path position is used to retract or back away the probe instead of the safety plane. See explanations on clearance distance ➤*„Value definition" on page 2-30*.



Measurement

Requirements

In principle nominal data are required to measure and process space, edge and corner points using KAM.

- The nominal data are allocated to a KUM workpiece. Each set of nominal data is assigned to a curve.
- During the measuring operation, the actual data can be allocated to these nominal data and processed in all operations available in KUM (plotting, printing, etc.).

Nominal data can be generated from:

- transferred VDA data,
- input (edited) data,
- auxiliary measurement in KUM,
- Measurement with the KAM space point macro followed by conversion from measuring data to nominal data.

Options

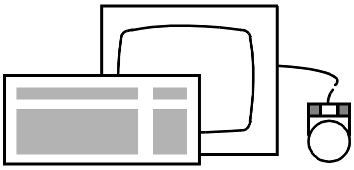
The KAM measuring options are listed in the following table.

Measuring Mode	Space pnt.	Edge pnt.	Edge pnt. + corner pnt.	Corner pnt.
Fully automatic	X	X	X	
Semi-automatic	X	X	X	
Single meas. manual				X
Single meas. fully aut.	X	X		
Single meas. semi-aut.	X	X		

Calling basic functions

The SAM basic functions input mask forms the platform for invoking individual KAM functions

Function call



<DI 3800>

Input mask

```
KAM - Basic functions

<VDA=>NOM>        VDA - data ==> NOMINAL data
<MEA=>VDA>        MEASURED data ==> VDA data
<MEAS/SOL>        Meas. acc. to NOMINAL data
<MACRO    >       Macro - Space/edge/corner pt

|        |        |VDA=>NOM|MEA=>VDA|   *   |MEAS/NOM| MACRO  |        |        |
|  BACK  |        |        |        |       |        |        |        |  INFO  |
```

Softkeys

MEAS=>VDA

VDA=>NOM

A VDA data file is converted into a NOMINAL data file and vice versa (see KUM).

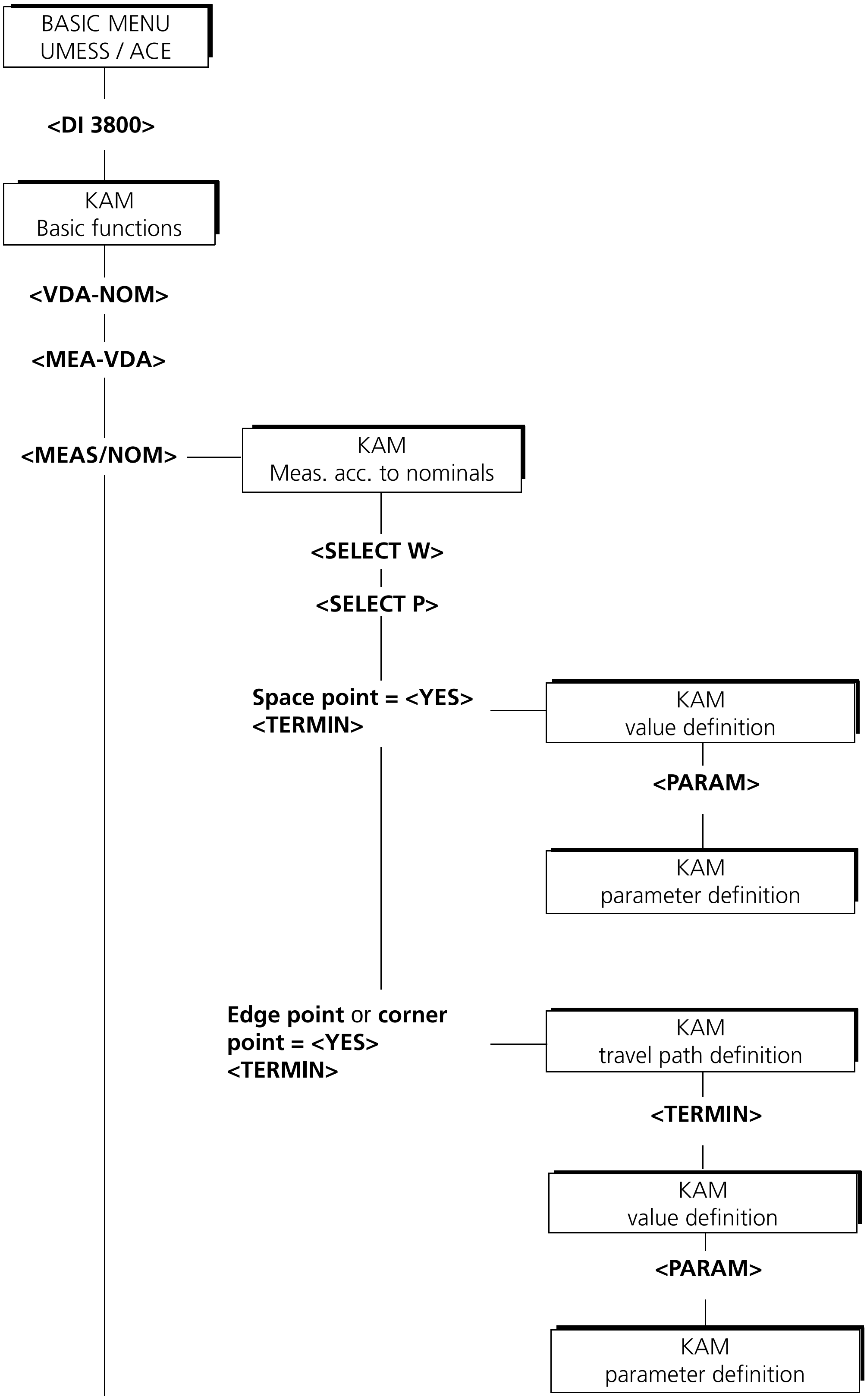
MEAS/NOM

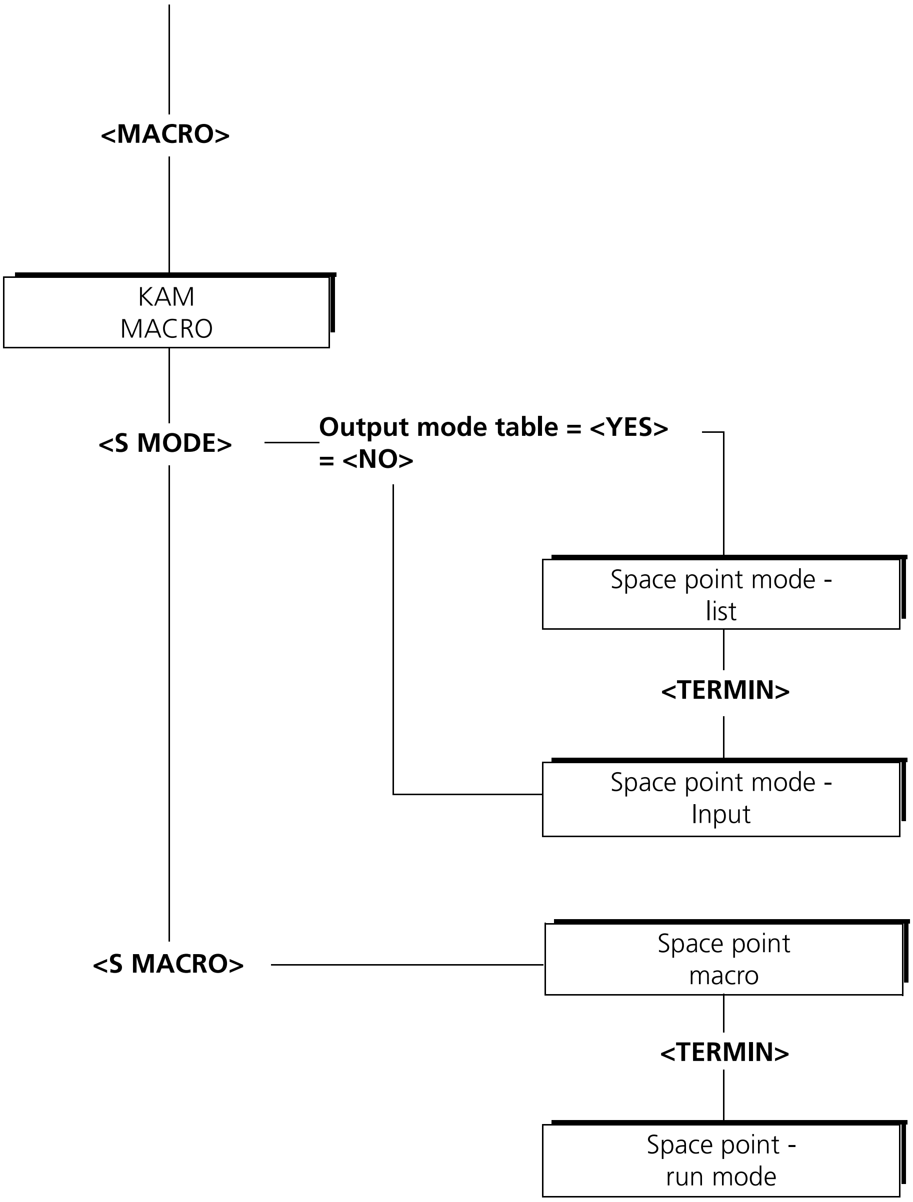
Measurement according to nominal data. Using data from the nominal data file, the probe is positioned to a predefined safety plane. Then a space point, an edge point or a corner point is determined.

MACRO

Measurement of the important elements, selection via softkey.

