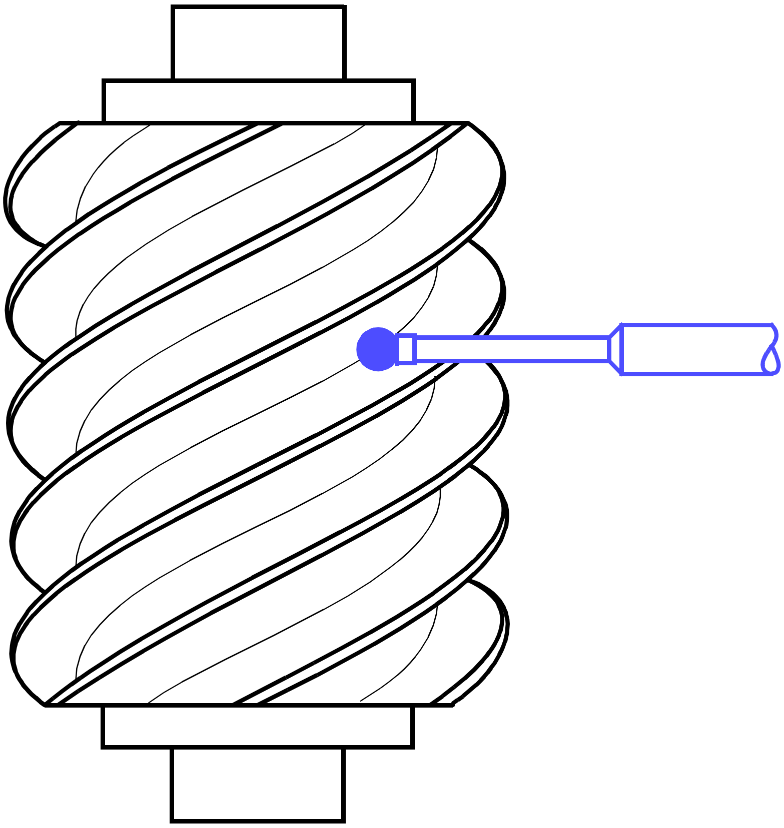
KUM

Curve Measuring Program for UNIX+LINUX



Operating Instructions

ZEISS

This manual is subject to modifications. The right is reserved to make modifications to the design and scope of supply of the measuring machine, the software packages and the associated documentation.

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Foreword

This operating manual describes the function and operation of the **KUM** measuring program for curve measurement.

It is assumed that the user is familiar with the measuring machine and the **UMESS** basic software. Please also keep all documents included in the scope of supply ready to hand.

The right is reserved to make modifications to the design and scope of supply of the measuring machine, the software packages and the associated documentation.

Conventions in this operating manual

Before you start using this operating manual, you should familiarize yourself with the conventions used.

Below you will find information on the fonts, characters and symbols used.

Typographical conventions

The character types and styles used in this operating manual have the following meaning:

– **bold**
  – Dialog element on the screen
    Example: "... the **<TERMIN>** key"
  – Term
    Example: "During the calculation, the spatial position of a **measuring element** to a **reference element** is determined."
  – File and directory names
    Example: **/home/zeiss/UB**
– *italic*
  – A highlighted text whose content is particularly important
    Example: "Click with the *right* mouse button ..."
  – Cross reference
    Example: "..., see also ➤*"Characters and symbols" on page -4* "
– **`Courier bold`**
  Text in dialog windows and reports

Characters and symbols

Special characters and symbols are used in this operating manual.

Symbols for warnings and notes

Danger!
Particular caution is advised in this case. The warning triangle indicates risk of injury. In the event of non-observance of this warning, there is a risk that you may be injured.

Attention!
This symbol is used to warn of situations which can result in data loss, incorrect measurements, faults in the measuring run,collisions or damage of machine and workpiece.

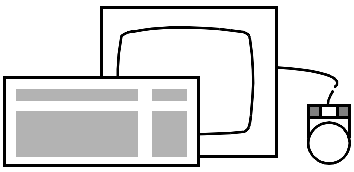
The **Note** symbol is placed next to important points in the text and helpful additional information.

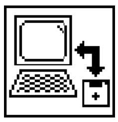
Symbol for function invocation

There can be several options:

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

Example:



DI	Pull-Down-Menu	Pictogram
3500	Service Data backup...	

s

Symbol for softkey

TERMIN

References to softkeys in dialogs are represented thus.

Chapter overview

This operating manual describes the function, operation and possible uses of the KUM measuring program.

You will find the following topics:

KUM command list

Command abbreviation	Program function	Chapter
DEV SET	Set mode for large deviations	➤ *Page 7-19*
DEV ELO	Eliminate deviations - outliers	➤ *Page 7-27*
DEV CAL	Calculate deviations	➤ *Page 7-16*
DEV EDI	Edit deviations	➤ *Page 8-18*
DEV FIL	Smooth curves, filter deviations	➤ *Page 7-25*
DEV LIS	Printer deviation record	➤ *Page 8-21*
DEV PLO	Plot deviations	➤ *Page 9-33*
DEV TRA	Transform deviations	➤ *Page 7-82*
ASG PLO	Plot fitted line	➤ *Page 11-27*
PGE CHG	Change page	➤ *Page 9-58*
ACC PLO	Plot acceleration curve	➤ *Page 11-30*
DIS CAL	Calculate distance	➤ *Page 7-39*
RES COP	Copy KUM best fit data to UMESS	➤ *Page 7-57*
SPE PLO	Plot speed curve	➤ *Page 11-29*
LIF PLO	Plot lift curve	➤ *Page 11-24*
ACT CAL	Calculate actuals	➤ *Page 7-25*
CMB END	End command block	➤ *Page 4-8*
LDE PLO	Plot linear plot of deviations	➤ *Page 9-49*
BLK DEF	Generate blank line	➤ *Page 4-8*
MVA ENV	Wind measured values	➤ *Page 7-92*
MVA DVL	Unwind measured values	➤ *Page 7-90*
MVA COP	Copy measured values	➤ *Page 5-56*
MVA EDI	Edit measured values	➤ *Page 6-16*
MVA BFT	2D best fit of measured values	➤ *Page 7-44*
MVA BTR	Transform measured values using best fit	➤ *Page 7-58*
MVA FIL	Filter measured values (homogeneous point set)	➤ *Page 7-59*
MVA GEN	Generate measured values	➤ *Page 5-28*
MVA LCAL	Calculate lift data	➤ *Page 11-11*
MVA IDE	Identify measured values	➤ *Page 5-58*
MVA COR	Correct measured values	➤ *Page 1-15*
MVA RD	Read measured values	➤ *Page 8-21*
MVA LIS	List measured values	➤ *Page 8-11*

Command abbreviation	Program function	Chapter
MVA CEN	Calculate center curve measured data	➤ *Page 7-83*
MVA PLO	Plot measured values	➤ *Page 9-33*
MVA TRA	Transform measured values,	➤ *Page 7-61*
MVA REF	Reformat measured values (UMESS file evaluation)	➤ *Page 6-33*
MVA REV	Reverse measured values	➤ *Page 7-98*
MVA CON	Convert measured values	➤ *Page 7-6*
MVA LNK	Link measured values	➤ *Page 5-51*
MVA SHI	Shift measured values	➤ *Page 7-100*
OFS CAL	Calculate offset	➤ *Page 7-30*
PLT INI	Define plotter basic data	➤ *Page 9-6*
RAV CAL	Set the mode for calculating radial vectors	➤ *Page 11-11*
NOM ENV	Wind nominal values	➤ *Page 7-92*
NOM DVL	Unwind nominal values	➤ *Page 7-90*
NOM CAL	Calculate nominals	➤ *Page 7-2*
NOM COP	Copy nominals	➤ *Page 5-56*
NOM DMS	Demask nomininals	➤ *Page 5-62*
NOM EDI	Edit nominals	➤ *Page 5-2*
NOM GEN	Generate nominals	➤ *Page 5-28*
NOM IDE	Identify nominals	➤ *Page 5-58*
NOM COR	Correct nominals	➤ *Page 1-15*
NOM RD	Read nominals	
NOM LIS	List nominals	➤ *Page 8-2*
NOM CEN	Calculate center curve nominals	➤ *Page 7-83*
NOM MSK	Mask nominals	➤ *Page 5-62*
NOM PLO	Plot nominals	➤ *Page 9-33*
NOM TRA	Transform nominals	➤ *Page 7-61*
NOM REF	Reformat nominals (UMESS file evaluation)	➤ *Page 6-33*
NOM REV	Reverse nominals	➤ *Page 7-98*
NOM CON	Convert nominals	➤ *Page 7-2*
NOM LNK	Link nominals	➤ *Page 5-51*
NOM SHI	Shift nominals	➤ *Page 7-100*
BRA LIS	List blade parameters	➤ *Page 8-25*
PIT CAL	Calculate pitch	➤ *Page 7-35*
PBI COR	Correct probe bend	➤ *Page 7-95*

Command abbreviation	Program function	Chapter
PBI SCO	Static correction of probe bend	➤ *Page 7-95*
TOL CAL	Calculate tolerances	➤ *Page 5-24*
TOL INP	Input tolerances	➤ *Page 5-13*
TXT PLO	Plot texts	➤ *Page 9-61*
FOR PLO	Define plotter format	➤ *Page 9-29*
CRF PLO	Plot certificate	➤ *Page 9-53*

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Chapter 1

Introduction

This chapter contains:

General remarks on KUM

General

The KUM software package is a supplement to the main UMESS software and enables measurements of 2D or 3D curves which can be known or unknown as well as open or closed. Some of the advantages of this supplementary program are described below.

User-friendly operation

Clearly organized dialog windows enable simple interaction between user and program. Mnemonic command abbreviations simplify inputs, but also permit input commands in plain text. With many of the dialog windows, the user is offered explanatory notes on operation via INFO files. The VDA interface enables reading in of nominal data via CARTRIDGE tapes and DAT tapes, as well as the on-line connection with host computers via LANIX. Nominal values can also be entered manually, calculated automatically from existing measured data or be specifically modified for calculating shrinkage dimensions.

Flexible data acquisition

Possibilities for manual scanning of individual parts or for measuring unknown contours – semi-automatic scanning for measuring runs in a plane – CNC scanning for continual scanning of any curved 3D surfaces. Trigger and measuring probe heads can be used for probing with tactile probes as well as all non-contact measuring methods with the laser probe or OPTAS probing system. The most suitable scanning method can be used depending on the job in hand:

– 1D scanning with special probes for extremely fast scanning runs
– 2D scanning for face cams or 2D profile sections
– 3D scanning for open or closed 3D curves with workpiece-specific control of the nominal path.

High performance data processing

To define a new coordinate system, the workpiece can be aligned according to the profile of a contour measurement. The routines for 2D best fit are used for separating form and position errors of individual or combined curves.

Point tolerances enable the assignment of individual tolerances for each nominal point; whereas tolerance zones offer the possibility of dividing curves into different sectors with different tolerances. In addition, a deviation calculation can be made in the direction of the normal.

Informative data output

Standard or variable protocol headers with variable output columns enable standardized layout or any layout of the output protocol. High performance graphics routines are available for 2D or perspective representations, for tolerance, profile or linear plots, as well as for grid plots and unwindings. The flexible output graphics allows different plotters to be connected. The simple language changeover enables the output texts to be adapted to different languages.

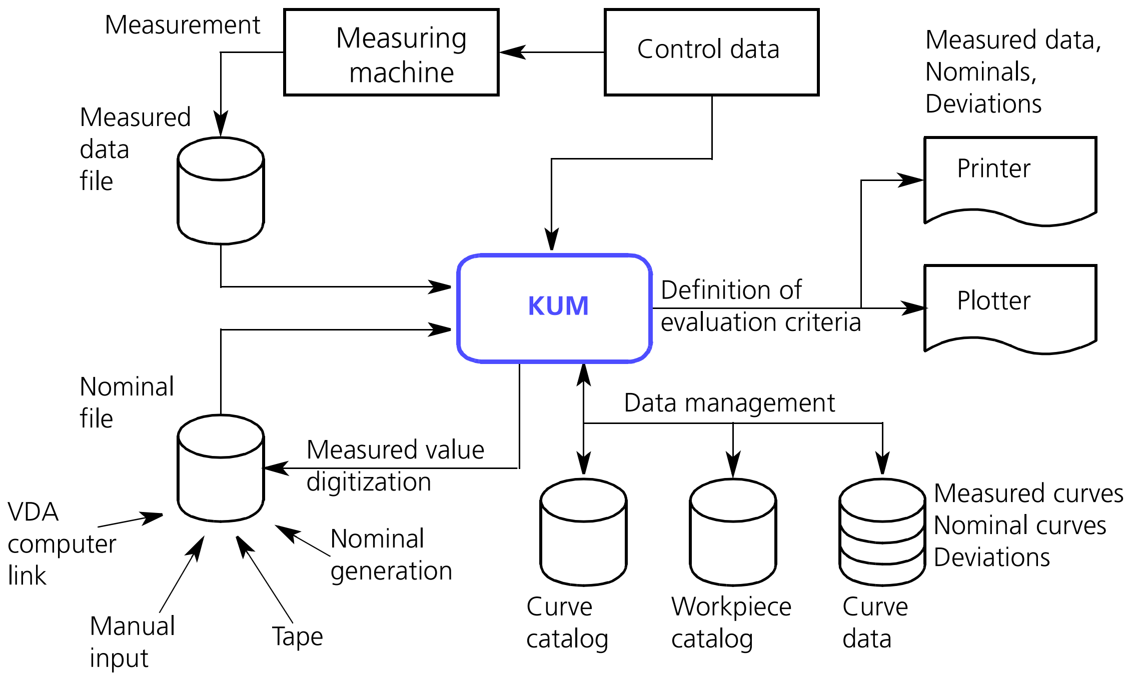
Interaction of UMESS and KUM

The KUM software package is a supplement to the main UMESS software and enables measurement of 2D or 3D curves which can be known or unknown, open or closed. When working with the curve measuring program it is assumed that the operator is familiar with using the UMESS software package. It is assumed that the machine operator is familiar with probe calibration, determination of the W-position and creating CNC programs.

The usual preparations must be made in UMESS before you can start working with KUM. The following chapters of the UMESS manual are referred to in particular:

– Probe calibration, probe catalog
– Determining the coordinate systems
– W-position determination, W-position catalog
– Control data correction
– Management and start of CNC programs
  The following is executed in KUM:
– Management of KUM workpieces, parts management
– Command blocks management, standard management
– Programming the measurement procedure
– Calculations and evaluations of curve metrology
– Graphic display and data output
– Generating data or exchanging data with other systems via VDA interface
– Data backup with the UMESS direct input **<DI 3500>**

KUM program structure



First the necessary data is acquired in a measuring run and stored. This data is then evaluated in KUM according to the criteria specified and can be displayed in a table or graph or compared with nominal values. The nominals required for the valuation can be produced in different ways; KUM offers a multitude of generation options.

Interaction with the program

Dialog between the user and KUM generally takes place via command inputs:

– selecting and
– answering input fields, as well as
– selecting the current softkey functions.

The dialog windows required are displayed on the screen corresponding to the program run in question.

The input dialog can be divided into several stages (levels). In the simplest case, you only have to press a single softkey to call a certain dialog window; on the other hand there are situations where a definite sequence of statements, dialog inputs and/or softkey actuations is required.

Function call (example)

KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*

– Press **<DEFINE>**.
– Enter the KUM command in the data boxes.
  Object: **NOM**
  Action: **EDI**
– Press **<DEFINE>**.

To facilitate the call of a specific dialog window, in this manual the function call is preceded with the input dialog necessary.

Softkeys

The softkeys can appear in the header or foot line of the window. Only those softkeys which are labelled and have a white background are active. They are generally explained after the graphics. The softkeys with a gray or blue background (which may also be labelled) do not have any significance in the menu in question.

Menu title

The menu title of a window is in the first line of the window.

Name of the window

The name of the window is in the header of the window.

Meaning of the data boxes

NOTE

In the KUM program package, the dialog windows are generally structured so that the necessary inputs are self-explanatory. The user can recognize which data input is expected with the help of the line pointer and the current labelling.

Line pointer

The line pointer is a square display box on the left of the page. At first it is located at the same level as the first data box and moves downwards line by line while the page is edited. A letter code shows which data input is expected:

I	(= Integer)	**C**	(= Numerals or capital letters),
D	(= Decimal number)	**W**	(= Angle in degrees),
c	(= Any text)	**Y**	(= Yes-No input)

Input dialog

During the input dialog, the data boxes are edited line by line from top to bottom and from left to right. In some boxes you must enter data; in these cases, the cursor only moves to the next box after a (permissible) input has been made.

Box activation

To facilitate use of the dialog windows, the current data box is highlighted white and marked by the line pointer on the left of the page. All other boxes are highlighted light blue and in this status are protected from being overwritten.

Types of data box

The data boxes can contain numerical values, texts and special characters; they can be divided into three categories, according to their meaning:

Data boxes

The data boxes are for numerical and text inputs and generally vary in length. They can be deleted by the user or new inputs made, if they are highlighted white.

Display boxes

Display boxes are used for information or checking of functions and cannot be changed in the current dialog window. These can be recognized by the fact that they are always highlighted light blue and cannot be selected (activated) by the cursor.

YES-NO boxes

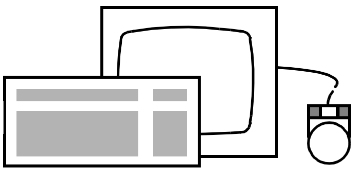
These are narrow boxes which can only be answered with **<YES>** or **<NO>** – other inputs are not allowed. If confirmed with yes, these boxes are marked with an asterisk (*) – otherwise they are left blank.

KUM Program Start

Calling the KUM Main Menu

General information

The KUM Main Menu is the central dialog window from which all further actions start. This is why all input dialogs (which are explained later in this manual) start with the KUM Main Menu; only then are individual inputs made for calling the desired program.

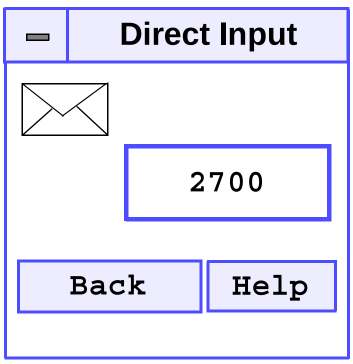


DI	Pull-Down-Menu	Pictogram
2700	Option KUM...	

Start menu: UMESS Main Menu

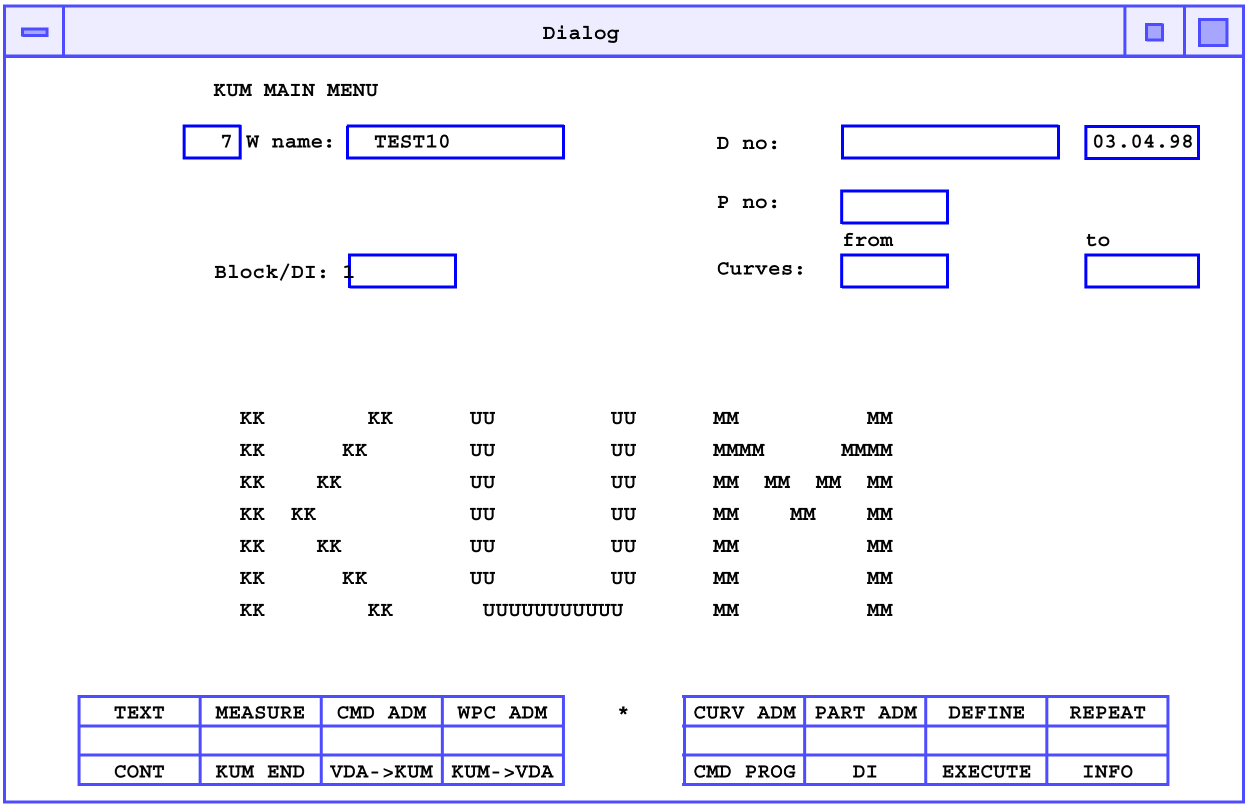
– Press **F12**.