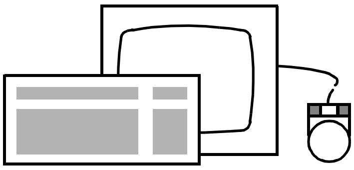
Branching of input masks in the KAM basic menu




<MACRO>
KAM MACRO
<S MODE>
Output mode table = <YES>
= <NO>
Space point mode - list
<TERMIN>
Space point mode - Input
<S MACRO>
Space point macro
<TERMIN>
Space point - run mode

Measurement according to nominals

Function call



<DI 3800>
<MEAS/NOM>

Input mask

```
KAM - Measurement acc. to nominals

W name          SKK
W number          2          P number    1          from curve  1          to curve     1
Automatic run

                          fully automatic      semi automatic        Single meas.
Space point
Edge point
Corner pt
Edge point with
corner pt
Cube

Accept previous point numbers ?
Single points
   1.    0     2.    0   3.    0   4.    0   5.    0   6.    0   7.    0   8.    0   9.    0
  10.    0    11.    0  12.    0  13.    0  14.    0  15.    0  16.    0  17.    0  18.    0
  19.    0    20.    0  21.    0  22.    0  23.    0  24.    0  25.    0

| * YES | NO       | POSITION | STEP     |   *   | I-POS    | DSE POS | PRB CHAN | TERMIN |
| BACK  | PRE MENU |          | SELECT W |       | SELECT P |         | COMB CHA | INFO   |
```

Softkeys

SELECT W For branching to the **KUM WORKPIECE SELECTION** input mask

SELECT P For branching to the **KUM METHOD FOR PART NUMBER SELECTION** input mask.

Input fields

W name, W number Display of preselected workpiece. Change possible via **<SELECT W>**.

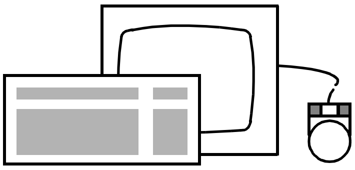
P number Part number (see KUM parts management)

from curve, to curve Start curve number and end curve number (see KUM curve administration)

Automatic run	Measurement of all curves entered with parameter definition.
Space point	Semi-automatic, fully automatic or individual measurement of space point (individual points specified in nominal data file).
Edge point	Measurement of edge point. Determination of two space points (semi- or fully automatic) and calculation of edge point.
Cornerpt	Manual measurement of corner points by probing 3 space points.
Edge point with cornerpt	Measurement of edge points along several edges. The corner point is measured when the edge is changed. The point number of the corner point must be entered under **Single points** in input field **1** (see below). Note on program: After the edge points of the 1st edge have been generated, the program waits for manual probing of 3 space points. To avoid collisions, probe the space point which is almost parallel to the safety plane last. The program then generates the edge points of the next edge automatically.
Edge point with Cube	Special function
fully automatic	The measurement is fully automatic (1st normal = probing direction).
semi automatic	A path is traveled on the safety plane according to nominal data. At the same time the probe tip is positioned to 5 mm + probe radius from the nominal point. Following a signal the measurement can be performed using the joysticks.
Accept previous point numbers?	The points preselected in the next input field are accepted.
Single points	Selection of max. 25 points from the nominal value file. A point number of the nominal file is assigned to each of the individual input fields.

Value definition

Function call



```
<DI 3800>
<MEAS/NOM>
Space point = <YES>, TERMIN>
```

Input mask

```
KAM Value definition

File name          S__020101_DATK       Curve number      1

from point                      1         to point    9999   Probe number       1

Clearance distance    10.0000     Deter. of normals            Tolerance input
                                                                UTOL        LTOL
Safety plane          +YZ * -YZ   Radius         0.1000   X   0.0000 /   0.0000
                      +ZX   -ZX   St angle         0.00   Y   0.0000 /   0.0000
                      +XY   -XY   Max. iterations     1   Z   0.0000 /   0.0000
Output in                                                 D   0.0000 /   0.0000
     - Netpoint coordinates     Space point coord.

Meas. data - Format  MSW1000        Storage mode 1          Delete file first
File name       - I__020101_DATK    Storage mode 2

Meas.data - Format       VDA         /CZ_MES_UI/I020101 _____B

| * YES | NO | POSITION | STEP |  *  | I-POS | DSE POS | PRB CHAN | TERMIN |

| BACK | PRE MENU |      | TEXT |     | PARAM |         | COMB CHA | INFO   |
```

Softkeys

PARAM

Branches to the KAM parameter definition input mask.

Input fields

File name, Curve number

The file name is defined in the KUM administration, display only.

from point, to point

Start point, end point (within the nominal value file),

Probe number

Number of the probe to be used.

Clearance distance

Distance referenced to the nominal point or workpiece zero point. **0** should be entered as clearance distance for inner contours to avoid collisions. In this case the probe travels to the back-away position nmax/2. **n** = number of the travel path position, uneven numbers are rounded off.

Examples:
Travel path positions = 1 to 4, back-away position = 4 / 2 = 2,
Travel path positions = 1 to 5, back-away position = 5 / 2 = 3.

Deter. of normals

<YES>
The program automatically determines the normal with iterative measurement.

<NO>
Edge point: The direction normal is determined from the probing direction. Space point: If nominals contain the normal.

Tolerance input

<YES>
A tolerance input is possible.

Safety plane

Select safety plane required with **<YES>**. If the safety plane is displaced by positive values in relation to the position of the workpiece, then its sign is positive and vice versa.

Radius

Input of the circumference radius for determination of the normal.

St angle

Angle between the positive X axis and the 1st corner point of the definition triangle when defining the normal.

Max.iterations

Max. number of iteration loops for space point measurement.

Output in - Netpoint coordinates

Output of the two nominal coordinates in the probing plane and the actual coordinate in the probing direction.

Output in - Space point coord.

Output of actual coordinates of the probing point.

Storage mode 1, mode 2

A measured value is produced for every nominal point and stored under this number in storage mode 1.

In storage mode 2 the measured values are stored in succession. There is no longer any assignment to the nominal points.

Delete file first

The file is deleted before new values are stored.

File name KUM

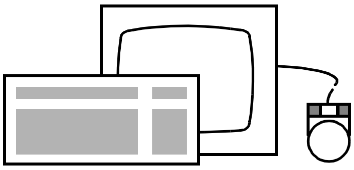
The computer proposes a default file name which can be modified.

Meas. data - Format VDA

<YES>
The measuring data generated using the nominal data file is stored in a VDA file. The file name can be edited.

Defining parameters

Function call



<DI 3800>
<MEAS/NOM>
Space point = <YES>, <TERMIN>
<PARAM>

Input mask

```
KAM - Defining parameters

Distance between intermediate positions
bef Probing (trigger ph)                  0.0000
after probing (trigger probe head)        1.0000

Distance between normals with the space point measurement
bef probing                               0.0000
after prob.                               0.0000

Generated intermediate positions        Position of the safety plane related to
     as rough position             *         Space point/edge point        *
or as fine position                     or workpiece zero point

Probe change with edge point measurement ?

| * YES | NO       |  |  |     *     |  |  |  | TERMIN |
| BACK  | PRE MENU |  |  |           |  |  |  | INFO   |
```

Input fields

Distance between intermediate positions bef Probing (trigger ph) after probing (trigger probe head)

Both values for the trigger probe head must be > 0. These values are entered in the control data in the programming mode.

Distance between normals with the space point measurement bef probing after prob.

These values are taken into consideration only in the case of a space point measurement with existing nominal normals. This information is important if nominal values were measured with the KAM macro.

Generated intermediate positions as rough position or as fine position

Generated intermediate positions are approached in the form selected. They are stored correspondingly in the programming mode.

Position of the safety plane related to Space point/edge point or workpiece zero point

The safety positions are defined based on the space or edge point to be measured or based on the workpiece zero point.

Probe change with edge point measurement

<YES>
The required probe numbers are requested after concluding the KAM value definition input mask.

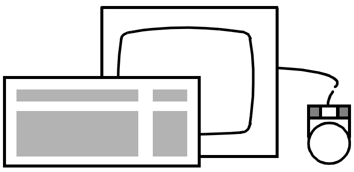
Defining travel paths for edge points

The travel path can be defined with this page. The basis for this is a rectangle with a width (W), a height (H) and 9 defined positions **P1-P9**.

This rectangle is positioned to the nominal edge point with its reference point (*****). The order in which the points are traveled to is defined by numbers 1-8 in the positions marked **P1-P9**. Positions not needed are marked with a minus (-) sign ➤ *„Travel path" on page 2-20* in the appendix.

The direction and rotating sense in the travel path rectangle must be defined as seen from the appropriate *POSITIVE* semiaxis.

Function call



<DI 3800>
<MEAS/NOM>
Edge point / cornerpt = <YES>, <TERMIN>

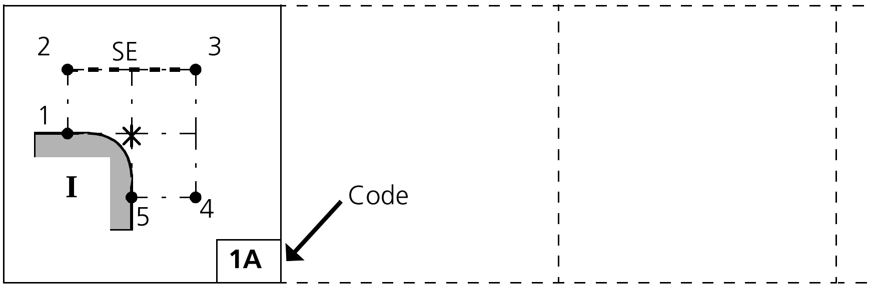
Input mask

```
KAM - Travel path definition

                                               Curve number        1
                                                                     Axis:
                                                                     (W)  (H)
2[P7]########-[P6]##X######3[P5]     Detour plane        - YZ         Y    Z
#            #      !      #                             - ZX         Z    X
#    B1      #    B2! H2   #                             - XY *       X    Y
X-----------(B)-----+-----X               Symbol definition -
#            #      !      #              '*'  ==> Ref. point
1[P8]########*[P9]  (H)  ###-[P4]    '1'-'8'  ==> Travel path pos.   >= 3 Pos.
#            #      !      #              '-'  ==> Lock position     <= 5 Pos.
#            #      !      #
#            #      ! H1   #          Size of rectangle         Aspect ratio
#            #      !      #          Width  (W)          40    B1/B2    1 /  1
-[P1]########5[P2]##X######4[P3]      Height (H)          30    H1/H2    1 /  1

                                      PRB routes corr. edge point?

 * YES  | NO        |     |     |      *     DEF STOR |     |     | TERMIN

 BACK   | PRE MENU  |     |     |                     |     |     | INFO
```

Softkeys

DEF STOR

Selects the input field where the code from the travel path definitions can be entered from the table. Fields **P1-P9** are assigned correspondingly by pressing **<TERMIN>**.