The direct input window (DI) is then displayed.



– Enter **<2700>** in the window.

– Press **<ENTER>**.
The **KUM MAIN MENU** appears.



Softkey functions

TEXT	Generates text in the record, see UMESS manual.
MEASURE	Selection of measurement functions, ➤*““MEASUREMENT” dialog window” on page 6-4*.
CMD ADM	Call of command administration, ➤*“Administration” on page 4-15*.
WPC ADM	Call of workpiece administration, ➤*“Workpiece administration” on page 3-3*.
CURV ADM	Call of curve administration, ➤*“Curve administration” on page 3-40*.
PART ADM	Call of parts administration, ➤*“Parts administration” on page 3-22*.
DEFINE	Command input, ➤*“Using the commands” on page 4-1*.

REPEAT	Generally starts a plausibility check: The program checks whether all the input is correct and permitted in this form. If this is not the case, then the box with the incorrect input is jumped to and a message output. (Search function with workpiece administration, parts administration, main menu).
CONT	Call of the next softkey level for displaying more softkeys. If there are no more softkeys, the first softkey level is returned to.
KUM END	Return to UMESS Main Menu.
VDA-KUM	Call of VDA interface “reading VDA data”, ➤*“Transfer of VDA data to KUM” on page 10-19*
KUM-VDA	Call of VDA interface “producing VDA data”, ➤*“Converting KUM data to VDA format” on page 10-12*.
CMD PROG	PROG modes: Generation of control data Relevant boxes: Block, curves from/to
DI	Direct call of CMM or UMESS functions without exiting KUM, ➤*“Direct input of CMM or UMESS functions” on page 1-13*
EXECUTE	Execution of command block.
INFO	Information menu, ➤*“Information menu <INFO>” on page 1-11*.
TRANGLE	Rerotation about angle, see UMESS manual
DISPLACE	Zero point displacement , see UMESS manual.
ZEROPT	This function allows the origin of the workpiece coordinate system to be placed in a specific geometric element, see UMESS manual.
RTZEROPT	The rotary table position is set to 0°, see UMESS manual.
RT POS	The current position of the rotary table is displayed and a new angle position can be moved to, see UMESS manual.
RTSTEP	The current position of the rotary table is displayed, and an adjustment about a specific angle position can be entered, see UMESS manual.
RT PITCH	The current position of the rotary table is displayed and the rotary table can be rotated about an angular pitch, see UMESS manual.

RTANG

To align the rotary table parallel to the machine coordinates, see UMESS manual.

Notes on the input and display boxes

W-name:/D no:

This display box contains several workpiece-specific data which can be selected in ➤*"Workpiece selection" on page 3-5* or defined in ➤*"Creating a new workpiece" on page 3-8*.

P no

Display box with the current part number.

Block/DI

Data box for the block label:
Numerical input = command block,
Alphanumeric input = standard command block

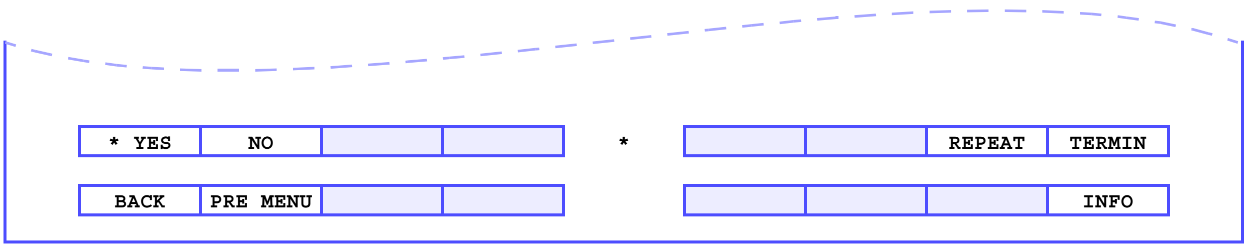
Curves from to

When defining command blocks, only the first value needs to be input; the second numerical value is then automatically set to the same value. However, this restriction does not apply for executing command blocks.

General softkey functions

Some softkeys have a general meaning; they are usually present in most dialog windows and placed in the same position.

To simplify this manual (i.e. to avoid repetition), these universally used softkeys will be explained first of all.



Universal softkeys

YES/NO

With these keys, input fields are answered with YES/NO.

If **<YES>** is pressed, an asterisk "*****" appears in this box. If the input sequence is repeated (↑ or ↓ key), this asterisk can be deleted by entering **<NO>** or replaced by a blank.

REPEAT

Usually starts a plausibility test: The program checks whether all the input in this form is correct and permitted. If this is not the case, the field is jumped to which has the faulty input and a message is output (search function with workpiece administration, parts administration, main menu).

TERMIN

Accepts the data entered and continues the operating path (e.g. jumps to the next dialog window).

BACK

Causes immediate cancelation (without executing previous inputs) and return to the KUM main menu or to the command input.

The data defined before the dialog window was called up is retained.

CONT

Call of the next softkey level for displaying more softkeys. If there are no more softkeys available, the first softkey level is returned to.

PRE MENU

Causes immediate cancelation and return to the previous menu. The data defined before the dialog window was called is retained.

INFO

The information available on the current box of the dialog window is output on the screen and the softkey assignment is changed. Different softkeys are active depending on the type of the current dialog window, input page or table (e.g. **<PRINTER>** and **<FILE>** or **<TAB PRI>** and **<TAB FILE>**).

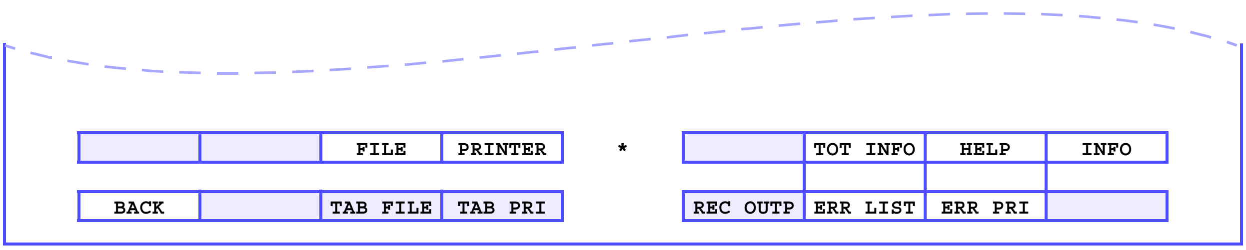
Information menu <INFO>

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

INFO

Press **<INFO>**.

A new dialog window is displayed.



Softkey functions

INFO

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

FILE

The **<FILE>** key is only active for input pages. When the function is called, the contents of the current dialog window are copied to a file called DID01BCRT_0nnk. The file directory is dependent on the operating system.
Operating system Directory
HP-UX 9.05/user/zeiss/CZ_UA
from HP-UX 10.20/home/zeiss/UA
➤*"KUM directories" on page 3-51*

PRINTER

The **<PRINTER>** key is only active with input pages. When the function is called, the contents of the current dialog window are printed out.

TOT INFO

General information on all fields of the current dialog window is displayed.

HELP

Information on the current dialog window is displayed.

TAB FILE

The **<TAB FILE>** key is only active for table dialog windows. When the function is called, the contents of the current table dialog window is copied to a file. The file directory is dependent on the operating system.

Operating system	**Directory**
HP-UX 9.05	**/user/zeiss/CZ-MES.UA**
from HP-UX 10.20	**/home/zeiss/UA**

➤*"KUM directories" on page 3-51*

TAB PRI

This key is only active for table dialog windows. In this case, the contents of the current table dialog window are printed out.

ERR LIST

Display of error list ➤*"Help with program faults" on page 1-14*.

ERR PRI

Printout of error list ➤*"Help with program faults" on page 1-14*.

REC OUTP

This softkey does not have any function in the program version.

Direct input of CMM or UMESS functions

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DI

Press **<DI>**.

A new window is displayed.

In the KUM menu, it is possible to call UMESS or CMM functions directly without leaving the KUM program.

Basically, the call of UMESS functions is only allowed in the **KUM Main Menu** and in the **KUM Measurement Menu**. Both of these have the **<DI>** softkey.

When the **<DI>** softkey is pressed, the direct input number is read from the box provided for input of the function number and checked. The direct input is then executed. Where appropriate, an input dialog is carried out. In the PROG mode, control data is generated if required.

Possible DI's

The direct inputs allowed are listed in the following ASCII files:

HP-UX 9.05 operating system

KUM Main Menu: **/users/zeiss/CZ_MES_UN/D__DIRWAL1_0__K**

KUM Measurement Menu: **/users/zeiss/CZ_MES_UN/D__DIRWAL2_0__K**

From HP-UX 10.20 operating system

KUM Main Menu: **/opt/zeiss/UN/D__DIRWAL1_0__K**

KUM Measurement Menu: **/opt/zeiss/UN/D__DIRWAL2_0__K**

NOTE

– These files can be extended if required by the system administrator. However, not all DIs are suitable for calling from other programs.
– These files may be renewed if the measuring software is updated.

Help with program faults

In order to be able to limit and remove errors due to a fault in the program run, a good error description and localization of the relevant program section is required. A printout of the current error file **ERRDOK-----$_{xx}$B** is helpful for the user.

(In the error file identification, $_{xx}$ = session number, ➤*"KUM directories" on page 3-51*) in the directory.

Operating system	Directory
HP-UX 9.05	**/users/zeiss/CZ_MES_UJ.**
from HP-UX 10.20	**/var/opt/zeiss/UJ**

If program errors occur, we recommend you contact the competent Hotline and send them the relevant error file.

Printing an error file

The current error file can be shown and/or printed as follows:

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

– Press **<INFO>**.
– Press **<ERR LIST>**.
  The error list is displayed.
– Press **<ERR PRI>**.
  The error list is printed.

Data errors occurring

Incomplete data

In unfavorable cases, the use of the commands **NOM EDI** or **MVA EDI** (edit nominals or measured values) and **ACT CAL** (calculate actual values) may lead to the data gained being incomplete.

With the **NOM LIS** command (list nominals) you can determine with the error code the data which is missing (**ER** output column, ➤*"Output columns for nominals" on page 8-4*).

Identical points

Identical points may occur during measurement. Using the commands **NOM COR** (correct nominals) or **MVA COR** (correct measured values), data errors and identical points can be deleted, ➤*"Check of nominal and measured data" on page 1-15*.

Check of nominal and measured data

With **NOM COR** (correct nominals) or **MVA COR** (correct measured values), the data errors mentioned in Chapter 1.3.1 and identical points can be automatically found and corrected or deleted. No additional dialog window is required to do this, you only have to enter the corresponding command.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

– Press **<DEFINE>**.

– Enter the following information in the data boxes.
  Object: **NOM**
  Action: **COR**
  or
  Object: **MVA**
  Action: **COR**

– Press **<DEFINE>**.

– Limit for double points mft $2e^{-4}$

UMESS 0.01* CMM resolution

Chapter 2

Definition of Terms

This chapter contains:

Terms used in curve metrology

Geometric elements such as circle, line, plane, cylinder etc. and their links can be measured quickly and reliably with the measuring routines of the standard UMESS measuring program. To measure freely-formed workpiece surfaces, i.e. on workpieces which have no flat, cylindrical, spherical or conical limiting surfaces, special measuring techniques are required.

With the KUM curve measuring program, you have available a universal curve measuring program with which known and unknown, 2D and 3D as well as open and closed curves can be measured and evaluated.

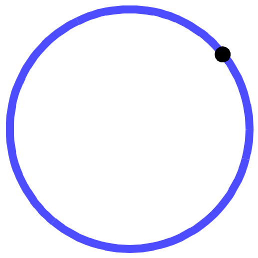
Due to the complexity of the material, special technical terms often cannot be avoided and are also to be found in this manual. For better understanding, the most important terms are presented and explained in the following sections.

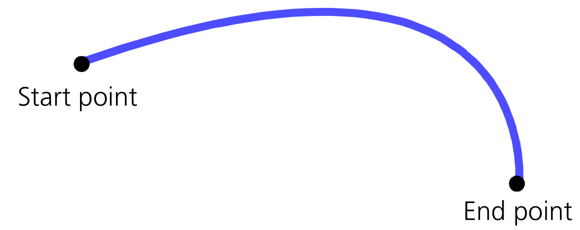
Open curve - closed curve

In general usage, a curve is a curved line in space. A special form is a 2D curve where all curve points lie in a plane. Curves can be described for example by a mathematical equation (polynomial), by support points or by the intersection of two planes.

In KUM a curve is described by a number of points on a 3D or 2D line ➤*"Types of curve" on page 2-10* . When nominal and measured curves are compared, the local deviations are determined and shown in a table or graph.

With a closed curve, the first nominal is identical to the last nominal, i.e. start and end point of the measurement coincide. With open curves, the start and end point lie apart and are not connected.





Known curve - unknown curve

Known curve

The term “known curve” is used if data already exists for the nominal curve on the workpiece of interest. After the measurement, a nominal-actual comparison can be made, e.g. calculation of a 2D or 3D deviation with graphical or numerical display.

Unknown curve

When measuring unknown curves (e.g. for digitizing 3D models) there is as yet no information on the spatial curvature (= contour in scanning direction) and the transverse (= contour transverse to the scanning direction). After the first measurement of an “unknown curve” the measured values gained can be displayed in a graph or table; normally the nominals are calculated from these. With this nominal data record, the same curve can be treated in a second measuring run as a known curve.

Measured value - contact point

Measured value

In general measuring technology, measured values are the result of measurements; they are given by numerical values and identified with a unit of measurement.

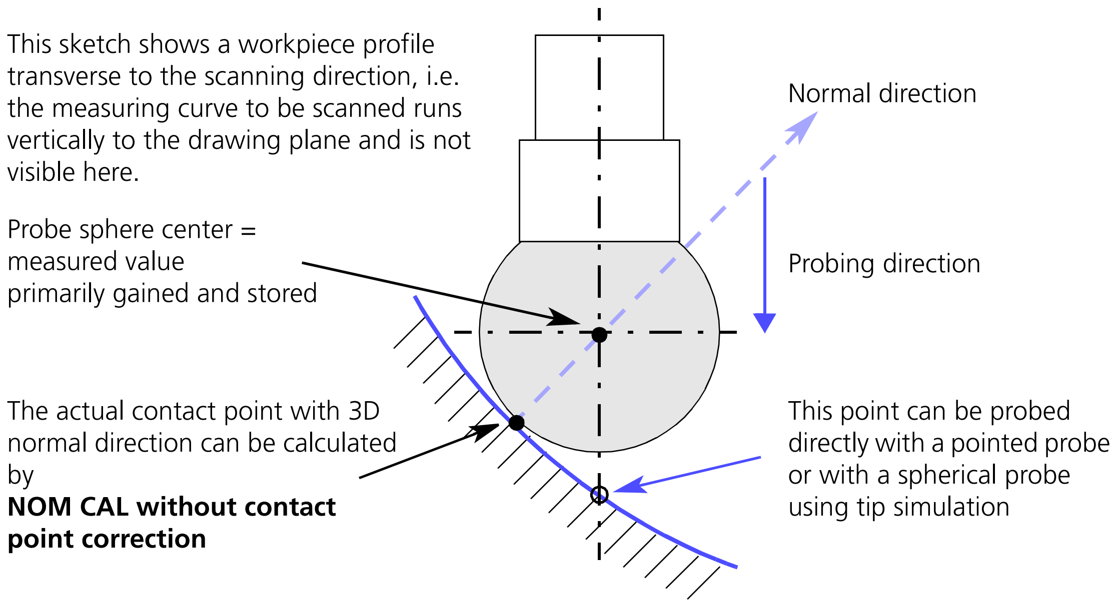
In KUM (primary) measured values are the probe center point coordinates which are gained and stored when measuring a workpiece. From the **primary measured values** the applicable **contact points** (by correcting the probe sphere radius), and the **actual values** (nominal + deviation) can be calculated.

Contact point

The **contact point** is the common point of the probe sphere and workpiece surface during probing. The **contact curve** results from connecting all the contact points. The coordinate points of the contact curve are only identical with the (primary) measured values when using a **pointed probe**; when using a **spherical probe** an offset/displacement occurs between measured and contact curve with **lateral inclinations** which can, however, be determined mathematically.

Lateral inclination

The curvature transverse to the course of the curve (lateral inclination) results in the contact point of the probe sphere not coinciding with the required measured point on the curve. If the transverse changes during the measuring run, this causes an additional **wandering** of the contact point on the probe sphere and the workpiece. This effect can be determined mathematically with a **special measuring method** and compensated by corresponding calculations in the measurement result, sketch ➤ *"3D measurement" on page 6-11* .



Nominal value - actual value - deviation

Nominal value

In KUM workpieces are described by nominal curves. For a complete description, several nominal curves may be needed at different section heights, depending on the workpiece and accuracy requirements.The nominal value is the reference size from which the applicable measured values should deviate as little as possible. Nominal values can be gained by direct input, generation, digitization or transfer from other computer systems.

Actual value

In general metrology, the actual value is the observed value of a magnitude (definition according to DIN 55350); generally it deviates more or less marked from a specified nominal value. The following relationship applies in KUM:

NOTE

Actual value = Nominal value + Deviation

Measuring uncertainty

Basically with all measuring runs, the actual values gained are affected by a machine-specific measuring uncertainty. In KUM when referring to nominals, the actual values can be defined in two different ways:

– Actual values from the deviation calculation in the normal direction of the nominal.

– Actual values from the deviation as distance nominal point – contact point
(only with the same number of nominals and measured values).

Deviation

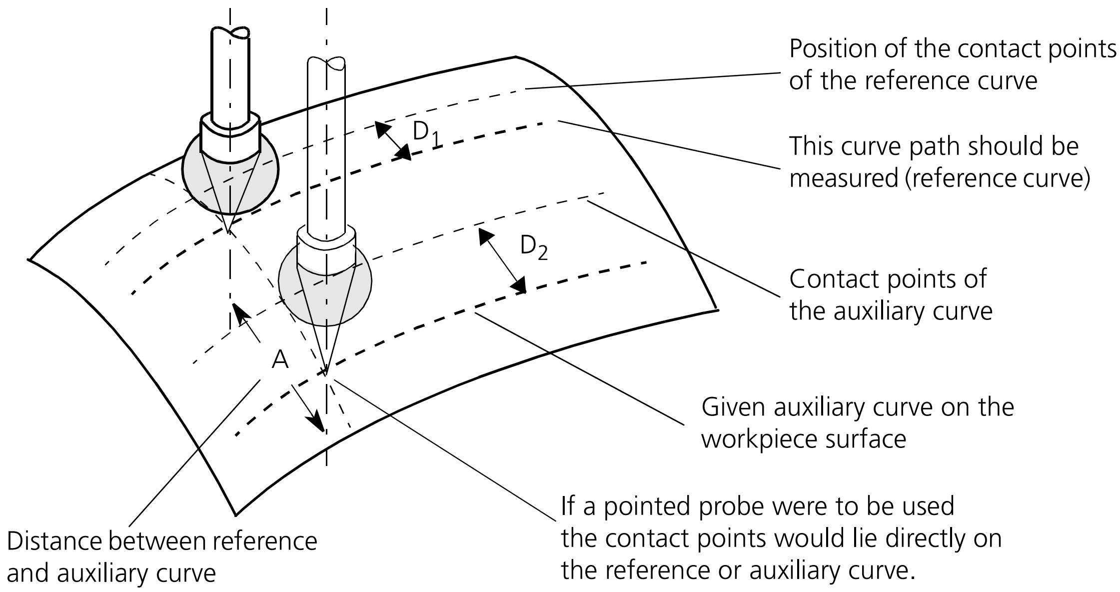
In KUM the deviation is the difference between nominal and measured value.

The deviations principally refer to the nominals and are defined as 3D vectors. During calculation two basic types of deviation are differentiated, drawings ➤*"(Standard) deviation calculation" on page 7-18* .

– Deviation in normal direction:
  Distance between actual and nominal value in the normal direction of the nominal value.

– Deviation from the nominal point to the contact point:
  The distance between nominal and contact point of the probe sphere is defined, with the same number of nominal and measured points.