Input fields

Curve number The current curve number is displayed for information.

P1-P9 Positions, permissible input /figure **1-8**/"**-**"/"*****"/

Detour plane Determination of the location of the rectangle.

NOTE Make absolutely sure that the definition for plane ZX is correct (assignment of abscissa, ordinates).

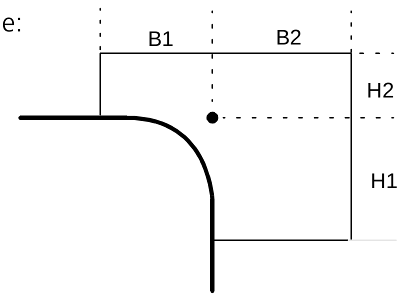
Size of rectangle Input in mm

Aspect ratio Aspect ratio for total widths/heights.

e.g.: Ratio of 1/3 divides W (H) into 4 parts,
W1 (H1) = 1 part, W2 (H2) = 3 parts

This makes it possible to position the required point anywhere in the rectangle.

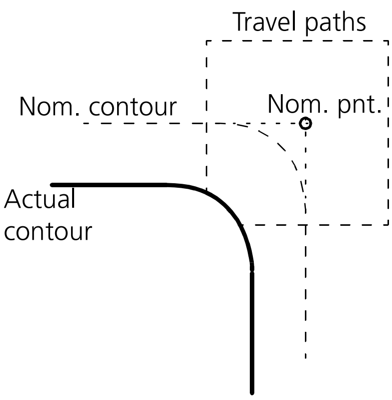
Example:



PRB routes corr. edge point?

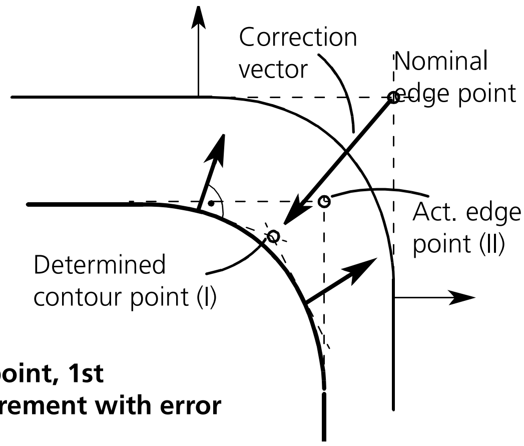
<YES>
The correction vector is taken into consideration during the travel path. The correction for the first edge point determines a correction vector from the nominal to the actual edge point. A new correction vector is defined for each edge point. For every edge point, the travel paths are corrected with the correction vector of the previous edge point.

Example



Probing points result from the shifted contour near the curve.

This undesirable effect can be avoided by probe route correction.

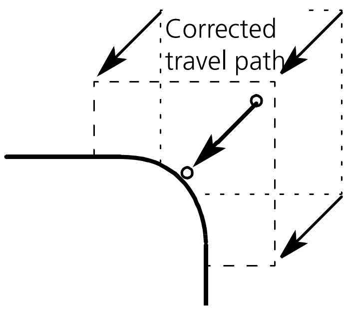


Edge point, 1st measurement with error

Here an edge point (I) is first determined with the given travel paths.

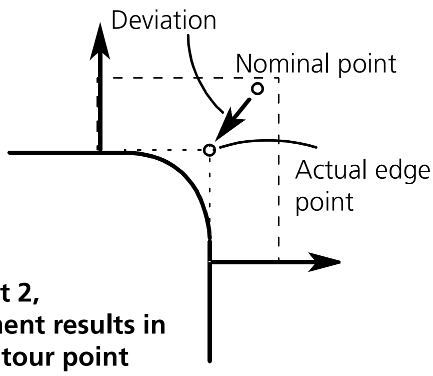
This determined edge point deviates from the wanted actual contour point (II).

The vector from the nominal contour point to the found contour point is used as the correction vector. All travel paths are shifted around this vector.



Edge point 2, measurement with corrected travel path

When measuring with a corrected travel path, the probing points are no longer near the curve.



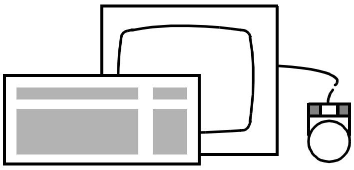
Edge point 2, measurement results in actual contour point

The deviation from the nominal contour is now determined with the actual edge point.

KAM macro

This menu enables selection of the most important elements in the car body measurement program.

Function call



<DI 3800>
<MACRO>

Input mask

KAM - MACRO

IP/PRB	DSE POS	STEP	POSITION	*	SPACE PT	EDGE PT	P-EDG PT	CORNERPT
BACK	NOMINAL	RECALL	TEXT		S MODE	S MACRO		INFO

Softkeys

S MODE

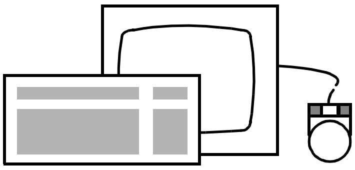
Branch to the "Space point mode input" input mask.

S MACRO

Branch to the "Space point macro" input mask.

Defining the space point mode

Function call



<DI 3800>
<MACRO>
<S MODE>

Input mask

```
Input run mode - Space point

Output mode table?


| * YES | NO |  |  |     *     |  |  |  |  |
|       | CANCEL | |  |           |  |  |  |  |
```

Softkeys

YES

Displays the parameters of the runs stored in the program memory on the screen. This list can also be printed out by pressing the **<PRINTER>** softkey. The **Space point mode - List** input mask can then be opened with **<TERMIN>**.

NO

Opens the **Space point mode - List** input mask immediately.

Input mask

```
Space point mode - Input

Point definition           - meas.         - Input        Normal NX,NY,NZ
 - Preset by manual measurement                           Angle A1,A2
        - max. no. of iterations    0

Normal definition with      - CNC

Output in - net point coordinates  *        - Space point coord.

Arc radius                   0.1000        Start angle              0

Position after measurement            - Norm. vec. dist.
                                      - Workpiece axis dist.
                                      - Clearance plane
```

* YES	NO		MOD INFO	*	TMP MOD1	TMP MOD2	TMP MOD3	
BACK	PRE MENU				LGT MOD1	LGT MOD2	LTG MOD3	INFO

Softkeys

YES/NO

Selects the desired input fields.

MOD INFO

Outputs the modes stored on the screen:

```
     Space point mode - List
                                          RUN 1          RUN 2          RUN 3
     Current run

    Point determination      - Measure
     Point input   - manual measurement
              - Max. no. of iterations     .... 0        .... 0         .... 0
     Input        - Normals NX,NY,NZ
                    - Angles W1,W2
    Determin. of normals with     - CNC  ....  .       ....  .        ....  .
     Output in - net point coordinates          *              *              *
               - Space point coord.
     Arc radius                             0.1000         0.1000         0.1000
     Start angle                              0.00           0.00           0.00
     Position after measurement
     Nor. vec distance                      0.0000         0.0000         0.0000
     Workpiece distance                     0.0000         0.0000         0.0000
    Clearance plane                         0.0000         0.0000         0.0000

  |      |      |      | PRINTER |    *    |      |      |      | TERMIN |

  |      |      |      |         |         |      |      |      |  INFO  |
```

TMP MODn

Saves the current screen contents under the corresponding number as **RUN n** in the program memory.

LGT MODn

Saves the current screen contents under the corresponding number as **RUN n** in the program memory and as Standard n on the Winchester disk.

Input fields

Point definition

The program requires the direction of the surface normals in the space point for the space point measurement.

The following possibilities are available:

– **Measure**
  The nominal normal is unknown. The program should gather the information on the normal direction via an automatically executed iteration measurement (standard case).

– **Preset by manual measurement**
  The nominal coordinates are unknown. They are specified by probing the test piece.

– **Max. no. of iterations** (relevant with measurement = *):
  Maximum number of iterations for automatic determination of the normal direction, see explanation under "Arc radius".

– **Input**
  The nominal normal is known. The program receives the information on the normal direction via screen inputs. The required data is obtained e.g. from the design drawing or was previously measured. Two types of input are available:

- **Normal NX, NY, NZ**
  The normal direction must be entered in vector form: NX, NY, NZ are the parts of the normal vector projected onto the corresponding axes of the of the workpiece coordinate system.
- **Angles A1, A2**
  The normal direction must be entered via the projected angles A1, A2.

Normal determination with CNC

<YES>
During the CNC run, the normal direction is determined by measurement for each space point.

<NO>
During the CNC run the normal direction of the part programmed workpiece is used for space points (provided that the points are determined via measurement).

Output in -

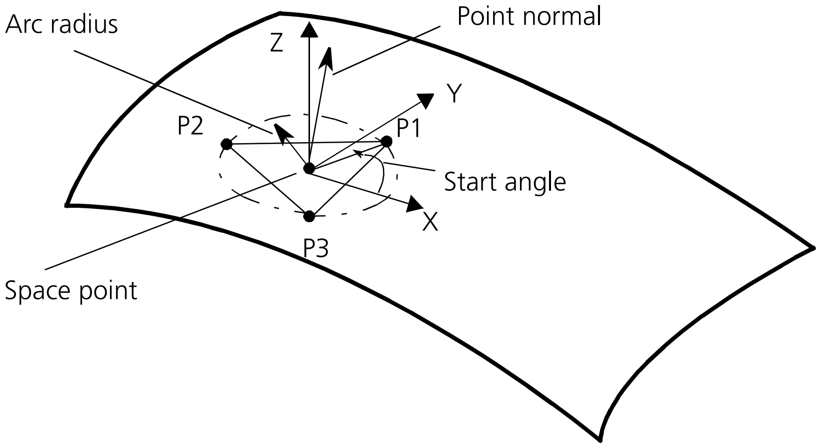
The result of the space point measurement can be output in space point or in grid point coordinates.

Select the required output form with **<YES>**/**<NO>**.

Arc radius / Start angle

Only for determining the normal via measurement.

The values entered here are used to define the normal via the following iteration method:



The program probes three points at 120° intervals around the space point specified with the distance entered with the arc radius and calculates the normal of this surface element. The nominal point is probed with this auxiliary normal and a new normal is defined with three probings. The space point is determined when the difference between the two normals falls below a minimum value. Otherwise this iteration is repeated corresponding to the repetition factor entered for **Max. no. of iterations**.

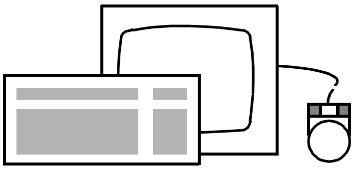
Position after measurement

After the space point measurement has been concluded, the probe backs away automatically. The direction and length of the backaway or retract path must be defined here. Possible selection criteria include the position of the space points, e.g. if collision-free backaway can be guaranteed only in the direction of the normal or only in the direction of the workpiece coordinate system. The following three backaway methods are available, however, they can be activated only one at a time (i.e.):

- **Norm. vec. dist.**
  Backaway occurs in the direction of the normal with tbe backaway path which has been entered.
- **Workpiece axis dist.**
  Backaway takes place in the direction of the workpiece coordinate system in the direction opposite to the last probing with the back-away path entered.
- **Clearance plane**
  Backaway occurs in the direction of the workpiece coordinate system towards the clearance plane. This plane lies perpendicular to the last probing direction at the distance above/below the work-piece zero point specified here (be careful with the +/-sign).

Space point macro

Function call



```
DI 3800
<MACRO>
<S MACRO
```

Input mask

```
Space point macro

Store space points
in meas.data form.   KUM          Append points ?
                     VDA          VDA file name VDARAUMP_____B

| * YES | NO |  |  |        *        |  |  |  | TERMIN |

| BACK | PRE MENU |  |  |             |  |  |  | INFO |
```

Input fields

Store space points in meas.data form.
KUM
VDA

Selection of the measured data format.

Append points?

<YES>
The points are appended to an existing KUM data file. If this file contains measured data without a normal direction, it is not possible to append points.

VDA file name

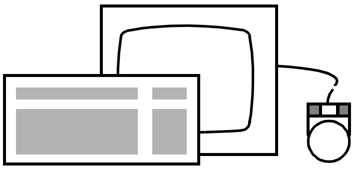
Name of the VDA file.

Space point run mode

The space points can be probed in succession while the normal is automatically defined via 3 points.

The measured values and normal directions thus generated can be saved as KUM measured values. A conversion to nominal values is then possible (**SOL UMR** without normal direction). Based on these nominal values, further parts can be automatically measured in KAM.

Function call



<DI 3800>
<MACRO>
<S MACRO>
<TERMIN>

Space point - run mode

Please select function

* YES	NO			*	RUN 1	RUN 2	RUN 3	TERMIN
BACK								INFO

Softkeys

RUN 1
RUN 2
RUN 3

Starts the run defined in the space point mode.

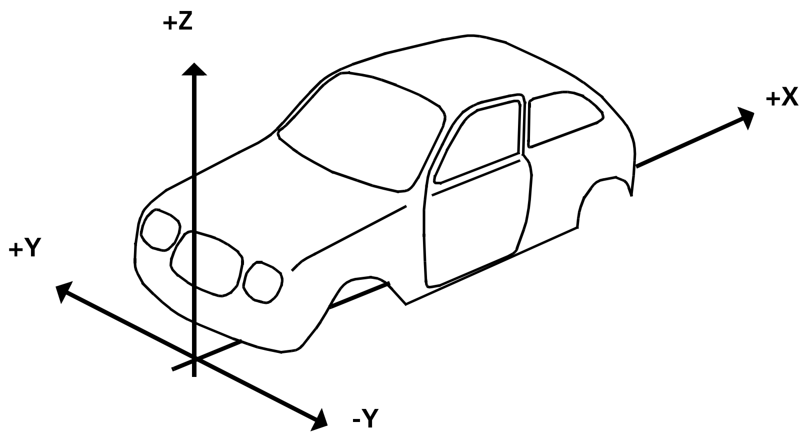
Chapter 3

Fast Contour Control (FCC)

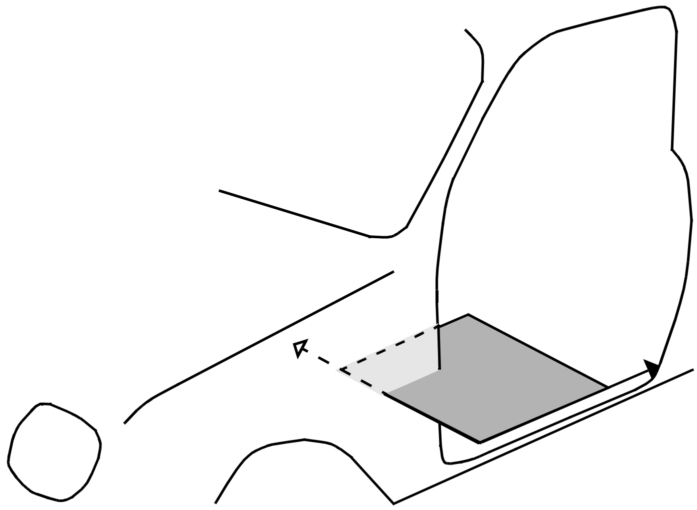
This chapter contains:

Definitions

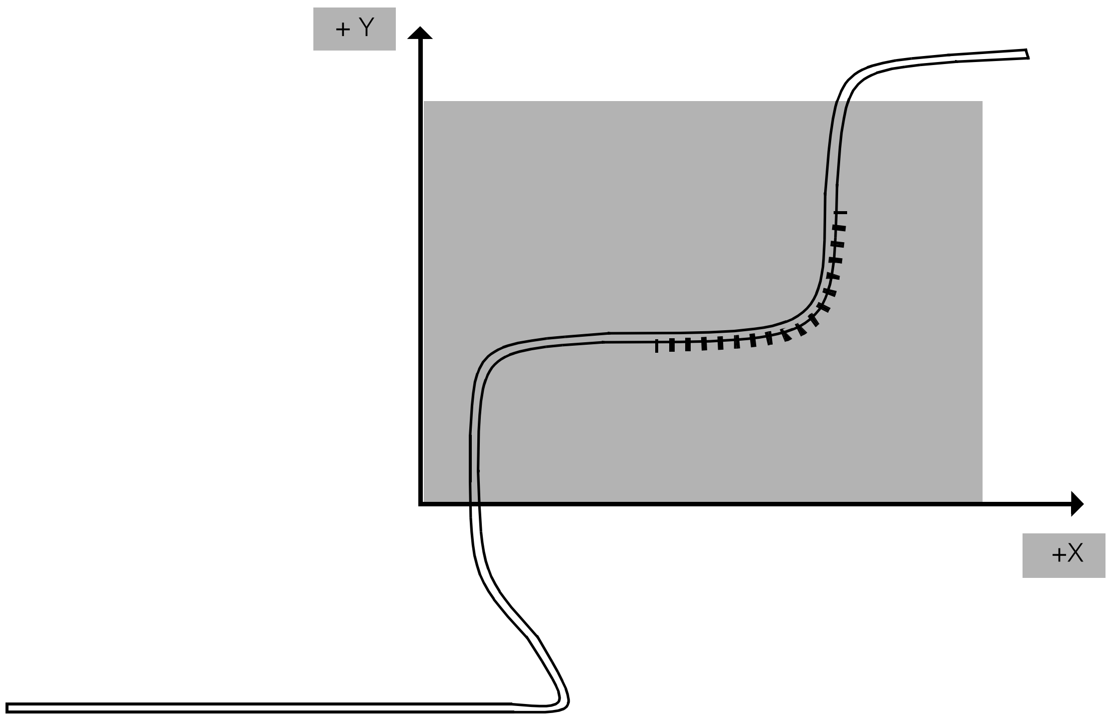
Fast Contour Control (FCC) replaces multipoint measuring gages when inspecting car body assemblies: A nominal curve is specified in a separate workpiece coordinate system for each measurement position. This coordinate system corresponds to the adjustment possibilities of the production tool at the location of the measurement position. After a best fit of the actual curve is scanned, the actual dimensions of the measurement position are available. Any resulting inadmissible deviations can be directly used as correction values in the production process. All parts of a car body are measured in a common coordinate system:



With Fast Contour Control, the data for each measurement position is usually contained in a separate coordinate system.



During measurement the nominal data of a measurement position are converted to a coordinate system which corresponds to the adjustment possibilities of the production tool. The direction of the coordinate system is derived from several auxiliary points which must be placed in front of the nominal points of each measurement position (➤*„Measurement“ on page 2-10*).



Requirements

- The data for each measurement position must be prepared on a CAD system.
- ACE (off-line parts programming) software must be available.
- The CMM must be equipped with a laser triangulation probe (LTP) and an articulating probe holder (DSE).

Preparing control data

Overview

The control data for Fast Contour Control is usually created on several different computers. The following overview is based on the configuration: CAD system - cell computer - CMM computer.

CAD system

– Generate or design auxiliary points and nominal data as a data record for each measuring position.
– Define the intermediate positions / travel paths to the next measurement position as a VDA data record with 10 points or less.