Reference curve - Auxiliary curve



In order to calculate the 3D normals for the contact curve, an auxiliary curve is needed. This auxiliary curve has to lie parallel to the contact curve. First the contact point correction (➤ *"Contact point correction with 3D normals" on page 7-6*) calculates the theoretical contact points and the 3D normal directions for the reference curve.

Notes on defining the auxiliary curve

– In many cases half the diameter of the probe sphere can be used as distance between reference and auxiliary curve (A). This corresponds to a realistic distance of 0.1 mm up to a few millimeters. However, a distance of 0.1 mm may even be too much with large curvature differences!

– The number of nominal points of both curves does not have to be identical. However, the mathematical accuracy increases the more points there are.

– The greater the transverse slope between reference and auxiliary curve, the smaller should be the probe sphere radius used.

– If a spherical probe is used for probing, the contact points are shifted with increasing transverse slope to the reference curve (see D_1 and D_2 in the drawing). The measuring point required on the reference curve can be calculated using the tip simulation.

Surface normal - Direction cosine

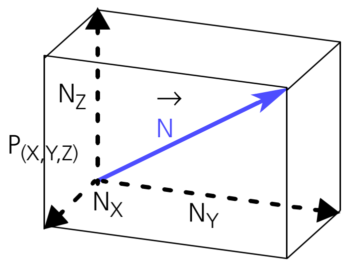
Normal vector

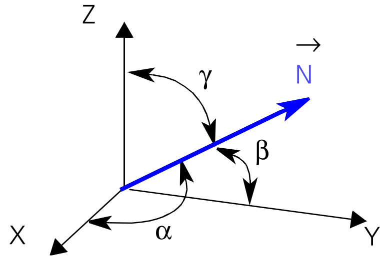
"Normal" is the abbreviation for the normal vector of the surface. The normal vector of the surface is the cross product between the two tangential vectors of a surface at the point considered; i.e. the normal is vertical to the tangential plane of the surface at the point considered and has the length 1 (= unit vector, definition according to Dreszer 1975).

Direction cosine

In KUM the normal lies vertical to the surface at the curve point considered and points away from the material (surface normal). The direction cosine is the component of the normal vector. If the surface normal is projected into the coordinate planes, the direction cosine is received.

The cosine of the angle between the normal vector of the surface (unit vector N) and the respective coordinate axis is identified as the direction cosine. The +/- sign of the cosine corresponds to that of the direction of the coordinate axis.





Direction cosine NX = cos α — α = Angle between X-axis and normal vector

Direction cosine NY = cos β — β = Angle between Y-axis and normal vector

Direction cosine NZ = cos γ — γ = Angle between Z-axis and normal vector

The projection of the unit vector onto the coordinate axes results in the components N_X, N_Y and N_Z in the cartesian coordinate system. These components are called "direction cosines" and are assigned to the angle enclosed between the unit vector and the respective axis. A measured point in space is defined by 6 values:

– 3 point coordinates (X, Y, Z) or (R, ϕ, H) or (R, ϕ, θ)
– 3 normal vectors (N_x, N_y, N_z).

NOTE

So that the vector N is a standardized vector, you must make sure that the total of the direction cosines squared is always 1 ($N_{X2} + N_{Y2} + N_{Z2} = 1$).

Deviation

Whereas when measuring geometric elements, (e.g. circle or surface) the deviation always takes place in the direction previously defined (measurement direction, axis direction), with curve measurement the direction of the deviation is dependent on the calculation type specified, ➤*"Deviations - Main menu" on page 7-16* .

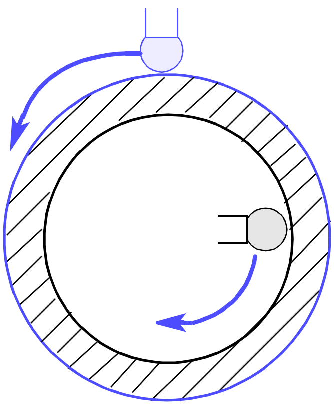
To assess the deviation, the normal direction of the curve points (vertical to the surface) is normally used. Deviations in the normal direction **(too much material)** are marked as **positive** and deviations opposite to the normal direction **(too little material)** are marked as **negative**.

Direction of travel

If the contour of a workpiece is to be measured, the scanning direction must be specified. If surfaces are very curved (especially with closed curves) the probe follows the workpiece contour, so that no linear direction must be given but the "direction of travel". This can be **positive** or **negative** depending on the task, whereby **inner** and **outer contours** must be differentiated.

Definition of the **positive direction of travel**
on a workpiece with inner and outer contour

If you look from the positive direction of the space axis onto the measuring plane, the probe element travels along the contour *in the counterclockwise direction*.



If you look from the positive direction of the space axis onto the measuring plane, the probe element travels along the contour *in the clockwise direction.*

Best fit

In measuring technology, what is understood as **best fit** is the mathematical separation of form and position deviations. In KUM this is the mathematical correction of the position deviation referring to the applicable nominal curve. In this case, the contact points of the probe sphere are shifted and/or rotated according to preset criteria, until the total of the deviations squared shows a minimum; only the form deviation is left as the result, ➤*"Deviations - Main menu" on page 7-16* , ➤*"Best fit of measured values" on page 7-44* .

Types of curve

Normally a **curve** is described as a curved line – in contrast to a straight line. Features of a curve are, apart from the location coordinates, the corresponding tangents and normals. The accuracy of a curve is influenced by the selection of suitable measuring and calculation methods.

In KUM, curves are shown in the form of support points or coordinates in a cartesian, cylinder or sphere coordinate system (➤ *"Coordinate systems" on page 2-15*).

The curve itself is described in more detail with curve specific data:

– Type of curve (open – closed).

– Number of points.

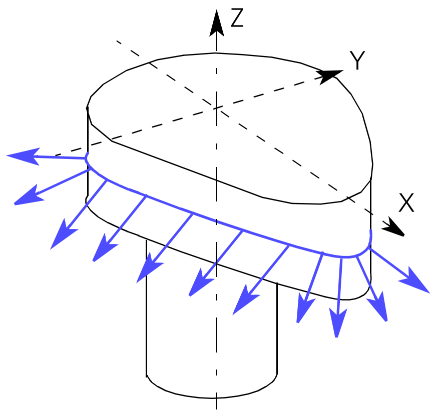
– Catalog on the existence of the following data: Coordinates, normals, tangents, tolerances, probing vectors, equidistants, curve center of gravity, arc lengths.

Flat curves (2D measurement)

Flat curves result on workpieces with two dimensional curve paths (e.g. control cams, camshafts, curve templates, polygon courses etc.). All curve points on a 2D curve lie in a plane which lies parallel to the main plane of the workpiece system. The normal direction is vertical to the measuring plane.

Conversion main menu 2D normal, 3D tangent

Characteristics one coordinate ~ constant (i.e. one component ~ 0)
two components variable



A typical part with a flat curve is a prismatic workpiece with a revolving [continuous?] curve path (e.g. control cam).
A characteristic feature here is that the curve form remains the same over a specific height range.

The result of this is that all normal directions are in one plane.

Spatial curves (3D measurement)

When measuring surface forms that are not flat, these curves are known as spatial curves, e.g. turbine blades, rotor blades, turbine wheels, propelling screws, impellers, worm compressors, model objects, car bodies, etc.

Three types of curve are differentiated with 3D curve measurement:

– Contour
– Edge line (line of intersection)
– Face cam.

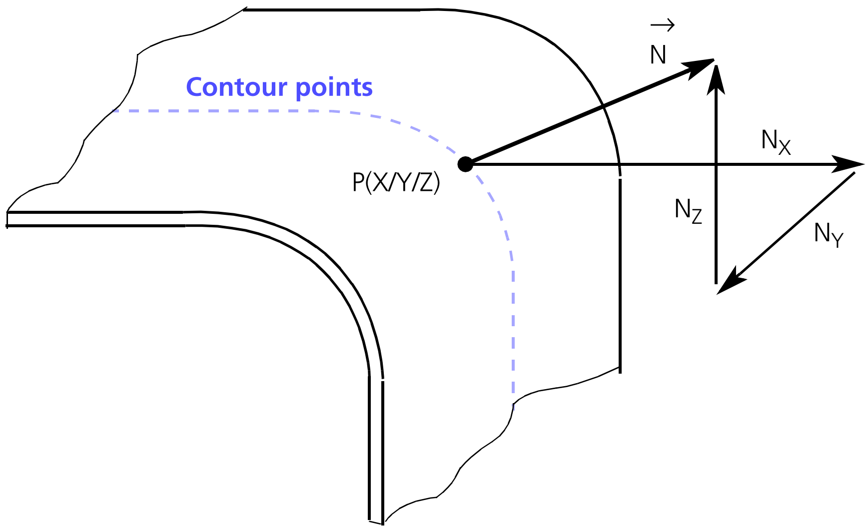
Contour

A contour consists of points whose point coordinates can be determined as well as their normal directions.

A contour lies on a uniform surface, i.e. all points have well-defined point coordinates and normal directions. The deviation of the contour is calculated in the direction of the normal.

Conversion main menu 3D normal, 3D tangent

Features 3D coordinates



Edge profile

Edge points

If two surface areas are connected by a rounded edge, the theoretical intersection line can be calculated by extrapolation of the two surface areas (mathematical extension). This geometric element is used in particular in car body manufacture and is called an edge profile. The virtual points, i.e. points which cannot be physically probed, are called edge points.

Virtual curve

As the edge profile cannot be measured directly, the relevant edge points must be calculated. The edge profile belongs to the group of virtual curves for which no normal direction can be defined.

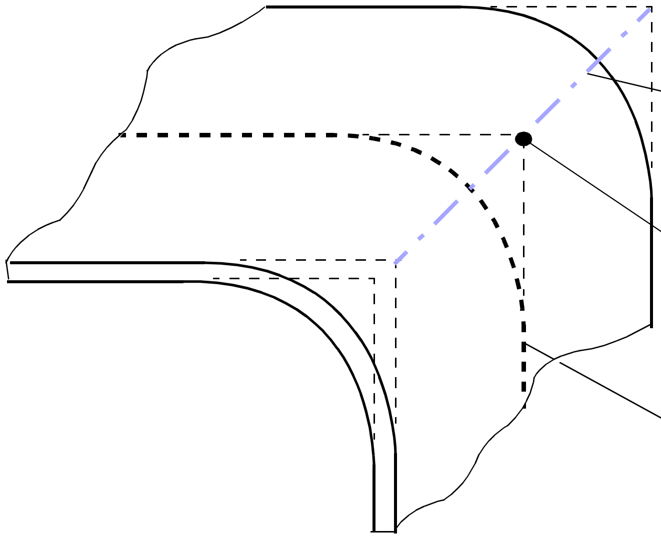
When measuring a workpiece, the deviation is given as the distance between nominal and actual value. Prerequisite for this is that the number of actual values is identical to the number of nominals.

Conversion main menu

3D tangent, no normal

Features

3D coordinates



Face cam

Constant radius

In some cases, only the curve deviation in one direction is of interest (e.g. pitch on a cylinder cam). The curve progresses in a constant radius about the rotation axis.

Deviation

The deviation to the nominal curve in this type of curve is given **in one direction** only, and this is calculated **parallel to the axis direction** in the normal direction.

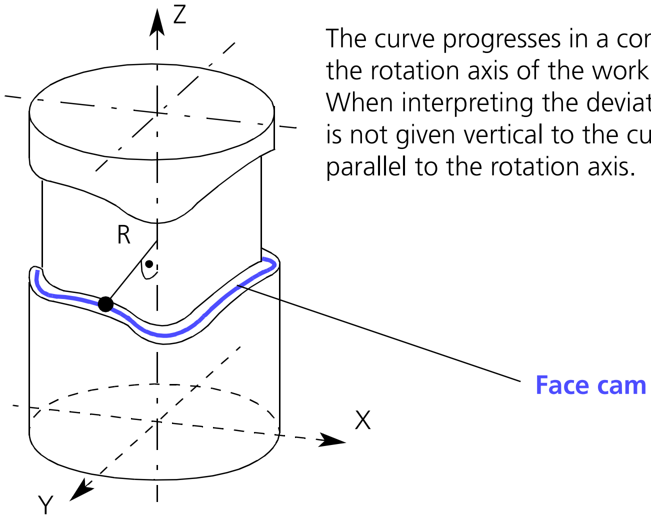
The evaluation takes place by showing the curve unwound, in a linear plot.

Conversion main menu

2D tangent, 2D normal

Features

3D coordinates (one component = 0); only the normal component parallel to the rotation axis is taken into consideration



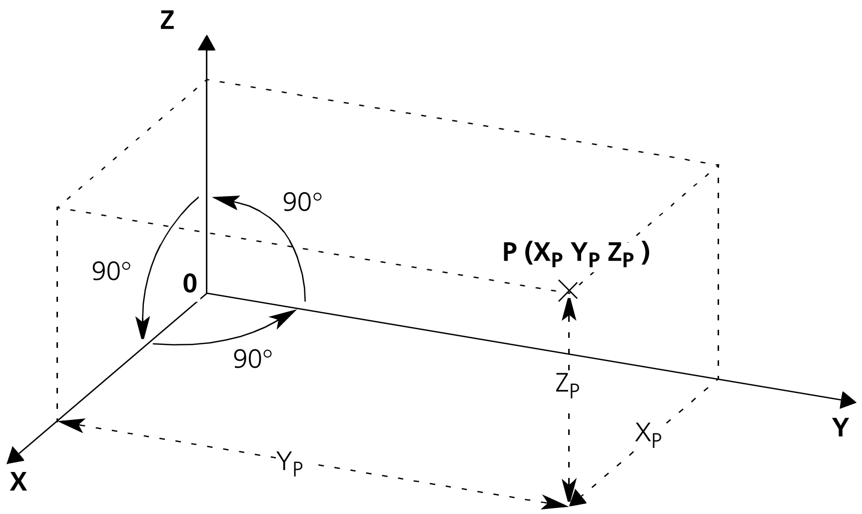
The curve progresses in a constant radius about the rotation axis of the workpiece.
When interpreting the deviation, note that this is not given vertical to the curve form but parallel to the rotation axis.

Coordinate systems

A spatial curve is completely described by the coordinates of the curve points and the corresponding normal directions. It does not matter whether the points in space are **cartesian coordinates, sphere coordinates** or **cylinder coordinates.** If required, the location coordinates can be converted from one coordinate system to another.

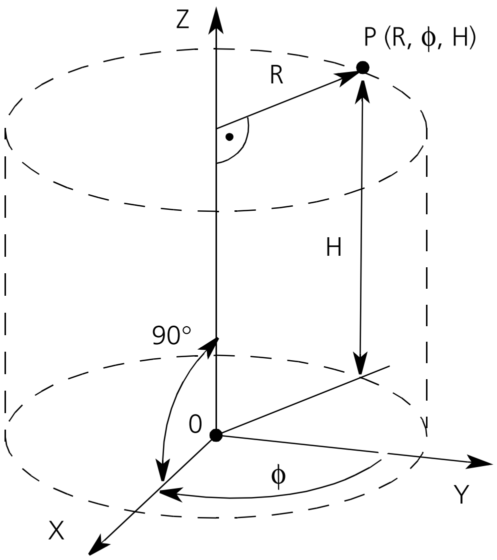
Cartesian coordinates

The position of a point P is described by 3 coordinates X, Y and Z. The coordinate axes are vertical to one another. Two axes form the measuring plane, the third axis is the space axis.



Cylinder coordinates

Use of the cylinder coordinate system is of particular advantage with rotationally symmetrical parts. The position of a point P in space is described by the vertical distance R from the space axis, the angle of rotation ϕ (pi) to the reference axis and the height H over the reference plane (measuring plane). The coordinate zero point and the reference axis lie in the reference plane, the space axis is vertical to the reference plane.

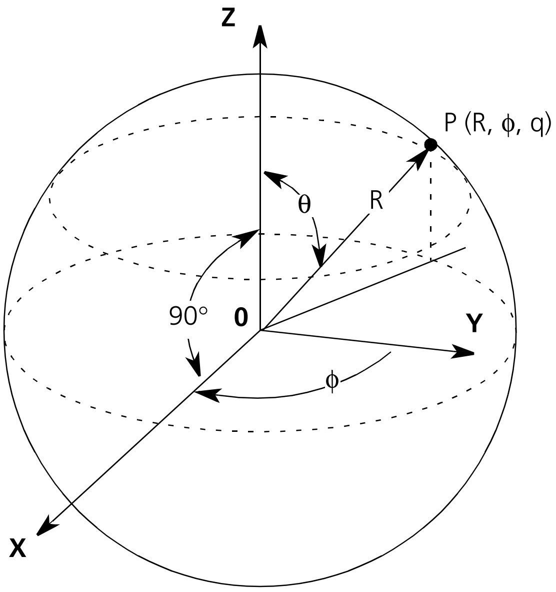


The following assignment applies for the rotation angle ϕ
(view from the positive space axis onto the reference plane):

Positive rotation angle with left hand (counterclockwise) rotation or negative rotation angle with right hand (clockwise) rotation

Sphere coordinates

The position of a point (P) in space is described by the radial distance from the coordinate zero point (R), the rotation angle ϕ (pi) to the reference axis and the tilt angle θ (theta) to the positive space axis. The coordinate zero point and the reference axis lie in the reference plane; the space axis is vertical to the reference plane.



The following assignment applies for the rotation angle ϕ
(view from the positive space axis onto the reference plane):

Positive rotation angle with left hand (counterclockwise) rotation or negative rotation angle with right hand (clockwise) rotation

Only positive values are permitted for the tilt angleθ (between 0° and 180°).

Chapter 3

Data Administration

This chapter contains:

Workpiece

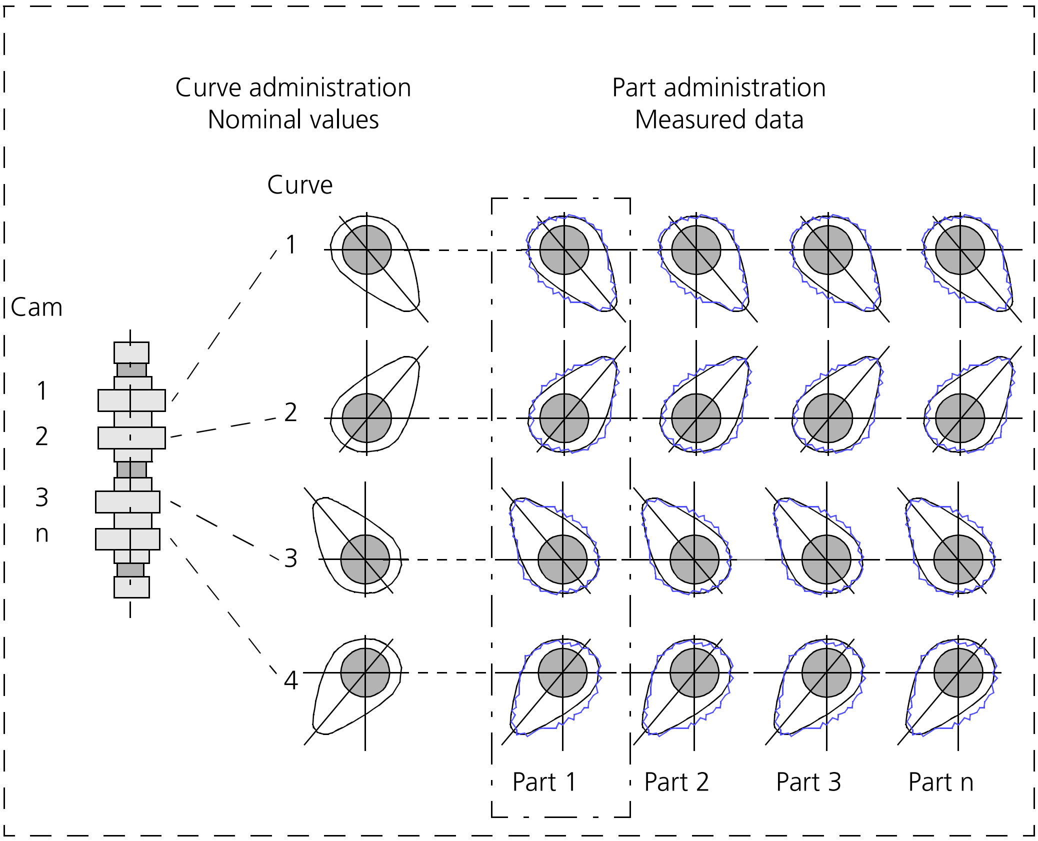
Each workpiece can consist of several curves. A typical example for a workpiece is a camshaft. In our example, the camshaft consists of 4 cams, ➤*"Workpiece administration" on page 3-3*.

Curve administration

Each cam is different to the next. This is why a nominal curve (nominal data) is saved for each cam. This is saved in the curve administration, ➤*"Curve administration" on page 3-40*.

Parts administration

The measured data (actual data) for all curves is gained after a measurement. This can be saved in the part administration, ➤*"Parts administration" on page 3-22*.



Directories

Listing of the directories where the data is saved, ➤*"KUM directories" on page 3-51*.

Workpiece administration

Workpiece

A workpiece can be identified by three parameters:

- Workpiece number
- Workpiece name
- Drawing number

Every workpiece must be identified by *at least one* parameter. You can decide whether you want to use the other parameters for a more accurate specification.

Functions

The following functions are available for the workpiece administration:

- Selecting a workpiece, ➤*"Workpiece selection" on page 3-5*.
- Creating a new workpiece, ➤*"Creating a new workpiece" on page 3-8*
- Listing the workpiece catalog on the screen, ➤*"Listing the workpiece catalog on the screen" on page 3-10*.
- Deleting a workpiece, ➤*"Deleting a workpiece" on page 3-12*.
- Correcting a workpiece name, ➤*"Workpiece administration" on page 3-3*.
- Releasing a workpiece.
  Start menu: KUM main menu, ➤*"Setting the workpiece "free"" on page 3-18*.

WPC-ADM

- Press softkey **<WPC ADM>**.
  The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.

Softkey functions

TERMIN
INFO
PRE MENU
REPEAT
BACK

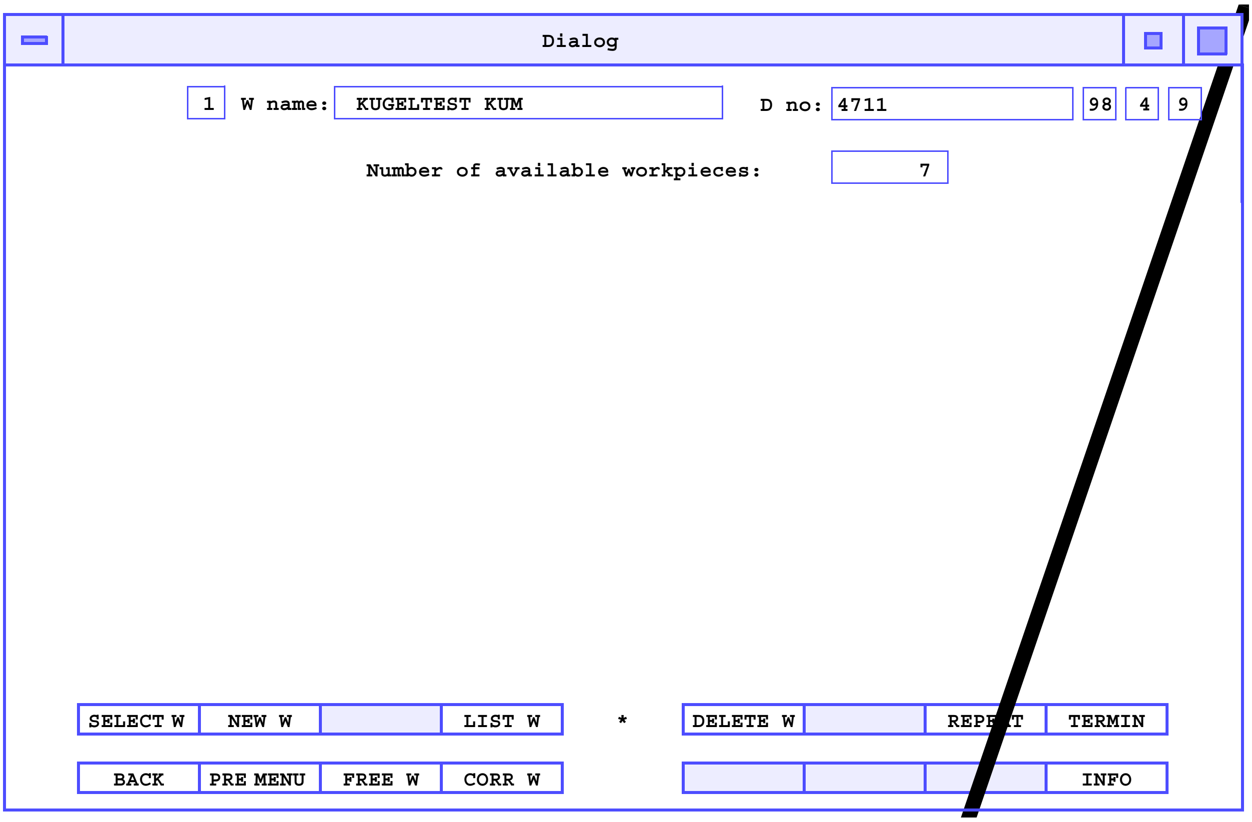
See general softkey functions, ➤*"General softkey functions" on page 1-10*.

SELECT W

To select an existing workpiece, dialog window ➤*"Workpiece selection" on page 3-5*

NEW W

To create a new workpiece, dialog window ➤*"Creating a new workpiece" on page 3-8*.



LIST W

To list the workpiece catalog on the screen, display ➤*"Listing the workpiece catalog on the screen" on page 3-10*.

DELETE W

To delete an existing workpiece from the workpiece catalog, dialog window ➤*"Deleting a workpiece" on page 3-12*.

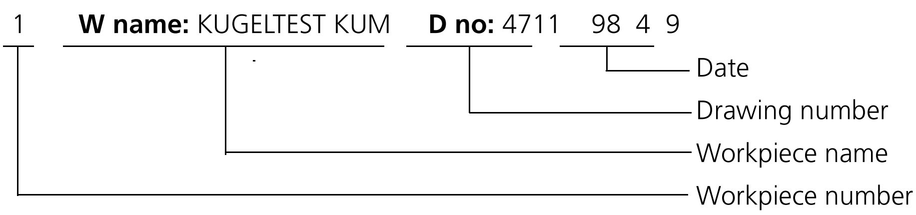
FREE W

To release a locked workpiece, dialog window ➤*"Setting the work-piece "free"" on page 3-18*.

CORR W

Correction of workpiece-specific data of an existing workpiece, ➤*"Correction of the workpiece identification" on page 3-16*.

Notes on the input and display boxes



These display boxes contain workpiece-specific data, ➤"*Workpiece selection" on page 3-5*. This header generally also appears for all subsequent dialog windows, whereby the workpiece data displayed cannot be changed.

The workpiece displayed is the current workpiece.

Number of available workpieces

The number of available workpieces is displayed in this field.

Workpiece selection

You are supported by a search function for selecting the workpiece

At least one characteristic must be defined from one of the three data boxes (workpiece number, workpiece name, drawing number). If the input is incomplete, the other characteristics are automatically completed by the program.

Input with search function

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

WPC ADM

– Press softkey **<WPC ADM>**.
  The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.

SELECT W

– Press softkey **<SELECT W>**.
  The dialog window with the menu title **KUM WORKPIECE SELECTION** is displayed.

YES

– Define at least one parameter using **<YES>** and the corresponding names or numbers.

REPEAT

– Press softkey **<REPEAT>**.
  The program completes or changes the missing parameters.

NOTE

Please note the priority of the parameters when working with the search function:
Workpiece number = highest priority
Workpiece name = average priority
Drawing number = lowest priority
If several parameters are entered, the program first checks the parameters with the highest priority to see if it matches. If it does, the other parameters are changed.

Example

The following workpieces exist:

Workpiece no.	Workpiece name	Drawing no.
1	Jack	
2	Peter	22
3		33

If you enter:

2

you will get the following display after pressing **<REPEAT>**

2	Peter	22

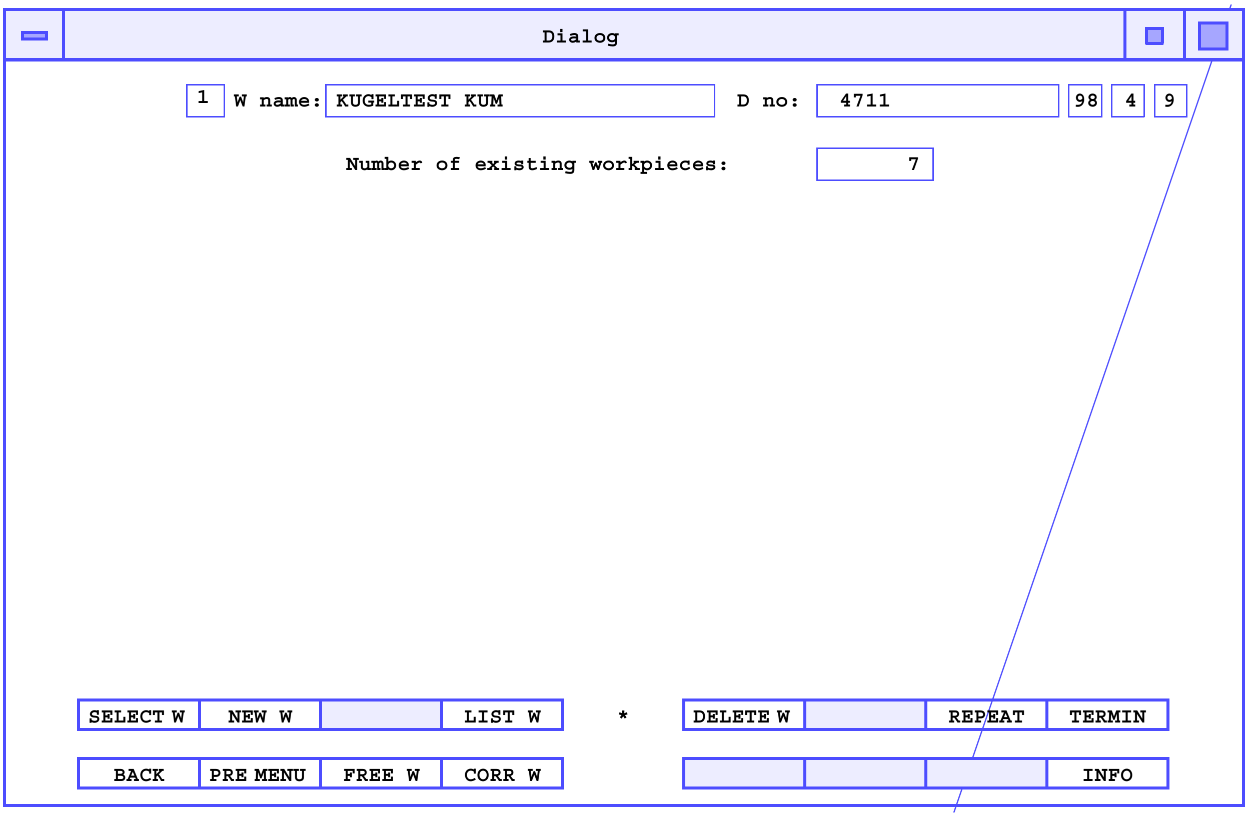
If you enter the "wrong" input:

3	Jack	

you will get the following display after pressing **<REPEAT>**

3		33

Explanation: The workpiece number has a higher priority than the workpiece name.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

REPEAT

This key can be pressed after the input of at least one workpiece characteristic. The input fields which are blank are completed automatically.

Notes on the input and display boxes

Workpiece number The workpiece number can be entered after confirming with **<YES>**.

Workpiece name The workpiece name can be entered after confirming with **<YES>**.

Drawing number The drawing number can be entered after confirming with **<YES>**.

Creating a new workpiece

Creation of a new workpiece and definition of the maximum number of curves to be measured (Curve administration ➤*"Parts administration" on page 3-22*).

- Inputs for **Workpiece name** and **No. of curves** must be made.
- Input for the drawing number is not necessary.
- The same workpiece names can be differentiated by different drawing numbers.

  If it becomes apparent that the "No. of curves" has been selected too small when the workpiece was created, this can be changed with **WORKPIECE CORRECTION**, ➤*"Correction of the workpiece identification" on page 3-16*.

Creating a new workpiece

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*

WPC ADM

- Press **<WPC ADM>**.

  The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.

NEW W

- Press **<NEW W>**.

  The dialog window with the menu title **KUM NEW WORKPIECE** is displayed.
- Define the parameters in the data boxes

  – workpiece name,

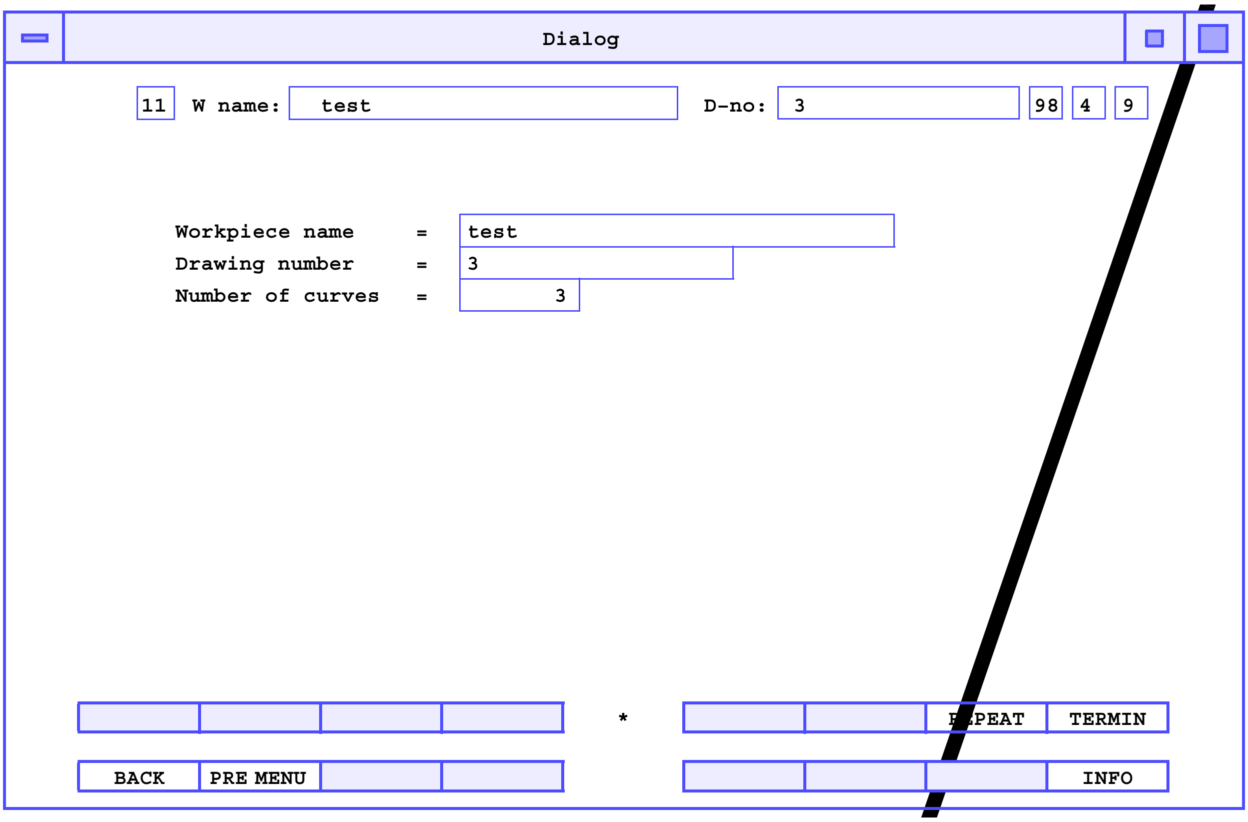
  – if necessary the drawing number,

  – number of curves.

TERMIN

- Press **<TERMIN>**.

  The program transfers the data entered. The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.



Softkey functions

INFO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

TERMIN

Causes the data entered to be transferred. The window with the menu title **KUM WORKPIECE ADMINISTRATION** is returned to.

Notes on the input and display boxes

Workpiece name
Input of the workpiece name of the new workpiece (max. 30 characters).

Drawing number
Input of the drawing number of the new workpiece (max. 18 characters).

Number of curves
Input of the **maximum** number of curves to be measured (up to 999)

Listing the workpiece catalog on the screen

Display of the entire workpiece catalog on the screen. A list is displayed of:

- the workpiece numbers occupied
- the workpiece names used
- the drawing numbers used
- number of existing parts
- the date of the last workpiece selection
- the session number

Listing the workpiece catalog

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

WPC ADM

- Press **<WPC ADM>**.
  The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.

LIST W

- Press **<LIST W>**.
  The dialog window with the menu title **KUM WORKPIECE CATALOG** is displayed.

SELECT L

TERMIN

- To select a specified line.
  Press **<SELECT L>**. Enter the line desired in the data box.
  Press **<TERMIN>**.
  The workpiece catalog jumps to the line selected.

PAGE UP

PAGE DOWN

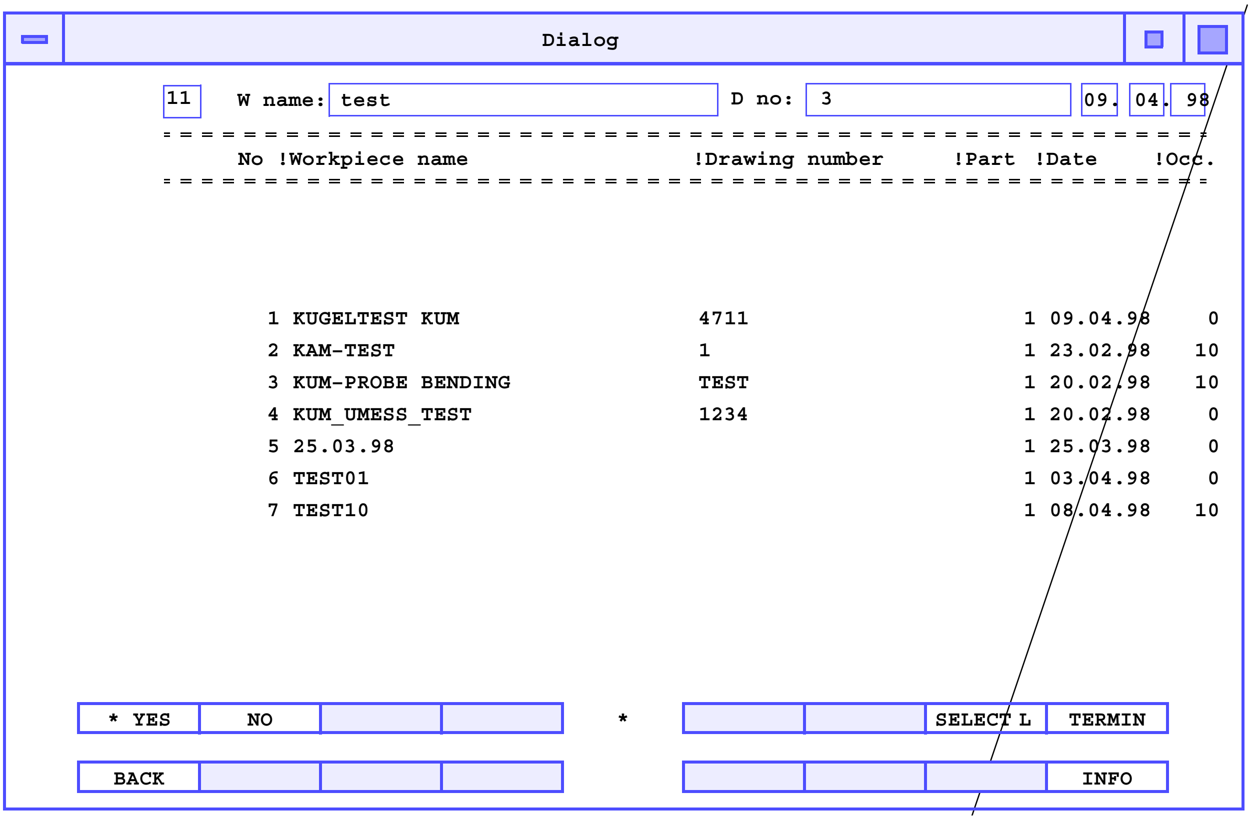
- To scroll to the next or previous page.
  Press **<PAGE UP>** or **<PAGE DOWN>**.
  The workpiece catalog scrolls to the next or previous page.

SHIFT

- To jump to the next or previous line.
  Press the **<SHIFT>** key and keep this pressed down. Press either the ↑ or ↓ key. The workpiece catalog jumps to the next or previous line.

TERMIN

- Press **<TERMIN>**.
  The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.



Softkey functions

TERMIN
INFO
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

YES
NO

These softkeys do not have any function in this dialog window.

SELECT L

Line selection. The line to which you want to jump can be entered in the data box.

Notes on the input and display boxes

No. Workpiece name

Drawing number Part Date Occ.

Workpiece number, workpiece name, drawing number, number of parts available under this drawing number, date of last workpiece selection and session number which the workpiece occupies ➤*"KUM directories" on page 3-51*.

Deleting a workpiece

To delete a workpiece from the workpiece catalog. You are supported by a search function for selecting the workpiece.