↓

Cell computer

1 Fetch VDA file to intermediate storage.	**DATACOM** **<DI 3452>**
2 Transfer VDA file to KUM.	**KUM** **<VDA->KUM>** Define workpiece name and enter it in KUM catalog.
3 Generate control data for object to be measured.	**MFT** Start learn (part) programming, select probe and read W position. Call **KAM** with **<DI 3870>** to generate the control data.
4 Transfer CNC program to intermediate memory.	**<DI 3500>**

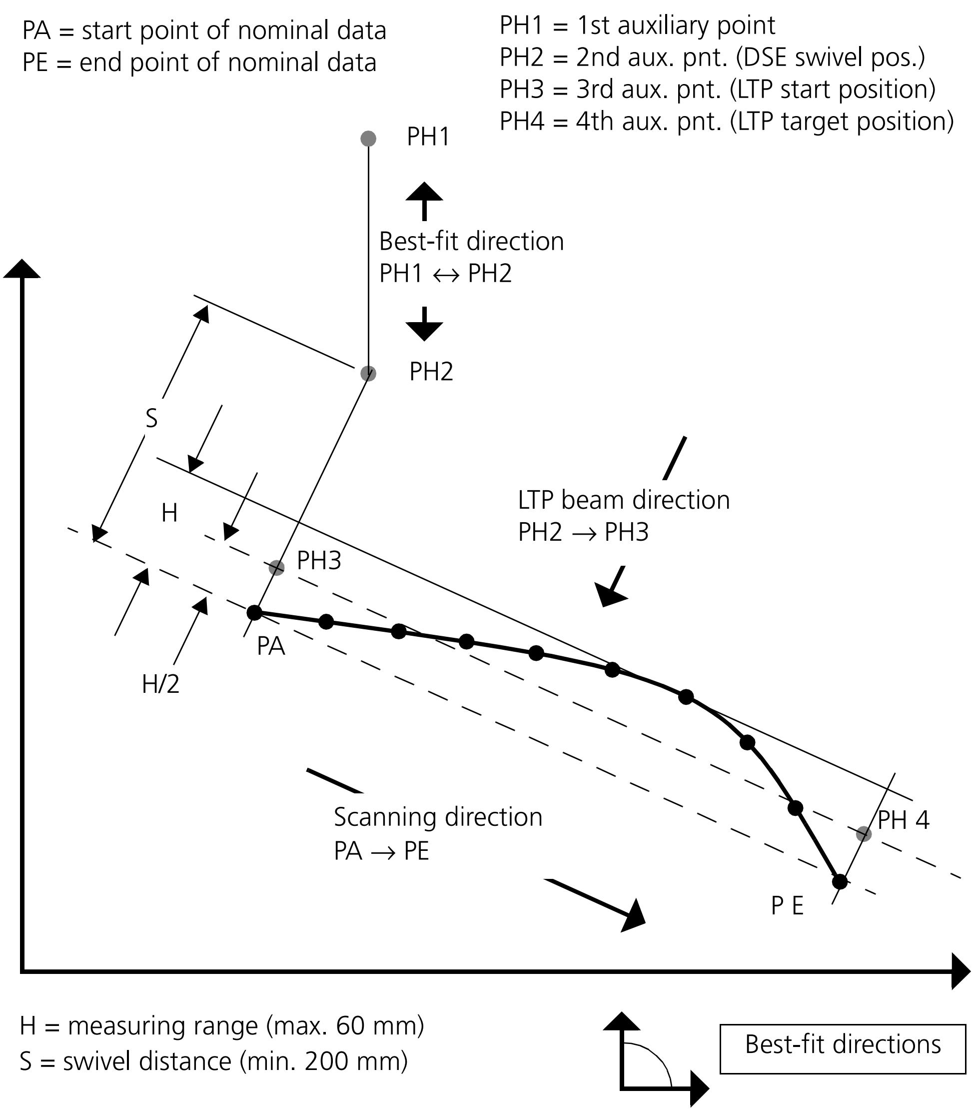
↓

CMM computer

1 Fetch CNC program from intermediate storage of cell computer to intermediate storage of CMM computer.	**DATACOM** **<DI 3457>** No entry in input field **Computer name**, Start data transfer by entering **getdata xxxx** (**XXXX** = name of cell computer) in **Command** input field.
2 Transfer CNC program from intermediate memory to control data file and enter it in the UMESS catalog.	**UMESS** **<DI 3500>**

Preparations on the CAD system

A data record comprising auxiliary points and a nominal contour is created on the CAD system for each measurement position (plane section). While the nominal contour is generated from the design data, auxiliary points **PH1**, **PH2** and **PH3** for the beam direction and best-fit direction must be created by the programmer.



NOTE

- All auxiliary and nominal points must lie in a single section plane.
- During Fast Contour Control the position transformation **ROTATE SPACE** is generated via points **PH1**, **PA** and **PE** and the position transformation **ROTATE PLANE** via points **PH1** and **PH2**. These points must therefore be located as far apart as possible.

- The laser probe requires considerable free space for rotating and swiveling movements. Adjustment position **PH2** should therefore lie 200 - 400 mm above the workpiece surface.
- Auxiliary point **PH3** defines the activate position and start point of the LTP. It also represents the center of the measuring range of 50 or max. 60 mm. Target point **PH4** is calculated from the existing information.
- All points must lie within the workpiece coordinate system!
- A data record must consist of at least 11 points. Otherwise the data will be interpreted as travel paths or intermediate positions.
- Fast Contour Control (block scanning) can be used only if the curve path to be measured in the beam direction does not exceed a length of 60 mm. As a safety precaution, the laser always switches off if a valid probing is no longer possible. Measured values are then no longer accepted!
- Due to the measuring speed, it is advisable to enter 30 - 40 nominal values per curve. 100 measured points should not be exceeded, since the time response would otherwise be impaired due to changes in the data administration.
- The curve path must not have any kinks, discontinuities or repeated points (continuous curve).
- The laser beam must be able to reach all curve points (no shading). For this purpose, the laser beam must be as perpendicular to the workpiece surface as possible. The angle between the laser beam and the workpiece surface must never be less than 45°. Otherwise no valid measurements can be taken.
- The VDA format is used to transfer CAD data to the CMM computer. The VDA elements **PSET** or **MDI** can be defined (others are also possible on request). Since the VDA data are taken from KUM, you will find more information in the KUM manual.
- The curve identifier can be entered by the CAD system as the VDA name:
  NAME = COMMANDWORD/ELEMENTPARAMETER.

Example: VDA file with a PSET

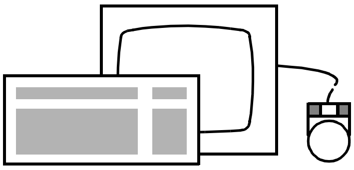
```
UEBUNG1 = HEADER/     20                                                       00000001
**********************************************************************00000002
VDAFS VERSION      : 2.0                                                       00000003
--------INFORMATION ABOUT SENDER------------------------------00000004
SENDER        :                                                           00000005
CONTACT     :                                                          00000006
-TELEPHONE          :                                                           00000007
-ADDRESS          :                                                            00000008
GENERATING SYSTEM : UNIX                                                      00000009
CREATION DATE    :                                                           00000010
SEND FILE NAME     : VDAHEADER__xxB                                            00000011
--------INFORMATION ABOUT WORKPIECE----------------------------------------00000012
PROJECT           :                                                            00000013
OBJECT DESIGNATION   :                                                          00000014
VARIANT          :                                                             00000015
CONFIDENTIALITY     :                                                          00000016
VALIDITY DATE  :                                                           00000017
-------INFORMATION ABOUT/FOR RECEIVER                                        00000018
RECEIVING COMPANY    :                                                          00000019
RECEIVER NAME     :                                                            00000020
***************************************************************************00000021
$$Nominals fast contour control                                                00000022
SET1=BEGINSET                                                                  00000023
PSET1 = PSET/        44,                                                       00000024
  3194.000,   526.300,  1100.000, (PH 1)                                       00000025
  3194.000,   525.500,  1073.500, (PH 2)                                       00000026
  3194.000,   695.660,  1012.000, (PH 3)                                       00000027
  3194.015,   714.465,  1005.134, (PA)                                         00000028
..
..
..
  3193.990,   697.365,   968.233  (PE)                                         00000068
SET1=ENDSET                                                                    00000069
UEBUNG1 = END                                                                  00000070
```

Preparations on the cell computer

Transferring a VDA file to the cell computer

The VDA file located in the CAD system must be transferred via the network to a directory in the cell computer for further processing (recommended: **/home/zeiss/UI**). This transfer is started with the DATACOM software:

Function call



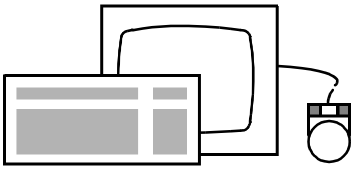
<DI 3452>

For more details, see the DATACOM operating instructions.

Converting a VDA file to KUM data

The data designed and/or generated in the CAD system must be converted so that it can be interpreted by the measuring software.

Function call



<VDA->KUM>

For more details see the KUM operating instructions.

NOTE

Nominal values must not be converted in KUM. All calculations required are performed in KAM.

Creating a learn (part) program in ACE (

The operator only creates the basic structure required for a learn program.

The data for the individual measurement positions prepared on the CAD system and the travel paths or intermediate positions located in-between must first be transferred to a KUM data file as a separate workpiece. This KUM data is integrated in the CNC run by calling **<DI 3870>**.

PROG Start learn programming.

PRB NO Select probe (preassignment with probe data of the LTP).

1712 Load control coordinate system for Fast Contour Control.

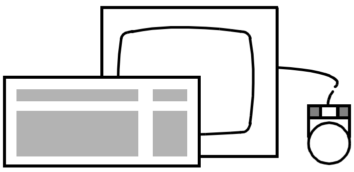
1713

REC.HEAD Call record head, set initial status.

DI 3870 Include the KUM data file in the measuring run.

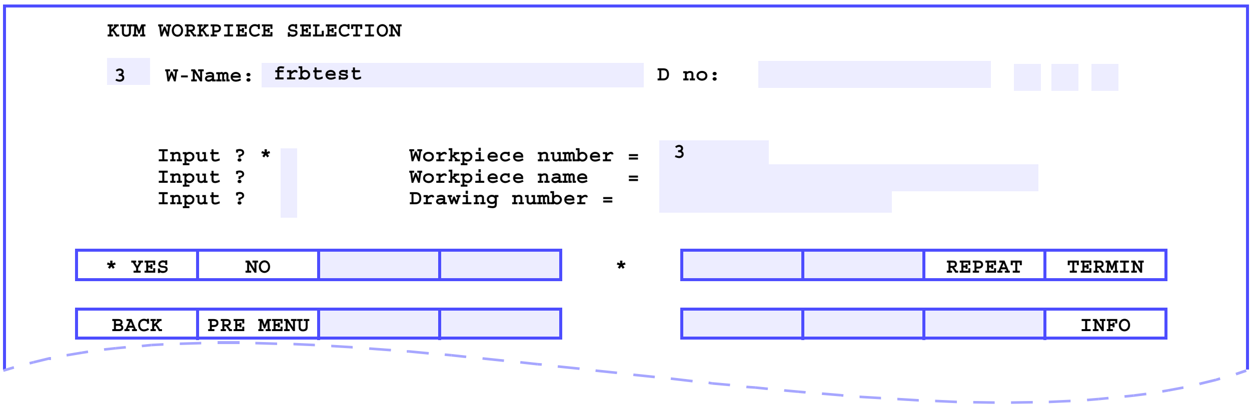
P-END Quit learn programming.