At least one feature must be defined from the **three input fields** (workpiece numbe, workpiece name, drawing number). If the input is incomplete, the program automatically completes the other features.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

WPC ADM

– Press **<WPC ADM>**.
  The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.

DELETE W

– Press **<DELETE W>**.
  The dialog window with the menu title **KUM DELETE WORKPIECE** is displayed.

DELETE W

– Press **<DELETE W>**.
  The dialog window with the menu title **KUM DELETE W** is displayed.

YES

– Define at least one parameter using **<YES>** and the corresponding names or numbers.

REPEAT

– Press **<REPEAT>**.
  The program completes or changes the missing parameters.

NOTE

Please note the priority of the parameters when working with the search function:
Workpiece number = highest priority
Workpiece name = average priority
Drawing number = lowest priority
If several parameters are entered, the program first checks the parameters with the highest priority to see if it coincides. If it does, the other parameters are changed.

Example

The following workpieces exist:

Workpiece no	Workpiece name	Drawing–no
1	Jack	
2	Peter	22
3		33

If you enter:

2

you will get the following display after pressing **<REPEAT>**

2	Peter	22

If you enter the "wrong" input:

3	Jack	

you will get the following display after pressing **<REPEAT>**

3		33

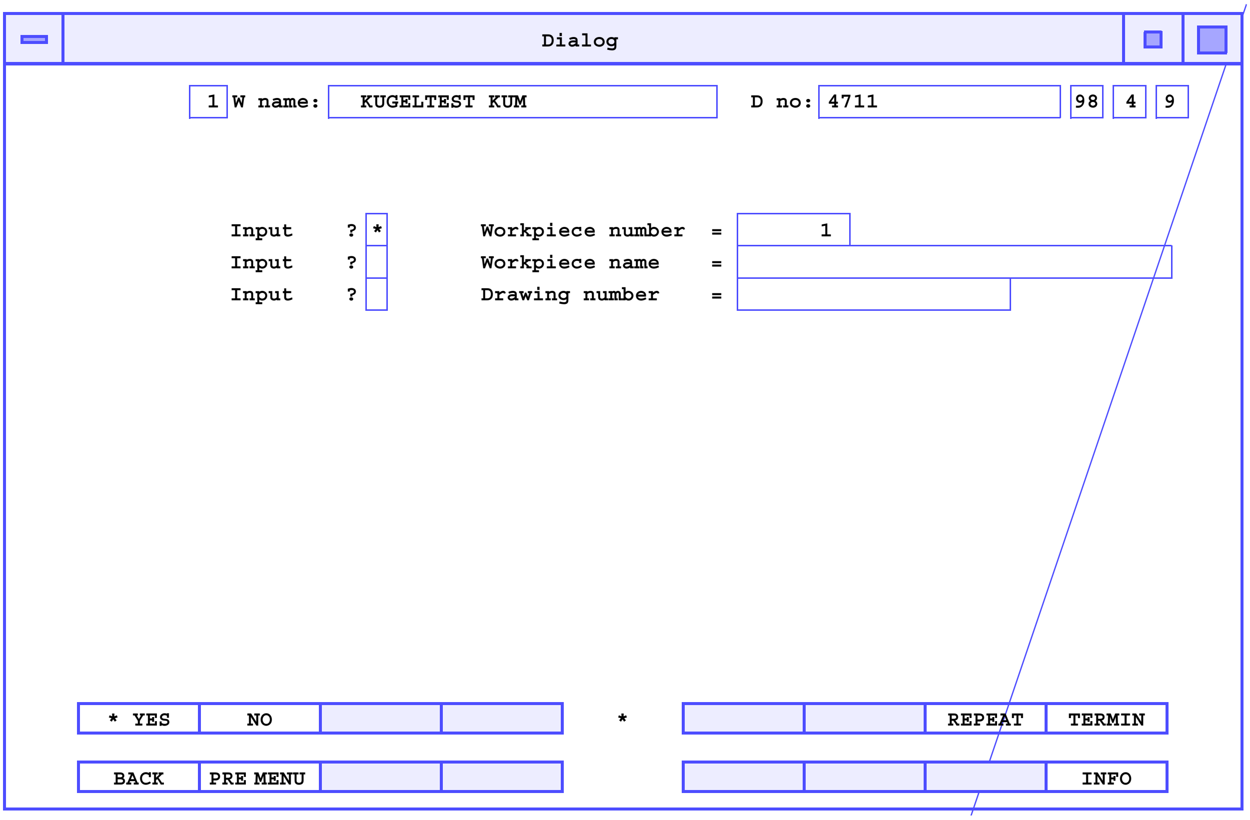
Explanation: The workpiece number has a higher priority than the workpiece name

TERMIN

– Press **<TERMIN>**.
The dialog window with the menu title **WORKPIECE: XXX** is displayed (verification query).

YES

– Press **<YES>**, to delete the selected workpiece.
The selected workpiece is deleted. The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.



Softkey functions

INFO
YES
NO
PRE MENU
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

REPEAT

This key can be pressed after at least one workpiece characteristic has been entered. The remaining input fields are completed automatically.

TERMIN

A verification query follows. If this is answered with **<YES>**, the workpiece marked is deleted.

Notes on the input and display boxes

Workpiece number

The number of the workpiece currently selected is entered automatically in the first input field. This number must be overwritten if a workpiece is to be deleted with another workpiece number! In order to be able to enter a new workpiece number, the “Input” field must previously be confirmed with **<YES>**.

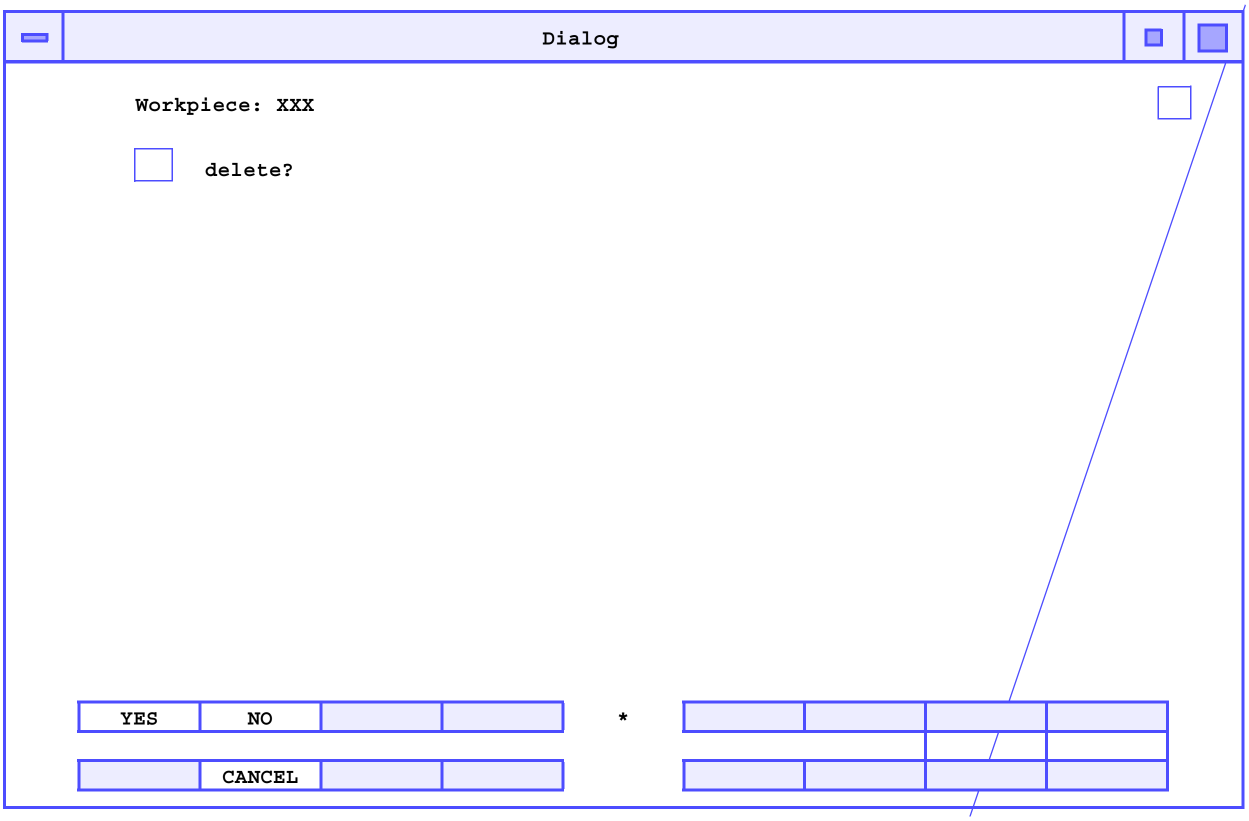
After confirmation of the field with **<YES>** the workpiece number can be entered.

Workpiece name

After confirmation of the field with **<YES>** the workpiece name can be entered.

Drawing number

After confirmation of the field with **<YES>** the drawing number can be entered.



Softkey functions

YES — The selected workpiece is deleted. The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.

NO — The selected workpiece is not deleted. Return to the **DELETE WORK-PIECE** dialog window. Another workpiece can be defined for deleting.

CANCEL — The selected workpiece is not deleted. Return to the **WORKPIECE ADMINISTRATION** dialog window ➤*"Workpiece administration" on page 3-3*.

Notes on the input and display boxes

Workpiece: XXX — The label of the workpiece to be deleted is here.

delete? — Only if this verification query is answered with **<YES>** is the workpiece specified actually deleted.

Correction of the workpiece identification

The following data can be changed by correcting the workpiece identification

- the workpiece name
- the drawing number
- the number of curves

The change always refers to the current workpiece ➤*"Workpiece selection" on page 3-5*. The workpiece data **before** the correction is in the second line. In this way you can compare the data before the correction with the modified data.

ATTENTION!
If a CNC run has been programmed for the corrected workpiece, the workpiece identifications in the control data list must also be corrected.

Workpiece correction

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

WPC ADM

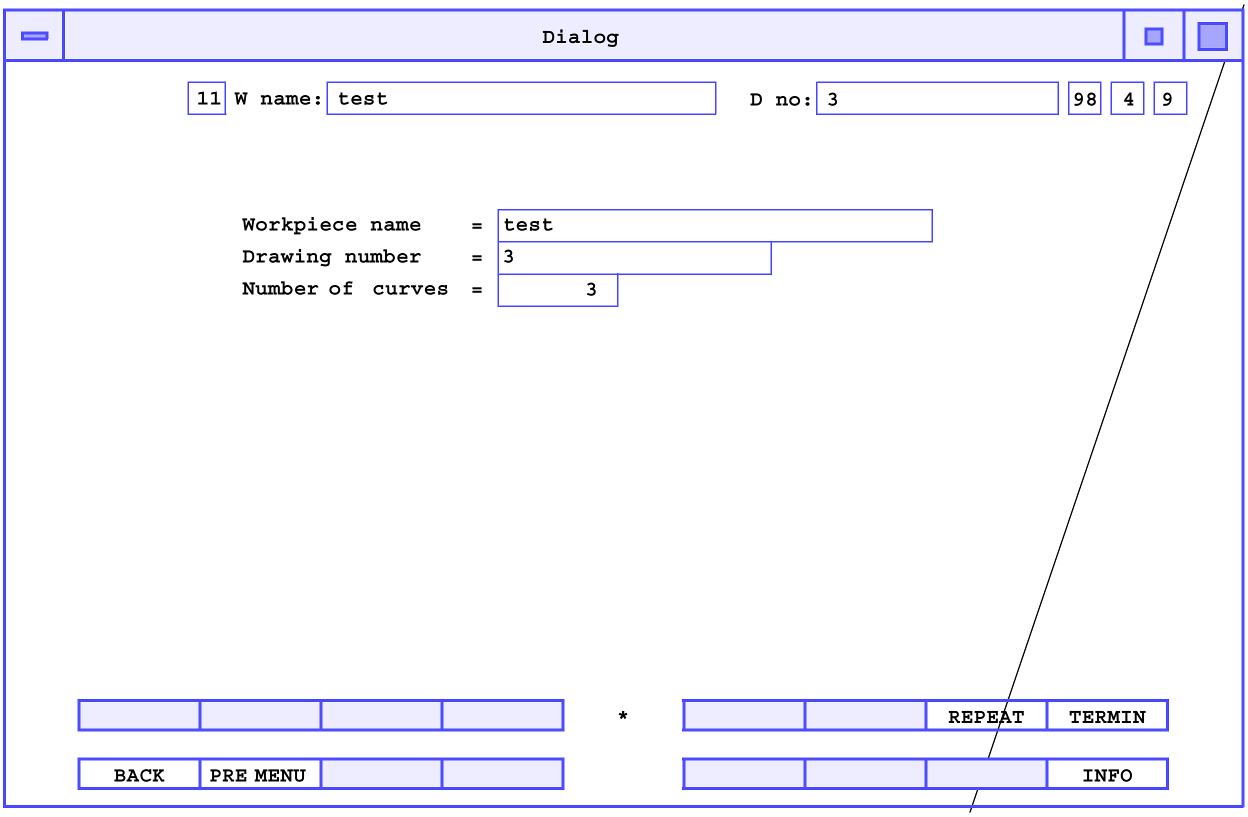
– Press **<WPC ADM>**.
  The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.

CORR W

– Press **<CORR W>**.
  The dialog window with the menu title **KUM WORKPIECE CORRECTION** is displayed.
– Select the line you wish to change using the ↑ or ↓ keys.
– Enter the new name or the new numbers.

TERMIN

– Press **<TERMIN>**.
  The program transfers the data entered. The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.



Softkey functions

TERMIN
INFO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Workpiece name

Input of the workpiece name of the new workpiece (max. 30 characters).

Drawing number

Input of the drawing number of the new workpiece (max. 18 characters).

Number of curves

Input of the **maximum** number of curves to be measured (between 1 and 999).

Setting the workpiece "free"

Several users

The program has a facility which protects against a workpiece being used at the same time from two terminals. In normal operation, the session number (➤*"KUM directories" on page 3-51*). and the user name are entered in the workpiece catalog and then removed after a workpiece change or move to UMESS.

If you do not exit the program correctly, the user name and session number are retained in the workpiece catalog.

Workpiece occupied

If the workpiece for which the user name and session number have not been deleted are now reselected, the following message appears: **Workpiece occupied by another system.**

Freeing the workpiece

In this case, the workpiece can be set to the status "free" with the following function call. You are then able to select the workpiece.

You are assisted in the workpiece selection by a search function.

At least one characteristic must be defined of the three input fields (workpiece number, workpiece name, drawing number). If the input is incomplete, the other characteristics are completed automatically by the program.

Start menu: KUM Main Menu, ➤*“Calling the KUM Main Menu” on page 1-7*.

WPC ADM

– Press **<WPC ADM>**.
  The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.

FREE W

– Press **<FREE W>**.
  The dialog window with the menu title **SET KUM WORKPIECE “FREE”** is displayed.

YES

– Define at least one parameter using **<YES>** and the corresponding names or numbers.

REPEAT

– Press **<REPEAT>**.
  The program completes or changes the missing parameters.

TERMIN

– Press **<TERMIN>**.
  The program sets the selected workpiece “free”. The dialog window with the menu title **KUM WORKPIECE SELECTION** is displayed ➤*“Workpiece selection” on page 3-5*.

NOTE

Please note the priority of the parameters when working with the search function:
Workpiece number = highest priority
Workpiece name = average priority
Drawing number = lowest priority
If several parameters are entered, the program first checks the parameter with the highest priority to see if it matches. If it does, the other parameters are changed.

Example

The following workpieces exist:

Workpiece no.	Workpiece name	Drawing no.
1	Jack	
2	Peter	22
3		33

If you enter:

2

you will get the following display after pressing **<REPEAT>**

2	Peter	22

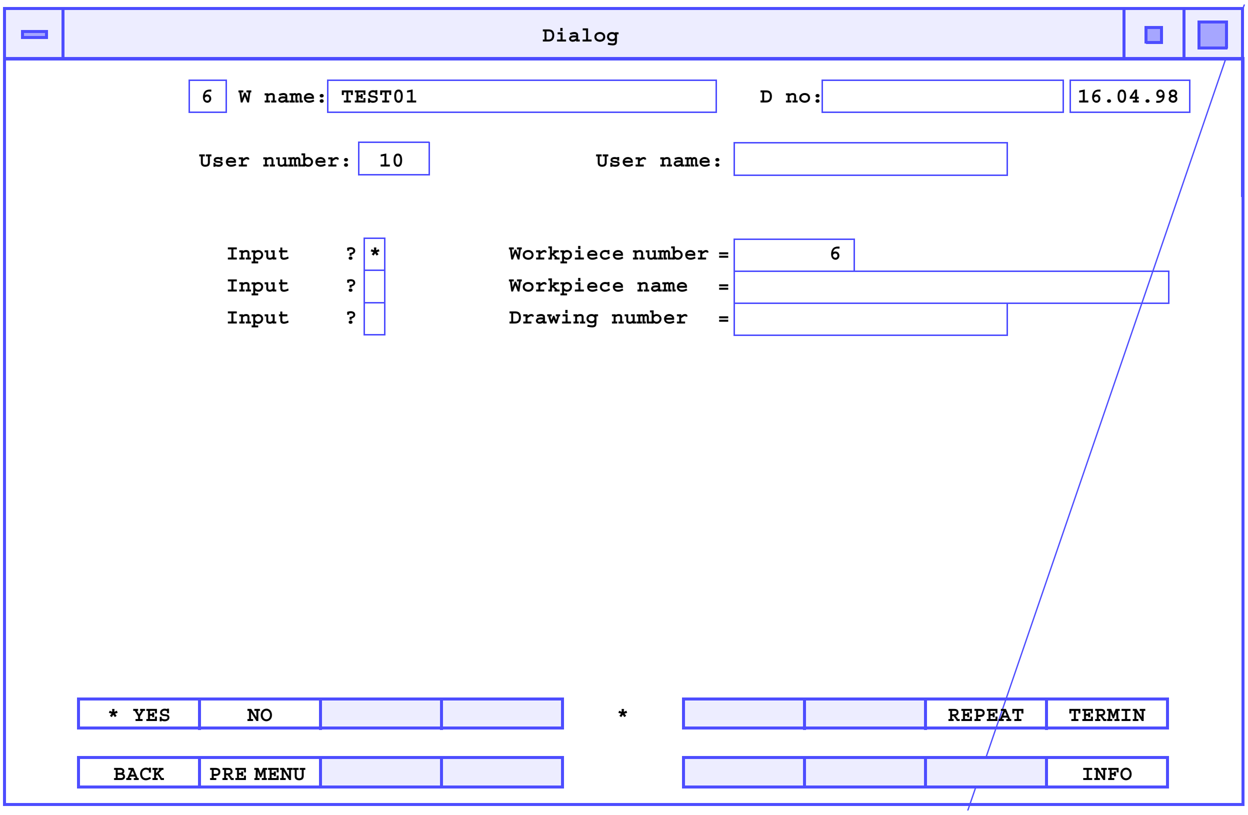
If you enter the “wrong” input:

3 Jack

you will get the following display after pressing **<REPEAT>**

3 33

Explanation: The workpiece number has a higher priority than the workpiece name.



Softkey functions

INFO
YES
NO
PRE MENU
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

REPEAT

This key can be pressed after input of at least one workpiece characteristic. The input fields not filled in are then completed automatically.

TERMIN

The selected workpiece is released. The window with the menu title **KUM WORKPIECE SELECTION** is returned to ➤*"Workpiece selection" on page 3-5*.

Notes on the input and display boxes

User number: 10

The user number tells you whether the workpiece has been released (0), or which user is editing the workpiece.

User name

The user name tells you who is editing the locked workpiece.

Workpiece number

The number of the workpiece currently selected is entered automatically in the first input field by the program. This number must be overwritten if a workpiece is to be released. In order to be able to enter a new workpiece number, the "Input" field must first be confirmed with **<YES>**.

After confirmation of the input field with **<YES>**, the workpiece number can be entered.

Workpiece name

After confirmation of the input field with **<YES>**, the workpiece name can be entered.

Drawing number

After confirmation of the input field with **<YES>**, the drawing number can be entered.

Parts administration

Functions

The following functions are available for administering the parts:

– To select a part, ➤*"Methods for selecting the part number" on page 3-26*.

– To create a new part, ➤*"Creating a new part" on page 3-29*.

– To list a parts catalog, ➤*"Output of the parts catalog" on page 3-33*.

– To delete a part, ➤*"Deleting a part" on page 3-36*.

– To correct a part identification, ➤*"Correcting the part identification" on page 3-38*.

General information

You should note the following:

– The nominal form of the curves is the same for all parts of a workpiece; this means that the nominal data is independent of the parts to be measured later. A change of the nominal data is only allowed if the number 1 is selected (this value is set automatically with **WORKPIECE SELECTION**).