Function call



```
<DI 3870>
```

Input mask 1



Input fields

W-name, D no

Display of previously selected workpiece.

Input?

Input can be entered in the following field with **<Yes>**.

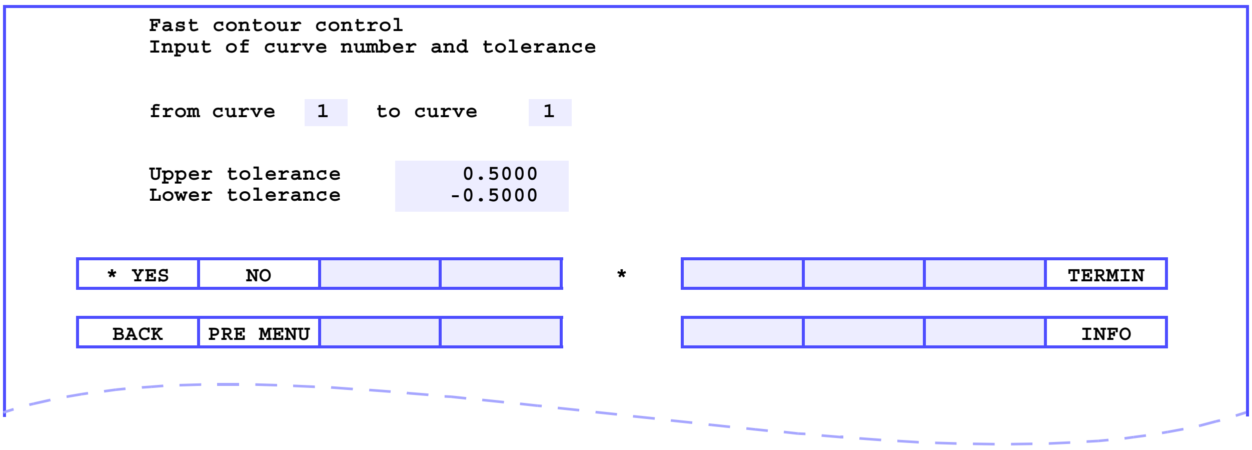
Workpiece no., Workpiece name, Drawing number

Enter the name of the KUM data file containing the data created on the CAD system here (see KUM operating instructions).

NOTE

The exact designation of the KUM data file can be read with **<PRE MENU>**. Access to the KUM workpiece catalog can then be gained via the KUM workpiece administration.

Input mask 2



Example of a control data list

```
================================================================================

                      CONTROL DATA LIST    ZEISS  UMESS

WORKPIECE NAME:   frbskk
FILE NAME:  CNC_________3B
CONTROL DATA LINES:     30            NOMINAL LINES:     3
================================================================================
     |     X     |     Y     |     Z     |            |      |      |      |      |
 NO  | ------------------------------------| Function  | SKZ  | AKZ  | PKZ  |StKZ  | ADR
                  Dialog
   Snr  | Record type                       | Idf  |Sy  |Nom.  | U.Tol  | L.Tol  |
   Snr  |                      |MEadr|      | Idf  |Sy  |   t     | (M) |    A   | (M)
================================================================================
   1       1       1       1       0  PRB-COM-CHAN     0     1  1552  1520
   2        11                        WPOS F DISK      0     1  1712  1610
   3                                  WPOS TO WSYS     0     0  1713  1640    1
   4   1005    3    0      0.0000  0.0000 P_PARAM      2     2     0  1500
   5   1006    3    0      0.0000  1.0000 LDL P_PARAM  2     0     0  1919
   6                                  KUM-START        0     1  2700     0
   7  SKK                             W-NAME           0     4  2711     0
   8                                   DL W-NAME       0     0  9911     0
   9  53170050                        DWG NUMBER       0     0  9911     0
  10         2                        WP NUMBER       0     0  9919     0
  11                                  KAM-START        0     1  3800     0
  12       0       2       0       0  SCAN DAT ACE     1     1     0  1339
  13  99   2   1   1     1.0000    1.0000  SCANNING MOD     1     1  1530  1330

  14                                  KAM-MEAS-SK      0     0  3850  1410
  15   15 S__020101_DATK              KAM-NOM-FILE     4     1  1530  1330
  16   3194.0000    713.0530   1003.9990 I-POS         0 11110     0  1101
  17      0.0000      0.7714      0.6364 DSE POSITION  0     2     0  1260
  18      0.0000      0.0000      0.0000 LDL DSE POS   0     0     0  1919
  19       4       0       0       0  SCAN DAT ACE     1     1     0  1339
  20   0.9226    0    0    0    0 1   0 SCANNING       1     3  1531  1331
  21   3194.0000    711.6840   1002.8620  DL SCAN RUN  0 11112     0  1911
  22   3194.0000    706.0510    996.7610 LDL SCAN RUN  0 11112     0  1919
  23       1       1       0       0  KAM TERMIN       0     1  3890  1420

  24  Y Z                      1          NOM VALUES       1     1  1452     0
   1  UMESS NOMINAL                   SK      Y       0.0000   0.5000  -0.5000
                                      SK      Z       0.0000   0.5000  -0.5000
  25       1       1       0       1  KAM-FIT-SK       0     2  3870     0    2
  26  PSET1                           LDL RESNAME      0     0  9919     0
  27                                  KAM-END          0     1  3888     0
  28       0       1       0       0  SCAN DAT ACE     1     1     0  1339
  29                                  KUM-END         0     1  2788     0
  30                                  P-END           0     0  9999  1999
```

NOTE

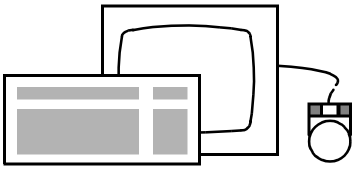
Auxiliary points **PH1-PH3** are removed from the nominal data during conversion so that a measuring position can subsequently be modified only within the range of the nominal data.
Together with the auxiliary points, the nominal data supplies important control information. Changes in the nominal data must therefore always be performed together with the auxiliary points and on the CAD system (make a backup copy of the nominal data to be on the safe side).

Preparation on the CMM computer

After the CNC program has been loaded to the intermediate memory of the cell computer with **<DI 3500>**, it can be transferred to the CMM computer as follows:

– Fetch the CNC program to the intermediate storage of the CMM computer

Function call



```
<DI 3457>
```

Input mask

```
DATACOM LAN: Command input
<COMMAND>

Target      Host name
            User name
            Password

            Net service      5

Command                      getdata xxxx

| * YES | NO | CNC-SND | CNC RECV |   *   | REC SND | CATALOG | EXECUTE | TERMIN |
| BACK  |    | SEND    | RECEIVE  |       |         | COMMAND | DEFINE  | INFO   |
```

Input fields

Target / Host name No input. The command will be entered later and executed at your own computer.

Target / User name Name of user on target computer. No input required at your own computer.

Target / Password User password. No input required at your own computer.

Net(-work) service Code = 5 for your own computer

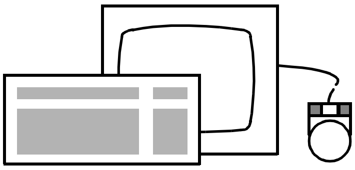
Command:
getdata xxxx

This script is used to transfer the KUM data of a cell computer to your own computer via the network.
xxxx = name of cell computer. (See DATACOM operating instructions)

Transferring the CNC program from intermediate storage to the control data file

In a second step the CNC program must be transferred to the control data file. At the same time an entry is made in the control data catalog. Only then is the CNC program available for measuring runs.

Function call



```
<DI 3500>
```

Performing a measurement

First the workpiece position is defined manually in UMESS or in the CNC mode. After the CNC run is started, the control data are processed and the different measurement and evaluation functions are executed.

NOTE

- Due to its degrees of freedom, the DSE can reach a specified direction vector and take different positions by rotating and swiveling in various ways. The position of the DSE depends on its fitting position and its previous position. Therefore before starting a CNC run you should bring the DSE to a defined position.
- During the evaluation the nominal and measured data are transformed to the best fit coordinate system, cf. chapter ➤*„Preparations on the CAD system“ on page 3-51*. A translational 2D best fit follows which supplies a center of gravity displacement between the nominal and the measured curve. The two vector components of this center of gravity displacement form the result of the FCC evaluation.

  The measured result contains the following information:

  Address: VDA name, result address

  Task: 2D-FIT

  Name: SK

  System: Identification of the 2 axes in the best fit coordinate system

  Actual: Center of gravity displacement per axis (mm)

  Nominal: 0.0000 mm per axis

  Upper tolerance: Tolerance data per axis (mm)

  Lower tolerance: Tolerance data per axis (mm)

  Deviation: Tolerance exceeded per axis (mm)

  Exceeded: Histogram of tolerances exceeded

  Angle A1: Not yet implemented

  xxP: Number of nominal points

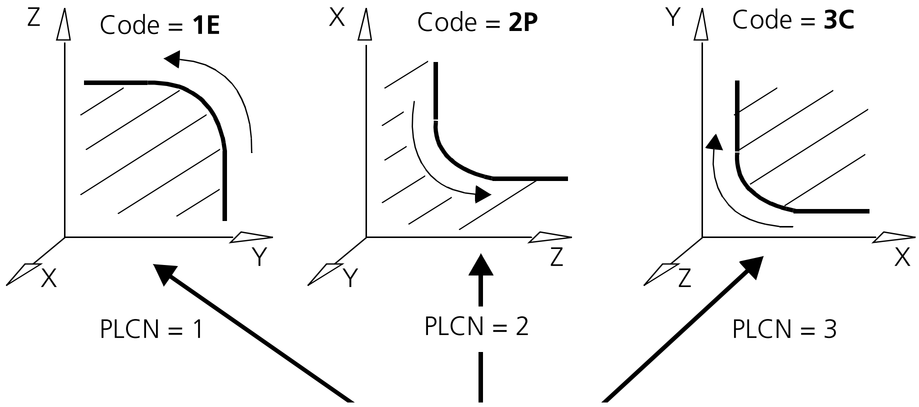
  S: Dispersion (mm)

  MIN: Nominal point number; minimum deviation (mm)

  MAX: Nominal point number; maximum deviation (mm)
- The original coordinate system is again valid following completion of the measurement.