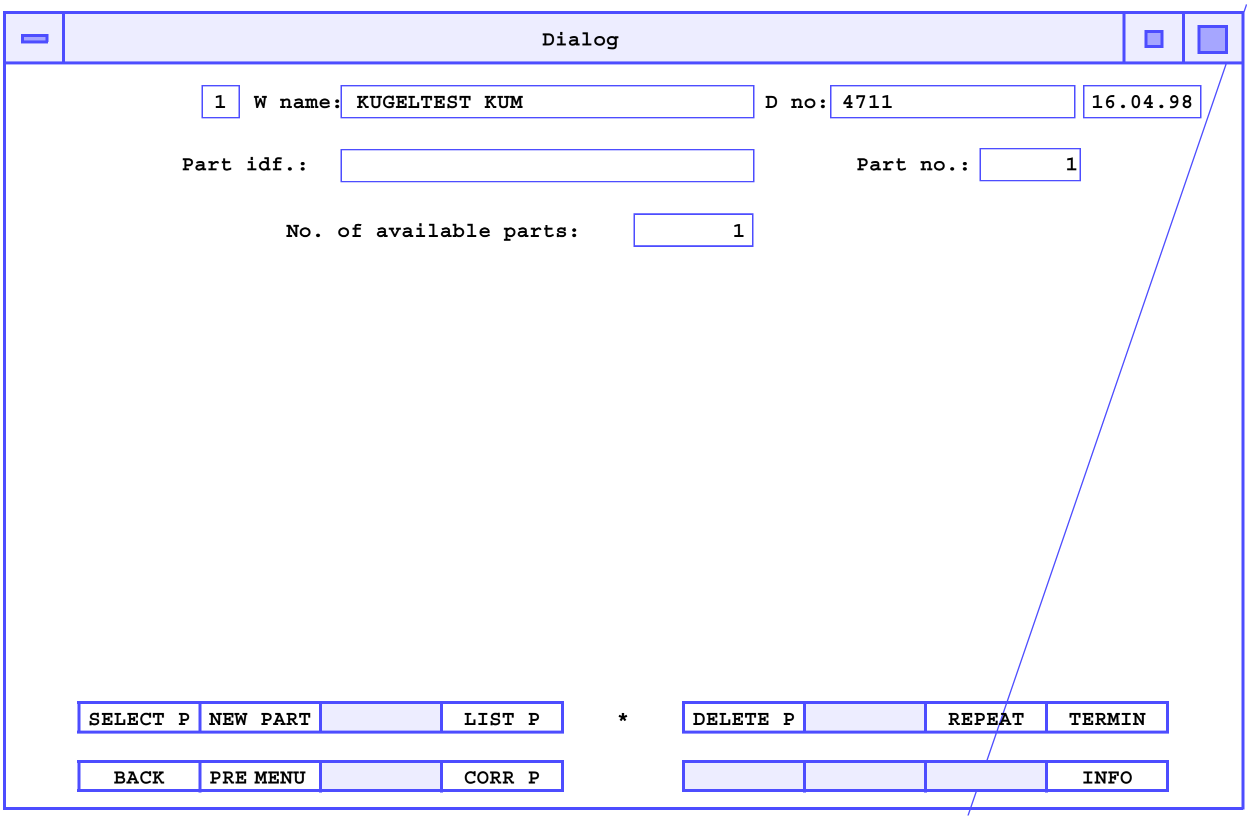
– When using another part number (not 1) functions with write access to nominal data (e.g. generating, copying, calculating, editing nominals etc.) are not allowed.
Possible error: The curve catalog for part no. 1 has not been updated after the nominal data was changed.

– When creating a new part, the memory requirement for measured data and deviations must be taken into consideration. Parts which are no longer needed should be deleted as soon as possible.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

PART ADM

– Press **<PART ADM>**.
The dialog window with the menu title **KUM PARTS ADMINISTRATION** is displayed.



Softkey functions

INFO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

SELECT P

Selection of an existing workpiece part, dialog window ➤ *"Methods for selecting the part number" on page 3-26*.

NEW PART

To create a new part, dialog window ➤ *"Methods for selecting the part number" on page 3-26*, ➤ *"Creating a new part" on page 3-29*

LIST P

Output of the part catalog on the screen, ➤ *"Output of the parts catalog" on page 3-33*.

DELETE P

To delete an existing part from the parts catalog, dialog window ➤ *"Deleting a part" on page 3-36*.

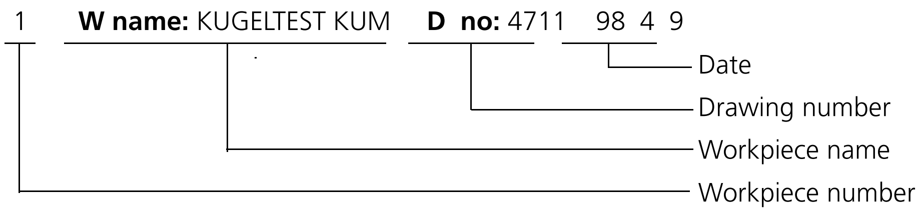
CORR P

Correction of workpiece-specific data of an existing part, dialog window ➤*"Correcting the part identification" on page 3-38*.

TERMIN

Return to the KUM Main Menu, description ➤*"Calling the KUM Main Menu" on page 1-7*.

Notes on the input and display boxes



These display boxes contain workpiece-specific data,➤*"Workpiece selection" on page 3-5*. This header line generally also appears for all subsequent dialog windows, whereby the workpiece data displayed cannot be changed.

The workpiece displayed is the current workpiece.

Part idf..: Part no: 1

The part identification and the part number of the current part are displayed.

No. of available parts

The number of available parts is displayed.

Example

In a CNC run the measurement data and deviations are not to be overwritten after a run, but are to be retained for exact evaluation. You have to proceed as follows when programming the run:

– Program the UMESS functions (W-position etc.)

– Transfer to KUM

– KUM workpiece selection

– KUM parts administration → part selection → accept part number from UMESS.

– Program KUM functions and command blocks

– Return to UMESS

– PROG end

The part number 1 can be specified with the CNC start in UMESS, this is incremented by one with each further start. This part number is then transferred to KUM and the measured data of all runs can then be saved.

The corresponding part number must then be selected for more exact evaluation of individual runs:

KUM parts administration → part selection → part number → specification of required part number. Then all evaluations can take place as for part number 1.

ATTENTION!
No KUM functions with write access to nominals are allowed to take place if the part number is ≠ 1.

Methods for selecting the part number

Transfer from UMESS

If the UMESS part number is a numeral between 1 and 999, this can be used as the KUM part number.

If the UMESS part number is not a numeral, it is assigned to the KUM part identification. The part number results automatically from the next free space in the parts catalog.

Entering the part number

The part number and part identification can be entered in the range 1 to 999. It is independent of the part number in UMESS.

Selecting the part number

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

PART ADM

– Press **<PART ADM>**.
  The dialog window with the menu title **KUM PARTS ADMINISTRATION** is displayed.

SELECT P

– Press **<SELECT P>**.
  The dialog window with the menu title **KUM METHOD FOR PART NUMBER SELECTION** is displayed.

YES

– Confirm the query **Accept part number from UMESS** or **Enter part number** with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  The program accepts the data entered. The dialog window with the menu title **KUM SELECT PART** is displayed.

YES

– If necessary define the part number or the part identification using **<YES>** and the corresponding name or numbers.

REPEAT

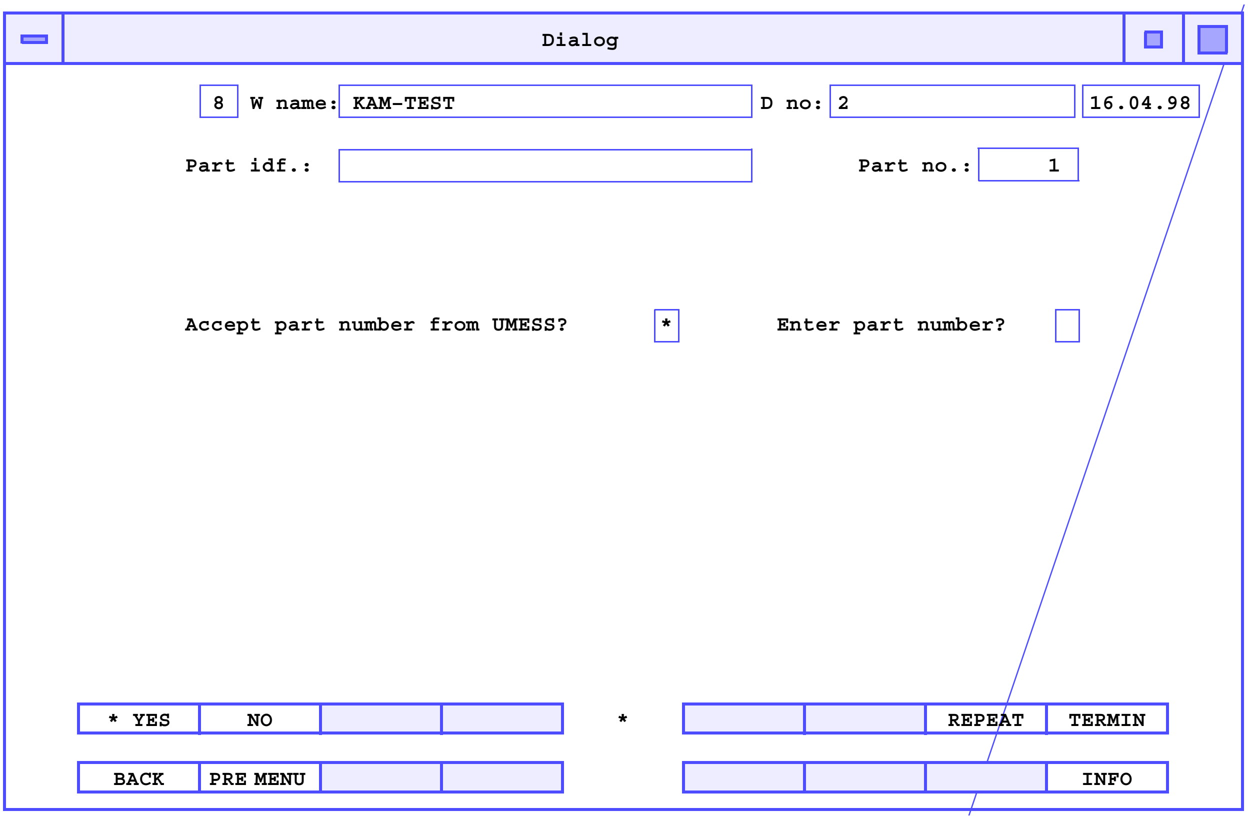
– Press **<REPEAT>**.
  The program completes or changes the missing parameters (search function).

TERMIN

– Press **<TERMIN>**.
  The program accepts the data entered. The dialog window with the menu title **KUM PARTS ADMINISTRATION** is displayed.

NOTE

When you are working with the search function you should be aware of the priority of the parameters:
Part number = high priority
Part identification = low priority
If several parameters are entered, the program first checks the parameter with the highest priority to see if it matches. If it does, the other parameters are changed.



Softkey functions

TERMIN

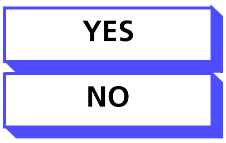
INFO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.



The fields are linked with an OR function. Therefore only one box can be selected with **<YES>**.

Notes on the input and display boxes

Accept part number from UMESS

If you confirm this input field with **<YES>** two cases are differentiated:

1 The UMESS part number is a **number**

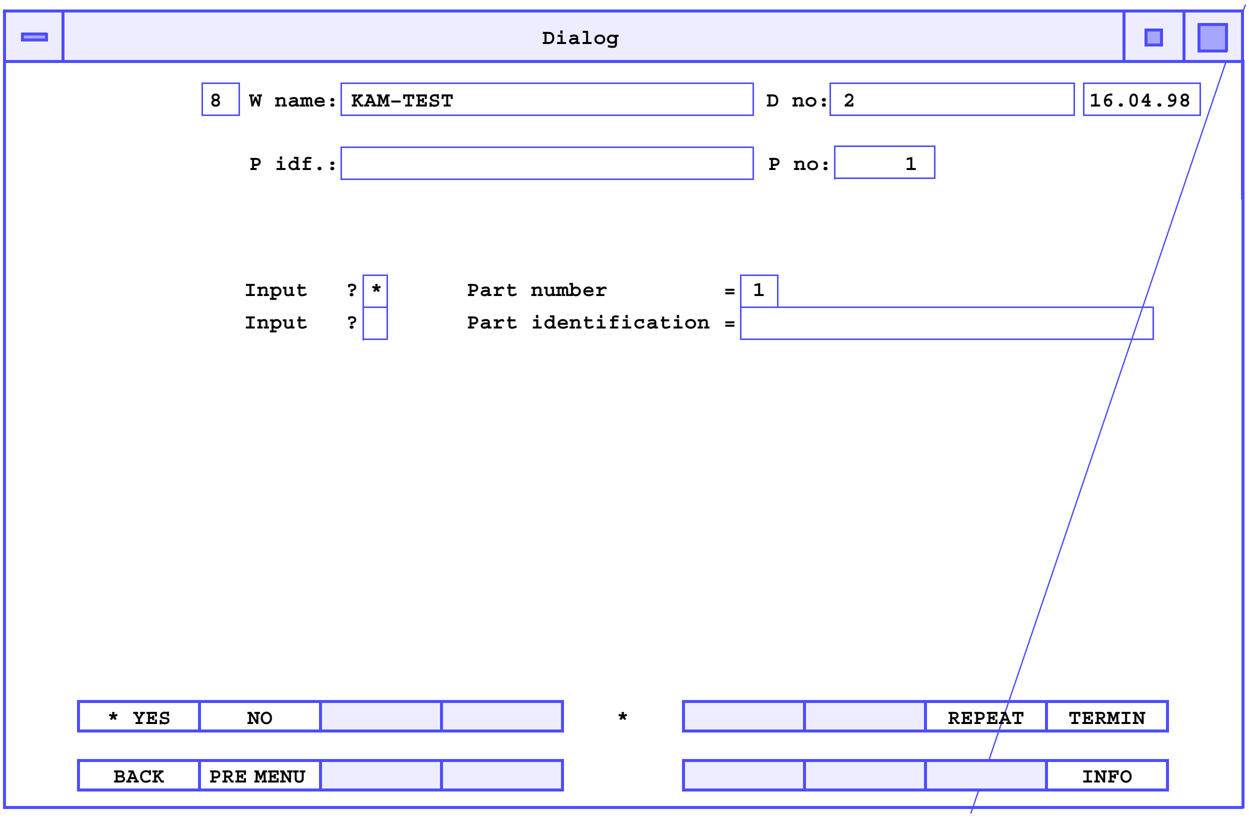
between 1. . . 999.

Then the assignment KUM part **number** = UMESS part **number takes place.**

2 The UMESS part number is **not** a numeral. In this case the assignment KUM part **identification** = UMESS part **number** takes place. The part **number** results from the next free position in the parts catalog.

Enter part number

If this field is confirmed with **<YES>**, the part number and part identification can be entered in the next window. This parameter is independent of the parameters in UMESS.



Softkey functions

INFO
YES
NO
PRE MENU
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

TERMIN

Execution of the part number and part identification entered. Return to the dialog window **KUM PARTS ADMINISTRATION.**

REPEAT

This key can be pressed when you have entered at least one work-piece characteristic. The input fields not filled in are then completed automatically.

Notes on the input and display boxes

Part number

Confirmation of the input field with **<YES>** and subsequent input of the part number (numerical value between 1 and 999).

Part identification

Confirmation of the input field with **<YES>** and subsequent input of the part identification (max. 30 characters).

Creating a new part

A new part is to be created.

To select the part number

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

PART ADM

– Press **<PART ADM>**.
  The dialog window with the menu title **KUM PART ADMINISTRATION** is displayed.

NEW PART

– Press **<NEW P>**.
  The dialog window with the menu title **KUM METHOD FOR PART NUMBER SELECTION** is displayed.

YES

– Confirm the query **Accept part number from UMESS or Enter part number** with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  The program accepts the entered data. The dialog window with the menu title **KUM NEW PART** is displayed.

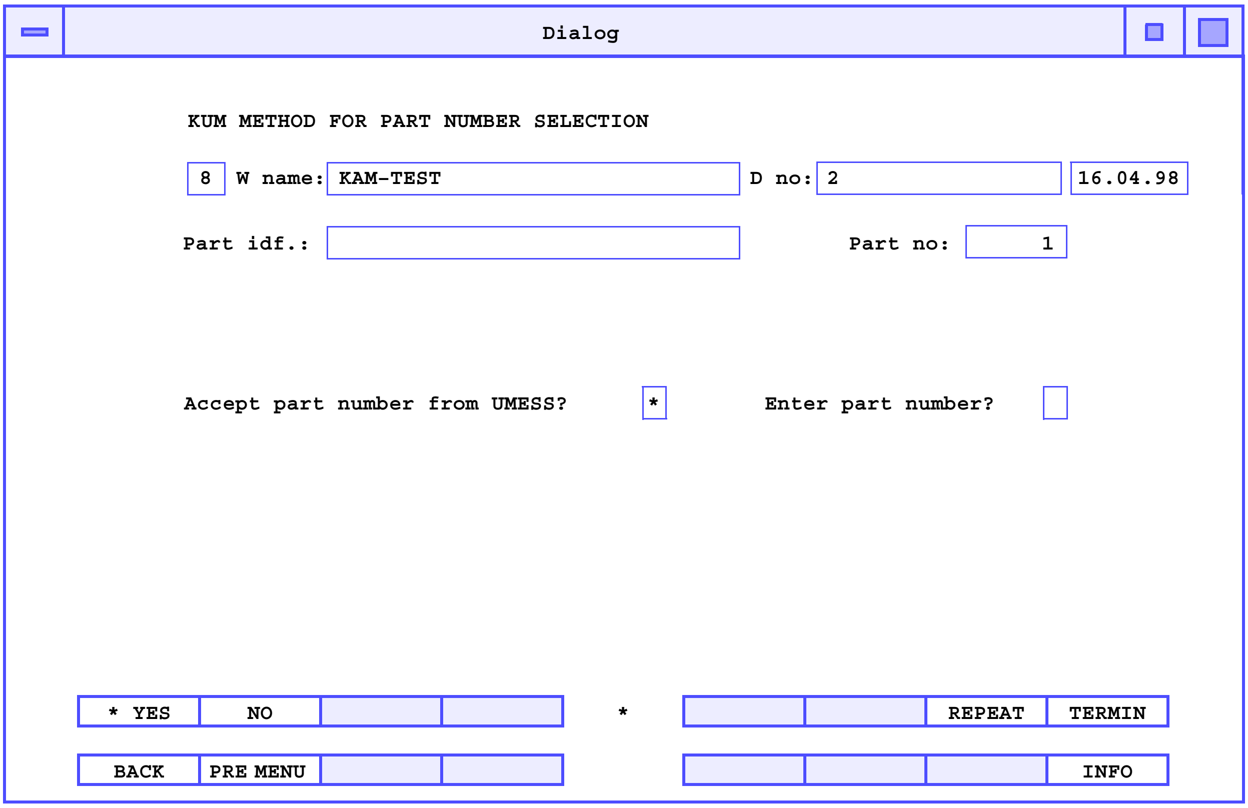
YES

– If necessary define the part number and/or the part identification using **<YES>** and the corresponding name or numbers.

TERMIN

– Press **<TERMIN>**.

The program accepts the data entered. The dialog window with the menu title **KUM PARTS ADMINISTRATION** is displayed. The number of parts available has increased by one.



Softkey functions

TERMIN

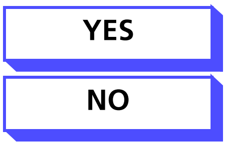
INFO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.



The boxes are linked by an OR function. Therefore only one box can be selected with **<YES>**.