Travel path definition code

The code for travel path definition is formed from the number of the travel plane (= PLCN) and a letter which determines the inner/outer contour, the travel direction of the probings and the orientation of the contour.



To determine the letter: Change the position of the contour to be measured to the correct travel plane, determine the letter of the corner which corresponds to the inner/outer contour to be measured the required travel direction.

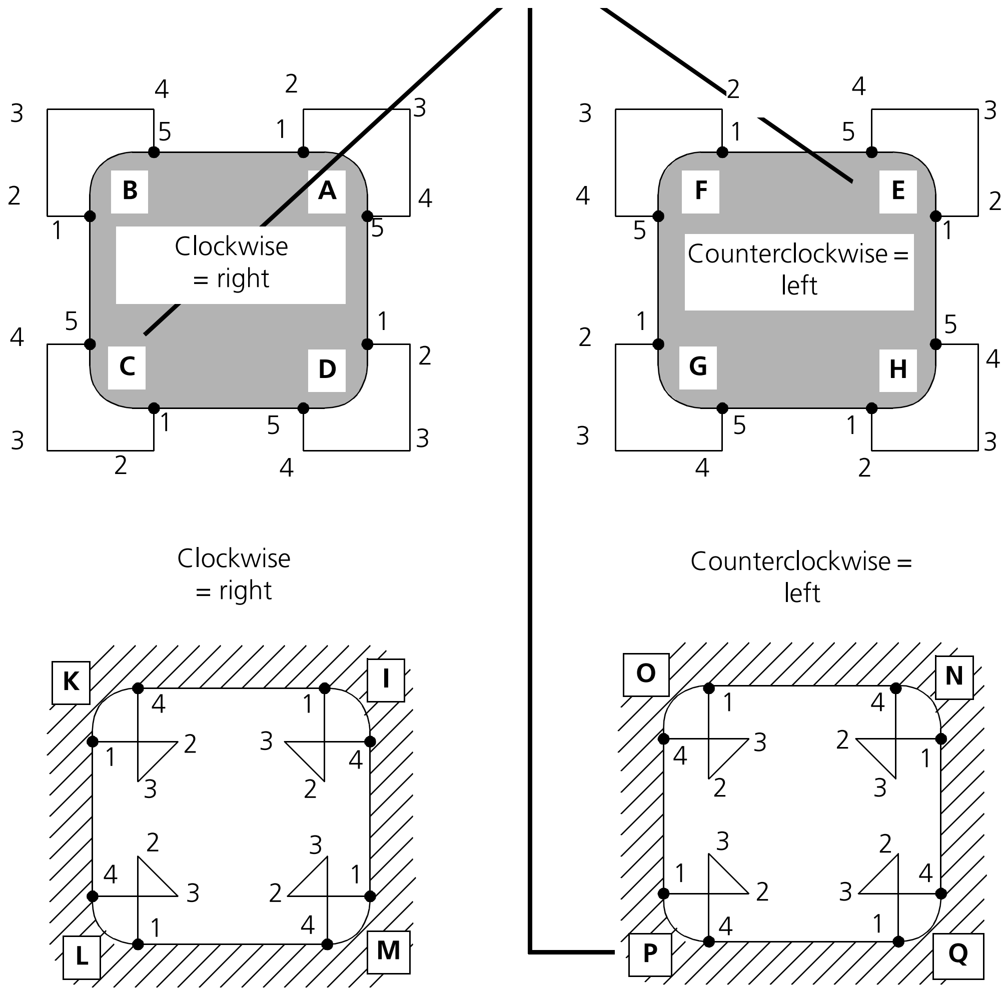
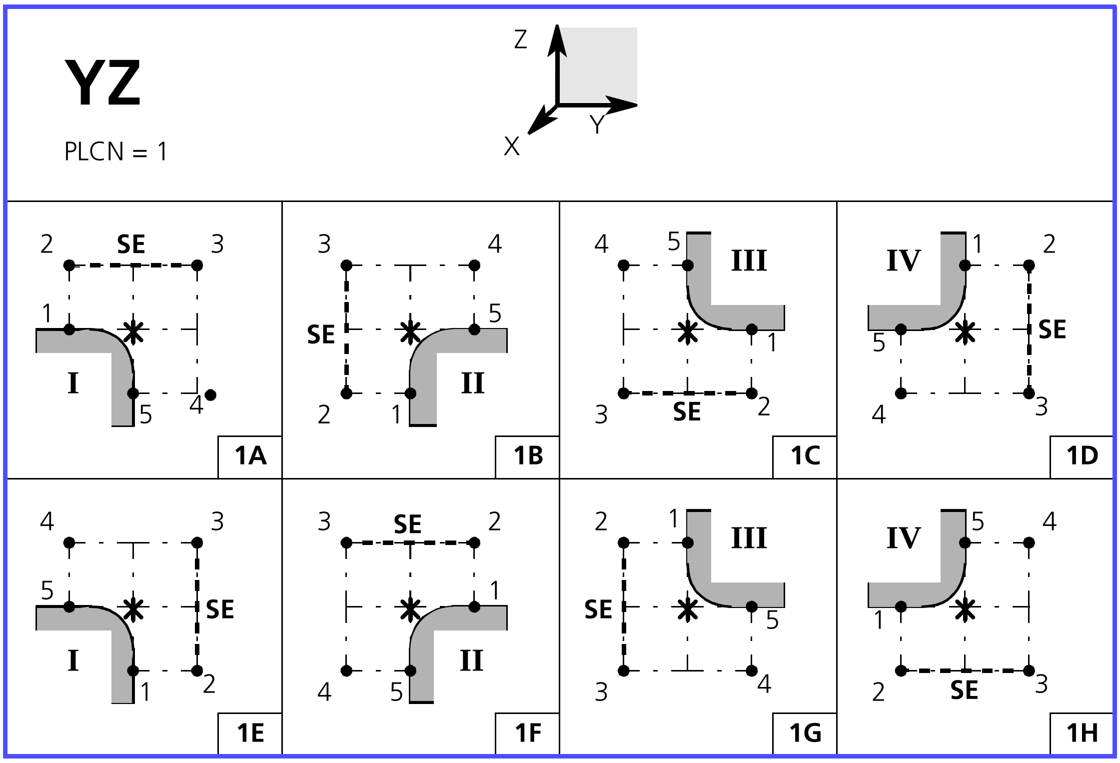
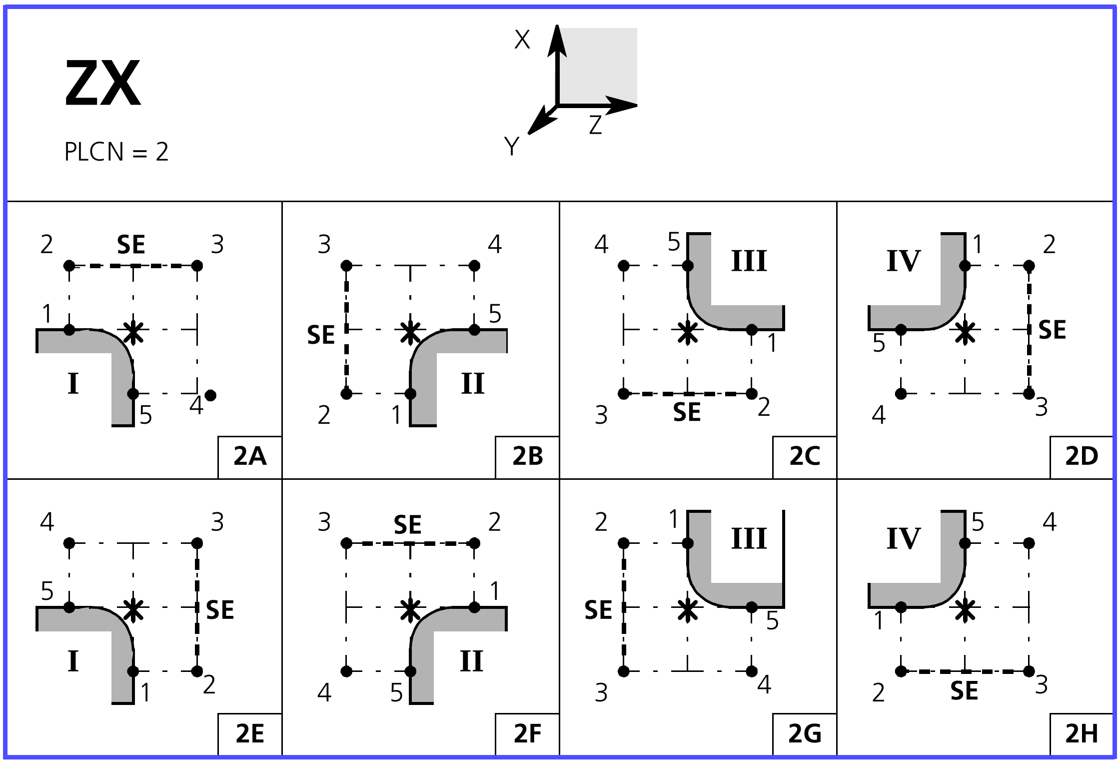