Notes on the input and display boxes

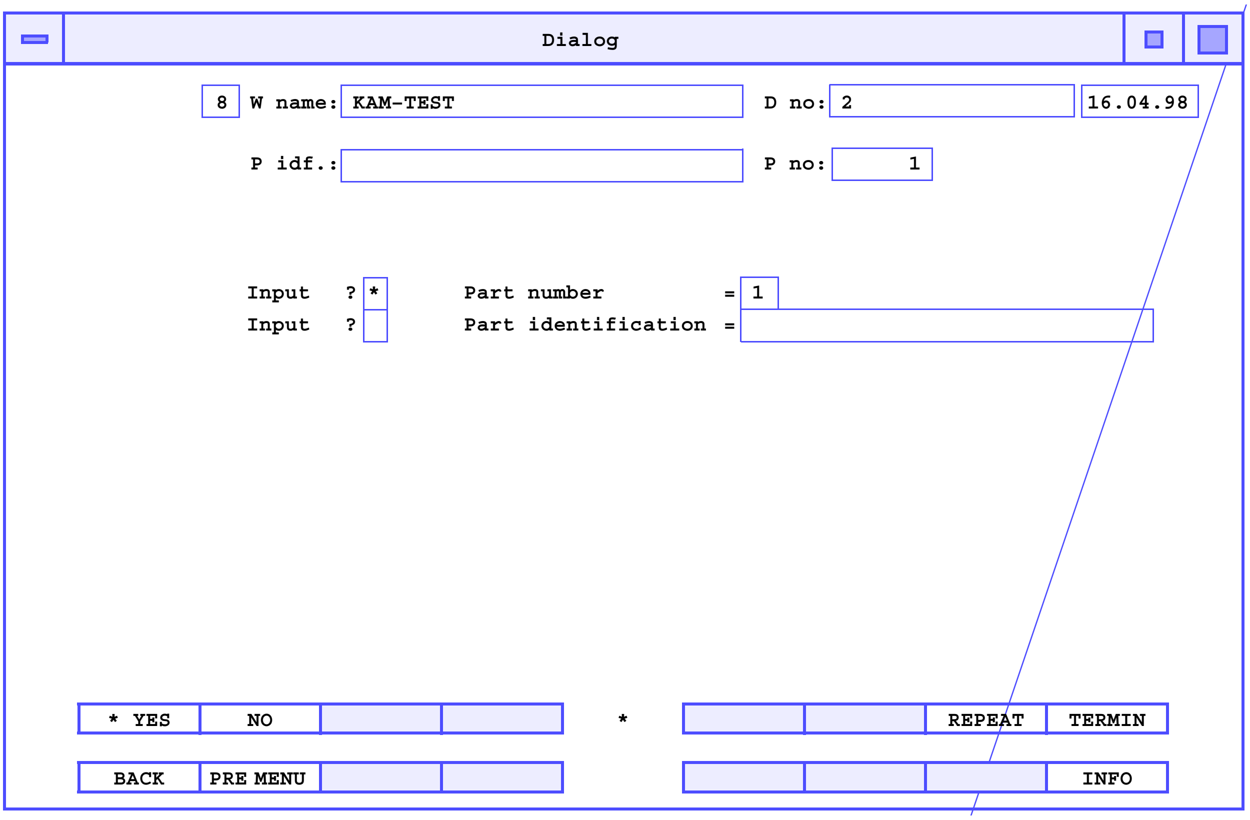
Accept part number from UMESS

Two cases are differentiated if you confirm this field with **<YES>**:

1. The UMESS part number is a **number** between 1 . . . 999.
   Then the assignment
   KUM part**identification** = UMESS part **number** takes place.
2. The UMESS part number is **not** a numeral. In this case the assignment
   KUM part **identification** = UMESS part **number takes place.**
   The part **number** results from the next free position in the parts catalog.

Enter part number

If this box is acknowledged with **<YES>**, the part number and part identification can be entered in the following window. The parameters entered are independent of the parameters in UMESS.



Softkey functions

INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

TERMIN

Execution of the entered part number and part identification. The window with the menu title **KUM PARTS ADMINISTRATION** is returned to.

Notes on the input and display boxes

Part number

Confirmation of the data box with **<YES>** and subsequent input of the part number (numerical value between 1 and 999).

Part identification

Confirmation of the data box with **<YES>** and subsequent input of the part identification (max. 30 characters).

Example

A new part is to be created and the part number transferred from UMESS. Two examples are shown in the following section. First a correct run and then an incorrect input.

Correct run

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

PART ADM

– Press **<PART ADM>**.
  The dialog window with the menu title **KUM PARTS ADMINISTRATION** is displayed.

NEW PART

– Press **<NEW P>**.
  The dialog window with the menu title **KUM METHOD FOR PART NUMBER SELECTION** is displayed.

YES

– Confirm the query **Accept part number from UMESS** with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  The program accepts the data entered. The dialog window with the menu title **KUM NEW PART** is displayed.

TERMIN

– Press **<TERMIN>**.
  The part number is accepted from UMESS, i.e. a new part is created in KUM with the UMESS part number. The dialog window

with the menu title **KUM PARTS ADMINISTRATION** is displayed. The number of parts available has increased by one.

Incorrect input

The following error occurs for example if the UMESS part number already exists in KUM or the UMESS part number is not a numeral or is greater than 999.

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

PART ADM

– Press **<PART ADM>**.
  The dialog window with the menu title **KUM PARTS ADMINISTRATION** is displayed.

NEW PART

– Press **<NEW P>**.
  The dialog window with the menu title **KUM METHOD FOR PART NUMBER SELECTION** is displayed.

YES

– Confirm the query **Accept part number from UMESS** with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  The program accepts the data entered. The dialog window with the menu title **KUM NEW PART** is displayed.
– Enter the new part number.

TERMIN

REPEAT

– Press **<TERMIN>** or **<REPEAT>**
  An error message occurs. The UMESS part number already exists in KUM or the UMESS part number is not a numeral or is greater than 999.

Output of the parts catalog

Display of the parts catalog for the current workpiece on the screen. A list of the following is displayed:

– the part number
– the part identification
– the file name of the curve catalog
– the user rights

To display the parts catalog

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

PART ADM

– Press **<PART ADM>**.
  The dialog window with the menu title **KUM PARTS ADMINISTRATION** is displayed.

LIST P

– Press **<LIST P>**.
  The dialog window with the menu title **OUTPUT OF PARTS CATALOG** is displayed.

SELECT L

TERMIN

– To select a specific line.
  Press **<SELECT L>**. Enter the desired line in the data box. Press **<TERMIN>**. The part catalog jumps to the selected line.

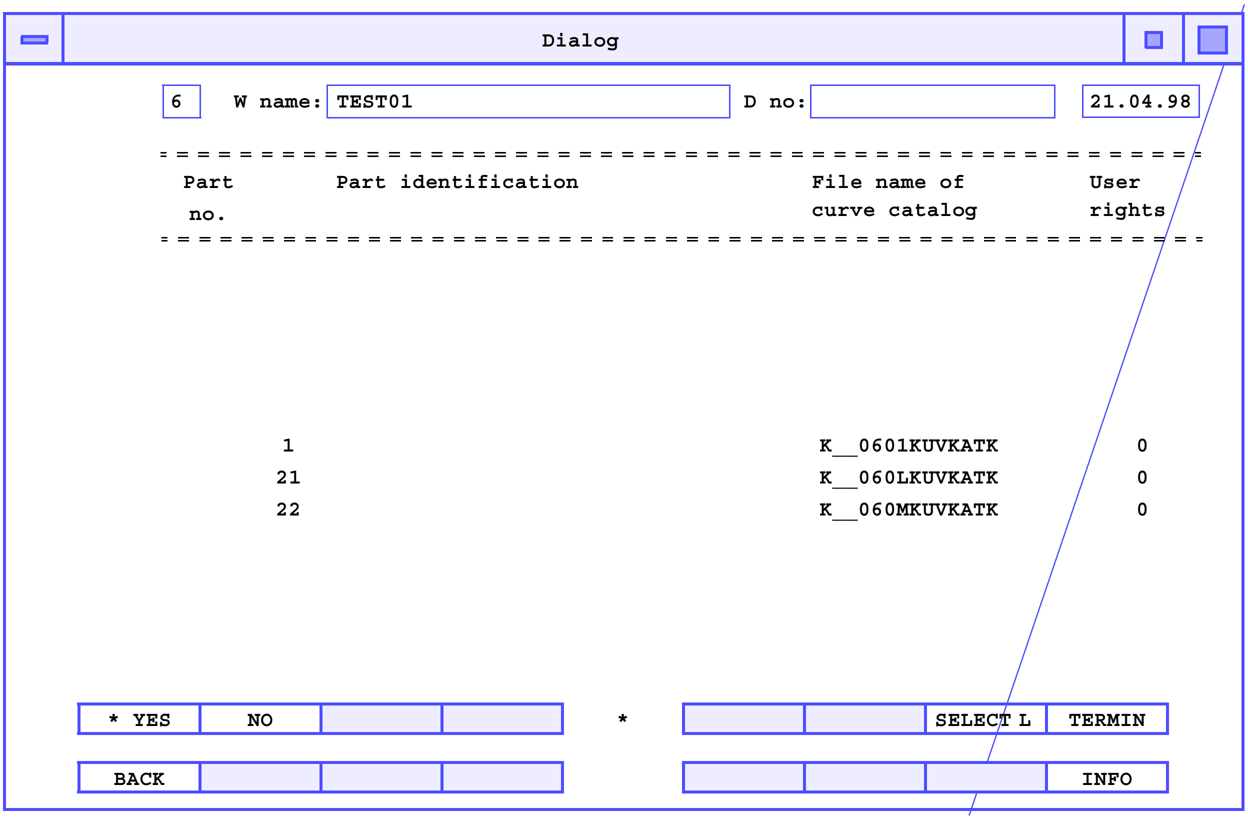
PAGE UP

PAGE DOWN

– To scroll to the next or previous page.
  Press **<PAGE UP>** or **<PAGE DOWN>**.
  The part catalog scrolls to the next or previous page.
– To jump to the next or previous line.
  Press the **SHIFT** key and hold down. Press the ↑ or ↓ key.
  The part catalog jumps to the next or previous line.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **KUM WORKPIECE ADMINISTRATION** is displayed.



Softkey functions

TERMIN
INFO
BACK

See general softkey functions, ➤*“General softkey functions” on page 1-10*.

YES
NO

These softkeys have no function in this dialog window.

SELECT L

Line selection. The line to which you want to go can be entered in the data box.

Notes on the input and display boxes

Part no.
Consecutive line number in the catalog

Part identification
Identification of the stored part

File name of the curve catalog
File name of the curve catalog

User rights
The code number of the relevant user rights is specified in this software version with the value **0** and cannot be changed.

Deleting a part

To delete a part by entering the part number or part identification. You are supported by a search function when selecting the part.

To delete the part

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

PART ADM

– Press **<PART ADM>**.
The dialog window with the menu title **KUM PART ADMINISTRATION** is displayed.

DELETE P

– Press **<DELETE P->**.
The dialog window with the menu title **KUM DELETE PART** is displayed.

YES

– Define at least one parameter using **<YES>** and the corresponding names or numbers.

REPEAT

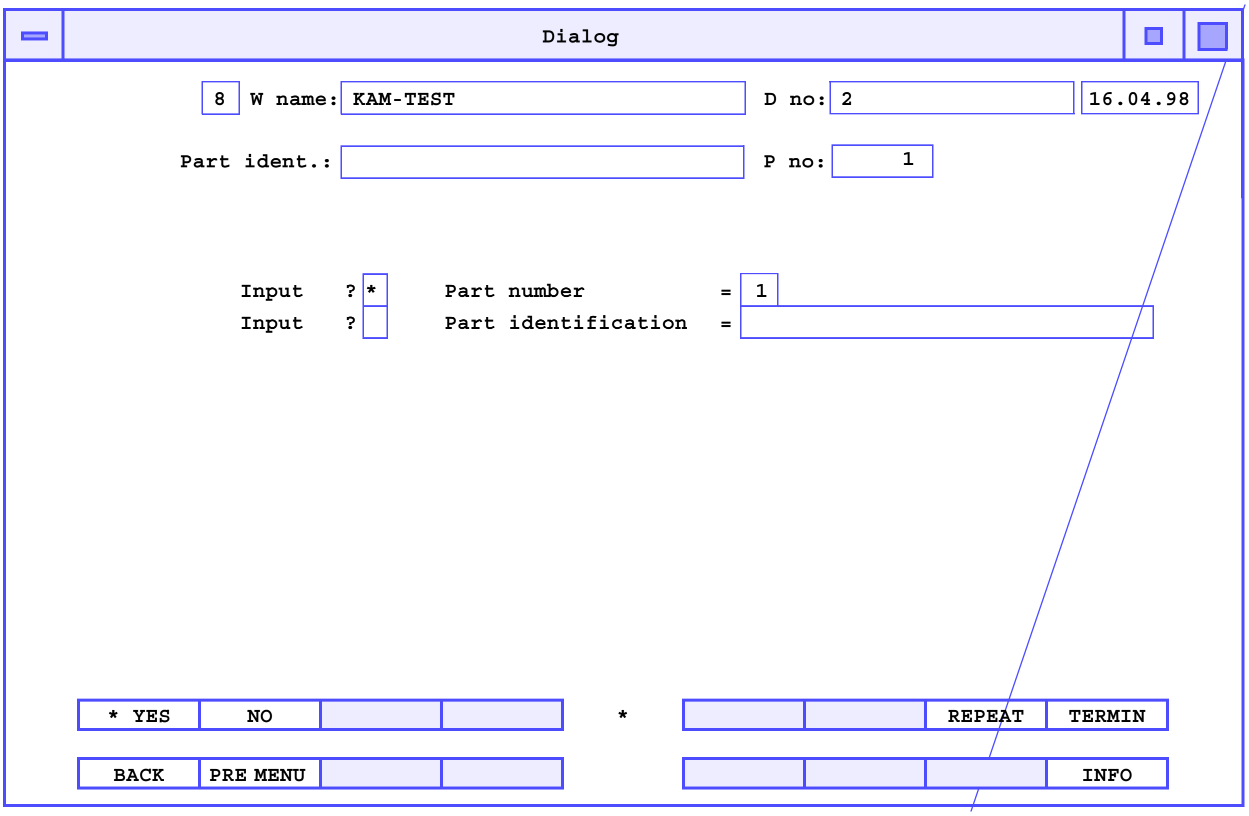
– Press **<REPEAT>**.
The program completes or changes the missing parameters (search function).

TERMIN

– Press **<TERMIN>**, to delete the part selected. The part selected is deleted. The dialog window with the menu title **KUM PART ADMINISTRATION** is displayed.

NOTE

When you are working with the search function, you should be aware of the priority of the parameters:
Part number = high priority
Part identification = low priority
If several parameters are entered, the program first checks the parameter with the highest priority to see if it matches. If it does, the other parameters are changed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

REPEAT

This key can be pressed after entering the part number or the part identification. The data boxes not filled in are then automatically completed.

Notes on the input and display boxes

Part number

Confirmation of the data box with **<YES>** and subsequent input of the part number (numerical value between 1 and 999).

Part identification

Confirmation of the data box with **<YES>** and subsequent input of the part identification (max. 30 characters).

Correcting the part identification

Possibility of correcting the part identification.

Correct P idf.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

PART ADM

– Press **<PART ADM>**.
  The dialog window with the menu title **KUM PART ADMINISTRATION** is displayed.

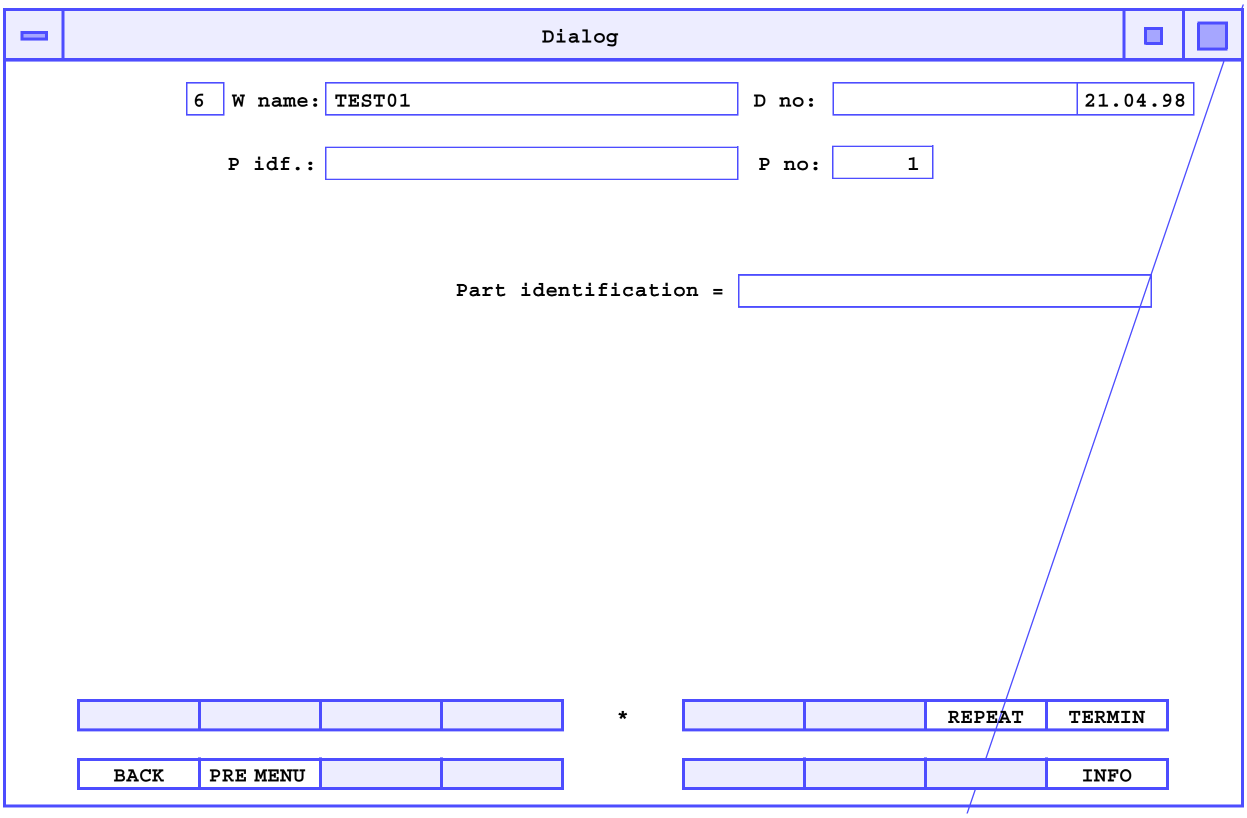
CORR P

– Press **<CORR P>**.
  The dialog window with the menu title **KUM CORRECT PART IDENTIFICATION** is displayed.

– Enter the new name or the new numbers.

TERMIN

– Press **<TERMIN>**, to accept the part identification.
  The dialog window with the menu title **KUM PART ADMINISTRATION** is displayed.



Softkey functions

TERMIN
INFO
PRE MENU
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

REPEAT

This softkey does not have any function in this dialog window.

Notes on the input and display boxes

P idf. The previous part identification is displayed in this data box.

Part identification In this data box the part identification for the part specified above can be changed or re-entered.

Curve administration

Functions

The following functions are available for the curve administration:

– Output of the curve catalog, ➤*"Output of the curve catalog" on page 3-42*.

– Output of curve-specific data, ➤*"Output of the curve-specific data" on page 3-44*.

– To delete curves, ➤*"Deleting curves" on page 3-48*.

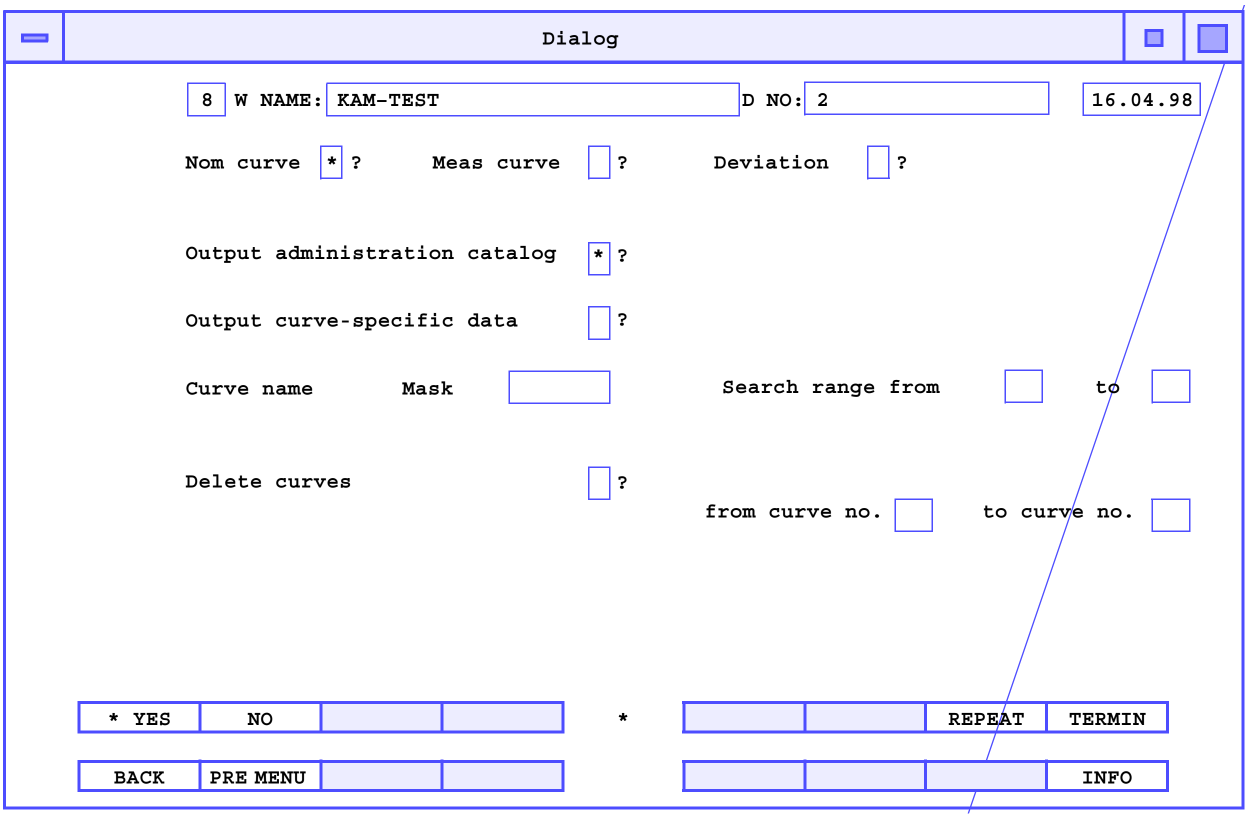
Type of data

Preselection of the type of data to be output for the curve administration catalog.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

CURV ADM

– Press **<CURV ADM>**.
  The dialog window with the menu title **CURVE CATALOG ADMINISTRATION** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Nom curve/Meas curve/ Deviation

One of these three data boxes must be answered with **<YES>** (if necessary, skip the previous data boxes with **<NO>**)

Output administration catalog

Is the data to be output in the administration catalog?