Table of travel path definitions: outer contour





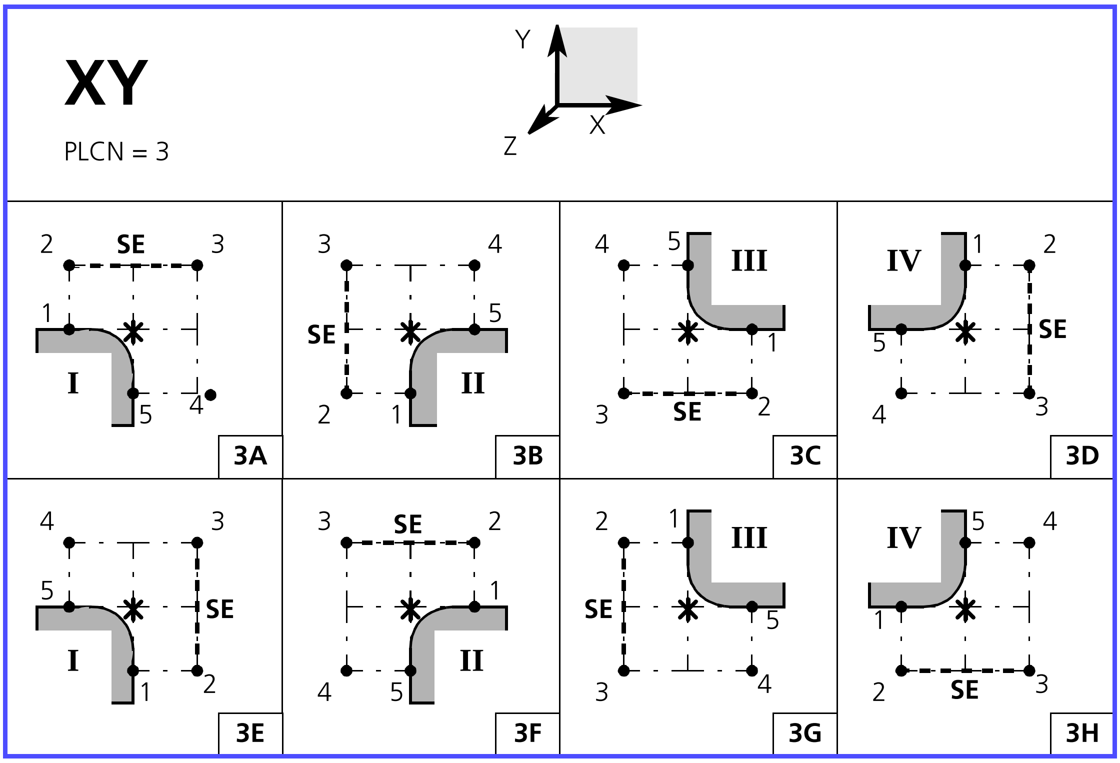
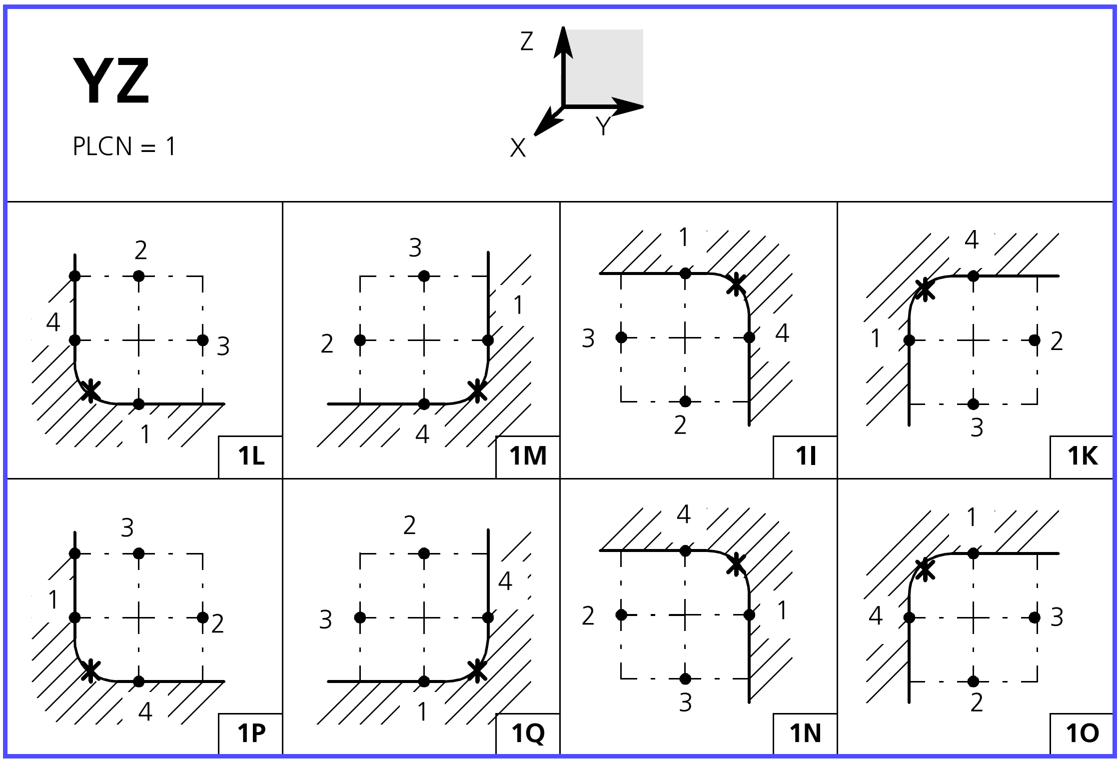
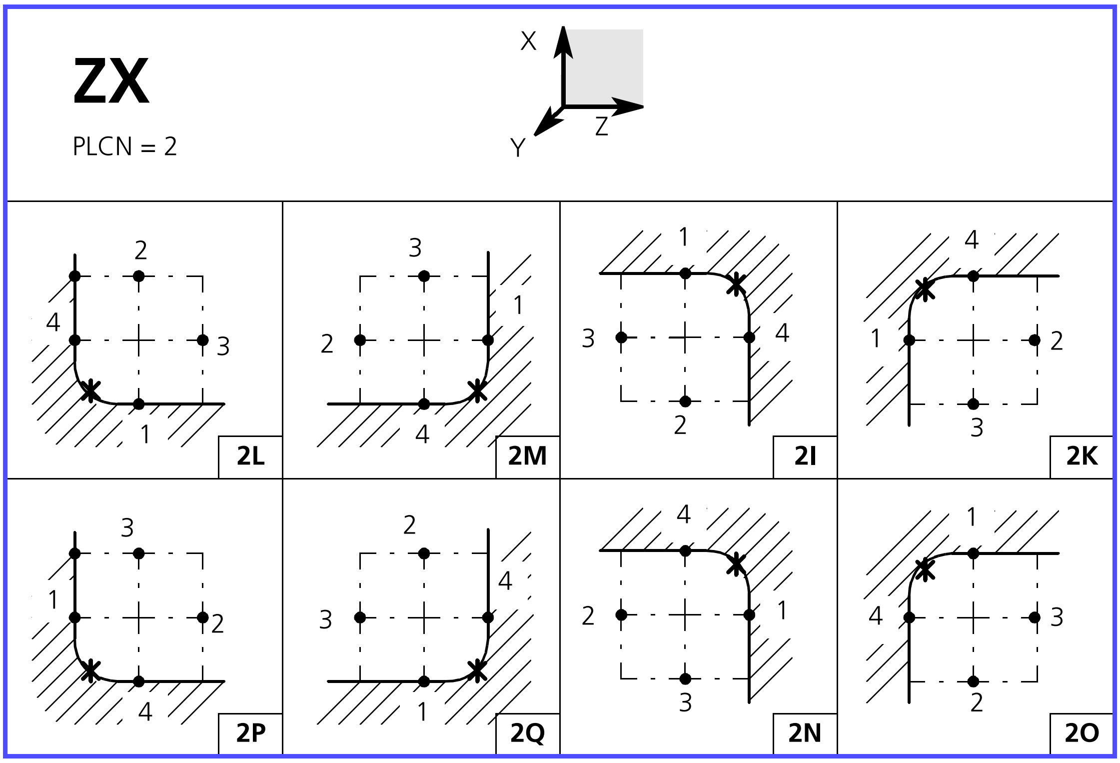

XY
PLCN = 3
Y
X
Z
2 SE 3
1
I
5 4
3A
3 4
SE 5
II
2 1
3B
4 5 III
1
3 SE 2
3C
IV 1 2
5 SE
4 3
3D
4 3
5 SE
I
1 2
3E
3 SE 2
1
II
4 5
3F
2 1 III
SE 5
3 4
3G
IV 5 4
1
2 SE 3
3H

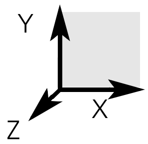
Table of travel path definitions: inner contour

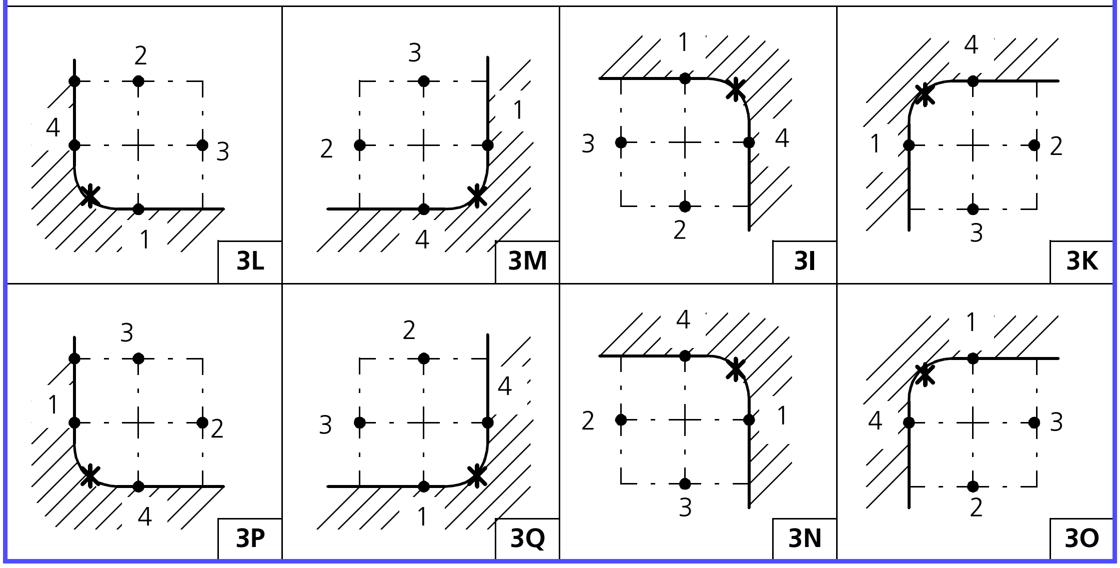




XY

PLCN = 3


Y
X
Z


2 4 3 1
3L
3 1 2 4
3M
1 3 4 2
3I
4 1 2 3
3K
3 1 2 4
3P
2 4 3 1
3Q
4 2 1 3
3N
1 4 3 2
3O

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