Curve-spec. data output

Is the curve-specific data to be output.

Curve name Mask

The required character combination can be entered here corresponding to the input of the two previous data boxes. All curve names beginning with this character string are listed on the output device previously selected. All curves are listed if no mask is specified.

Search range from to

Determination of two curve numbers for limiting the search range in which the curve name is to be looked for according to the mask specified.

Delete curves/from curve no./to curve no.

If the first data box is confirmed with **<YES>**, individual or several curves can be deleted. This input can be made for nominals and measured values as well as for deviations. Once the dialog window has been exited with **<TERMIN>**, the corresponding curves in the KUM catalog and the KUM directory are deleted.

Output of the curve catalog

Output of the curve catalog corresponding to the selection made beforehand ➤*“Curve administration” on page 3-40*.

Start menu: KUM Main Menu, ➤*“Calling the KUM Main Menu” on page 1-7*.

CURV ADM

– Press **<CURV ADM>**.
The dialog window with the menu title **CURVE CATALOG ADMINISTRATION** is displayed.

YES

– Acknowledge the **Nom curve** data box with **<YES>**.

YES

– Acknowledge the **Output administration catalog** with **<YES>**.

– If necessary, define a curve name and/or a search range.

TERMIN

– Press **<TERMIN>**.
The dialog window with the menu title **OUTPUT OF CURVE CATALOG FOR NOMINAL CURVES** is displayed.

SELECT L

TERMIN

– To select a specific line.
Press **<SELECT L>**. Enter the desired line into the data box. Press **<TERMIN>**. The curve catalog jumps to the selected line.

PAGE UP

PAGE DOWN

– To scroll to the next or previous page.
Press the **<PAGE UP>** or **<PAGE DOWN>** keys.
The curve catalog scrolls to the next or previous page.

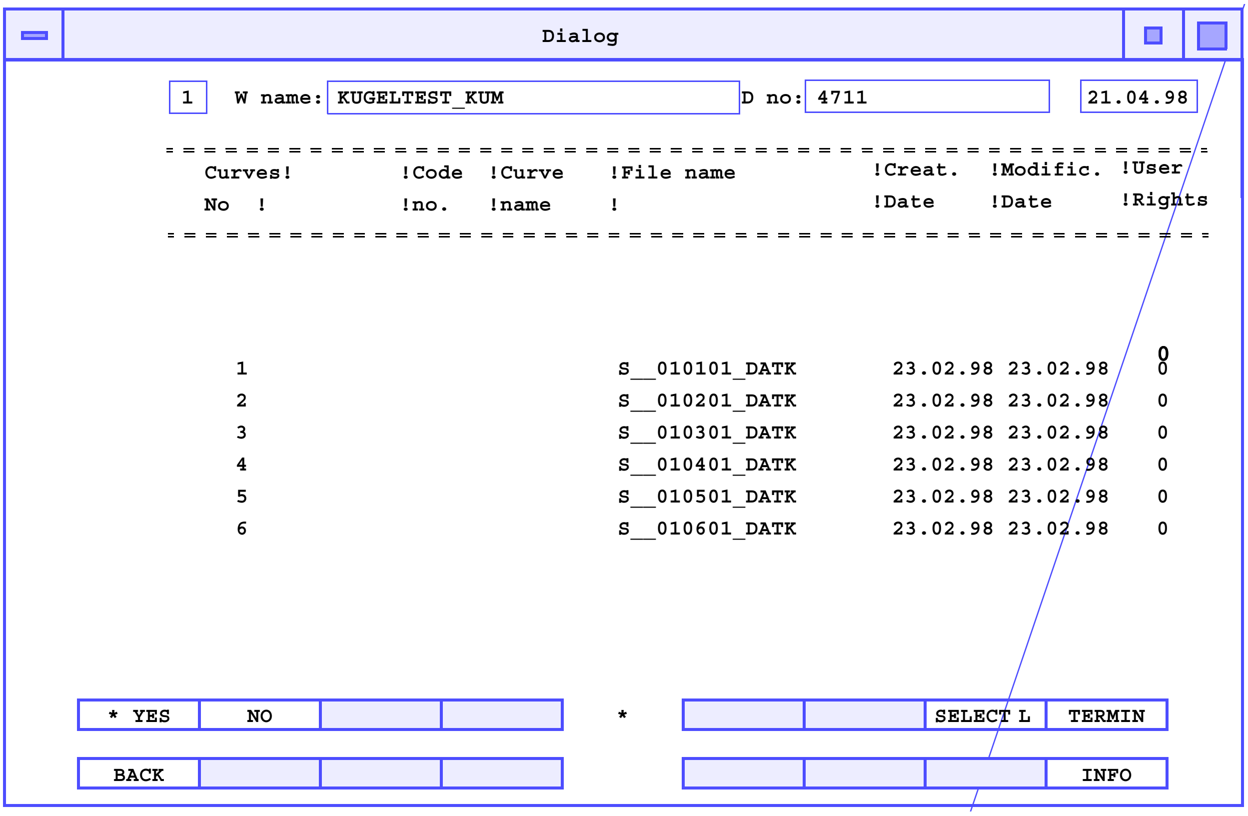
– To jump to the next or previous line.

SHIFT

– Press the **<SHIFT>** key and hold down. Press the ↑ or ↓ key.
The curve catalog jumps to the next or previous line.

TERMIN

– Press **<TERMIN>**.
The dialog window with the menu title **KUM MAIN MENU** is displayed.



Softkey functions

TERMIN
INFO
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

SELECT L

Line selection. The line to which you want to go can be entered in the data box.

YES
NO

These softkeys have no function in this dialog window.

Notes on the input and display boxes

Curve number Consecutive curve number in the catalog.

Code no. Additional identification.

Curve name The curve name can be entered for each nominal curve.

File name Name of the file in which the data is stored.

Creat. date Creation date of the data file in question.

Modific. date Date of the last modification.

User rights The code number of the relevant user rights is specified in this software version with the value **0** and cannot be changed.

Output of the curve-specific data

Output of the curve-specific data corresponding to the selection already made ➤*"Curve administration" on page 3-40*.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

CURV ADM

– Press **<CURV ADM>**.
  The dialog window with the menu title **CURVE CATALOG ADMINISTRATION** is displayed.

YES

– Acknowledge the Nom curve data box with **<YES>**.

YES

– Acknowledge the Curve-spec. data output box with **<YES>**.
– If necessary define a curve name and/or a search area.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **OUTPUT OF CURVE-SPECIFIC DATA FOR NOMINAL CURVES** is displayed.
– To select a specific line.

SELECT L

– Press **<SELECT L>**. Enter the desired line in the data box.

TERMIN

– Press **<TERMIN>**.
  The curve catalog jumps to the line selected.
– To scroll to the next or previous page.

PAGE UP
PAGE DOWN

– Press the **<PAGE UP>** or **<PAGE DOWN>** key.
  The curve catalog scrolls to the next or previous page.

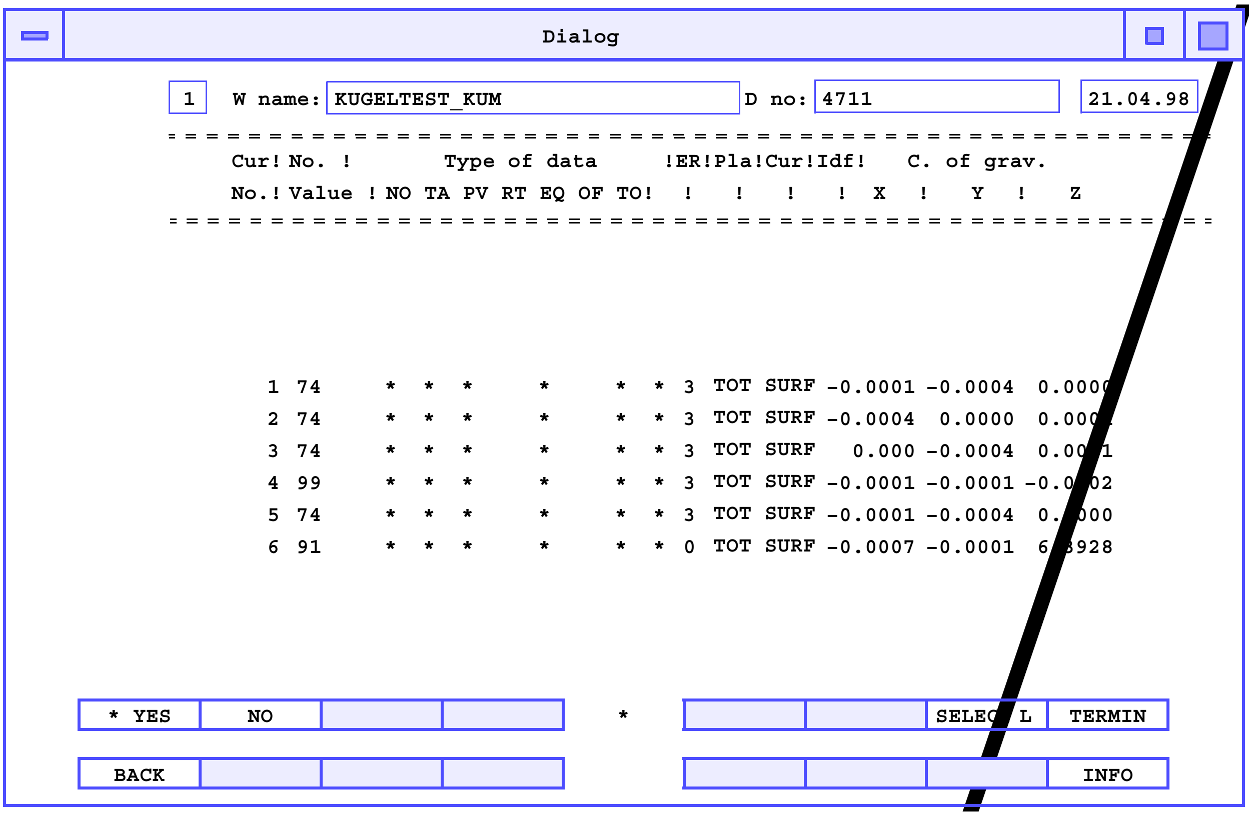
- To jump to the next or previous line.

SHIFT

- Press the **<SHIFT>** key and hold down. Press the ↑ or ↓ key.
  The curve catalog jumps to the next or previous line.

TERMIN

- Press **<TERMIN>**.
  The dialog window with the menu title **KUM MAIN MENU** is displayed.



Softkey functions

TERMIN
INFO
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

SELECT L

Line selection. The line to which you want to go can be entered in the data box.

YES
NO

These softkeys have no function in this dialog window.

Notes on the input and display boxes

Cur no. Curve number

No. value Number of points of the curve in question.

Type of data

Asterisks in the type of data columns show that the respective data is available. The different types of data are:

NO	Normal
TA	Tangent
PV	Probing vector
RT	Rotary table
EQ	Equidistant
OF	Offset
TO	Tolerances
ER	The curve data has been checked and there are no data errors.

Pla

Plane code number with the following meaning:

0	3D normal
1	YZ plane
2	ZX plane
3	XY plane

Cur

Curve type with the following possibilities:

OPE	open
CLO	closed

Idf

Identification of the type of coordinate, the following inputs are permitted:

SPH	Center point coordinates of the probe tip
SUR	Surface coordinates

C. of grav.

These coordinates are needed if a best fit is executed.

Deleting curves

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

CURV ADM

– Press **<CURV ADM>**.
  The dialog window with the menu title **CURVE CATALOG ADMINISTRATION** is displayed.

YES

NO

– Acknowledge one of the following data boxes with **<YES>**: Nom curve, Meas curve, or Deviation. If necessary, skip the previous data boxes with **<NO>**.

NO

– Answer the data box Output administration catalog with **<NO>**.

NO

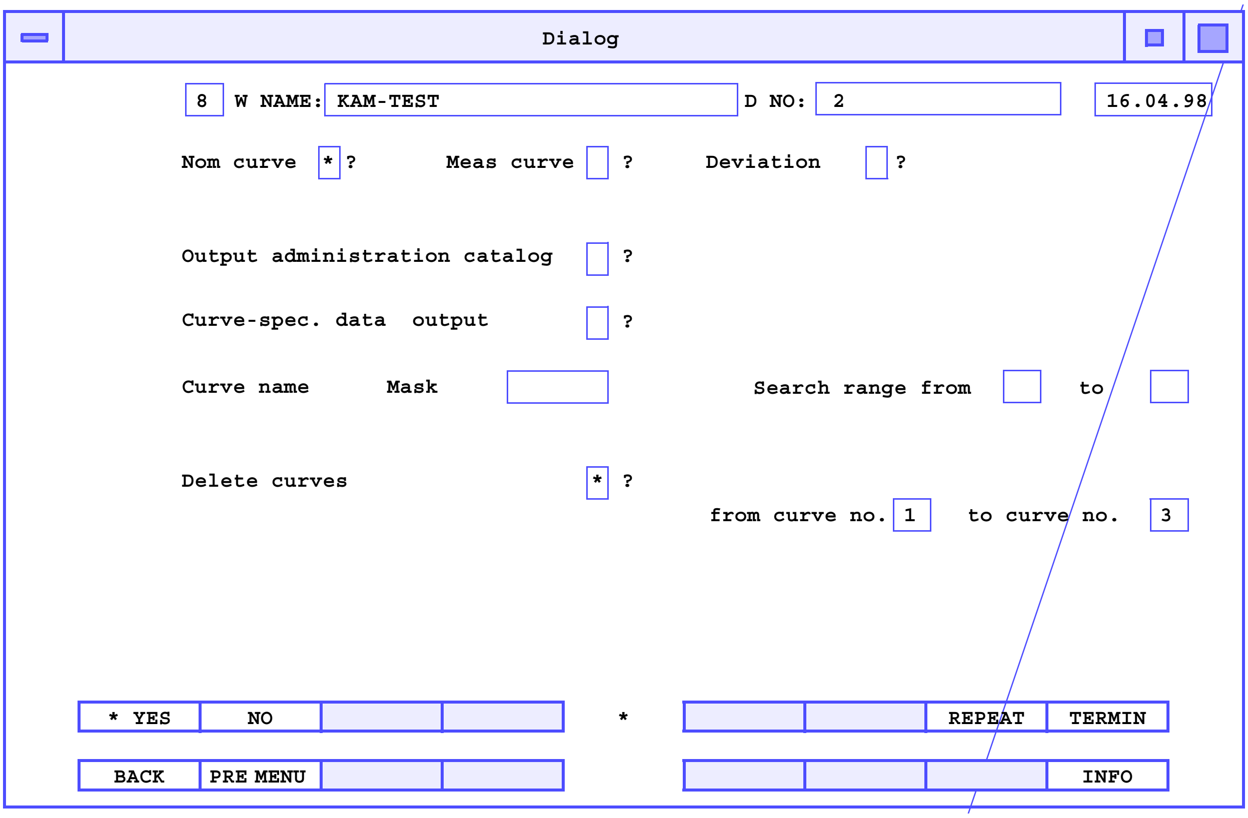
– Answer the data box Curve-spec. data with **<NO>**.

YES

– Acknowledge the data box Delete curves with **<YES>**.
– Define the range of deletion by entering the curve numbers.

TERMIN

– Press **<TERMIN>**.
  The defined curve range is deleted. The dialog window with the menu title **CURVE CATALOG ADMINISTRATION** is displayed. The data boxes are reset. Deletion of one or several curves.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Nom curve/Meas curve/ Deviation

One of these **three** data boxes must be answered with **<YES>** (if necessary, skip the previous data boxes with **<NO>**).

Output administration catalog

Is the data to be output to the administration catalog?

Curve-spec. data output

Is the curve-specific data to be output?

Curve name Mask

Corresponding to the input of the two previous data boxes, the desired character combination can be entered here. All curve names beginning with this character string are listed on the output device previously selected.

All curves are listed if no mask is specified.

Search range from to

Determination of two curve numbers for limiting the search range in which the curve name is to be looked for according to the mask specified.

Delete curves/from curve no./to curve no.

If the first data box is confirmed with **<YES>** individual or several curves can be deleted. This input can be made for nominals and measured values as well as for deviations. Once the dialog window has been exited with **<TERMIN>**, the corresponding curves in the KUM catalog and the KUM directory are deleted.

KUM directories

So that specific data can be found, the KUM directories and name conventions of the data in these must be known.

Session number

Notes on the session number

Session no. 10: Normal mode with CMM or column 1 with twin column mode

Session no. 20: Column 2 with twin column mode

Session no. 30: ACE

Name conventions

Name conventions for KUM files

Example

Output of an input mask on file with

<DI 2700> <INFO> <FILE>.

In this case the contents of the current dialog window are copied to a file in the directory.

Operating system	Directory
HP-UX 9.05	**/user/zeiss/CZ-MES-UA**
from HP-UX 10.20	**/home/zeiss/UA**

Example, KUM main menu: **DID 01 BCRT_O 3OK**

File type:
D = Dialog

File code
I = Record of the page contents of dialog windows

Language code:
D = German

Identification of the dialog window

Session no.:
30 = ACE

Program code:
K = KUM

KUM directories

KUM UX 7.9

Overview of the KUM directories for the **HP-UX 9.05 operating system**

KUM directories, see file	**/users/zeiss/udir/KONPAB–B**
Page contents	**/users/zeiss/CZ-MES-UA**
KUM dialog windows	**/users/zeiss/CZ-MES-UN**
Workpiece-dependent data	**/users/zeiss/CZ-MES-UO**
Standards	**/users/zeiss/CZ-MES-UP**
VDA data	**/users/zeiss/CZ-MES-UI**
Error documentation	**/users/zeiss/CZ-MES-UJ**

From KUM-UX 8.0

Overview of the KUM directories from **HP-UX 10.20 operating system**

KUM directories, see file	**/home/zeiss/udir/KONPAB-B**
Page contents	**/home/zeiss/UA**
KUM dialog windows	**/opt/zeiss/UN**
Workpiece-dependent data	**/home/zeiss/UO**
Standards	**/home/zeiss/UP**
VDA data	**/home/zeiss/UI**
Error documentation	**/var/opt/zeiss/UJ**

Chapter 4

Using the commands

This chapter contains:

Commands

Terms

In the KUM curve measuring program certain terms are used in connection with the commands, which have a clearly defined meaning. The following section explains these terms, the understanding of which is prerequisite for operating KUM.

Command

What is understood as a command is an instruction which is given in order to do something in a certain way. In the KUM software package, a command consists of the terms object and an assigned action, which may be supplemented by an execution specification.

Command = **Object** + **Action**

Example:		
Softkey text:	Nominal value	Convert
or abbreviated input:	NOM	CON
or softkey:	<NOMINAL>	<CONVERT>

Permissible commands

Not every object can be combined with every action. If the input is not allowed, then the **Illegal input** error message is displayed. All (permissible) commands are described in the manual.

Object

The object is generally a metrological term such as nominal value, measured value, deviation etc. The definition of the object can be made in plain text, as a softkey or in the form of command abbreviations. The following table gives an overview of the assignment between plain text, softkey and abbreviation.

Action

Plain text for the object			Foreign language abbreviation			
Abbrev.	<Softkey>	Plain text for the object	Germ.	French	Port.	Span.
ACC	<ACCEL>	Acceleration curve	BSL	ACC		
ACT	<ACTUAL>	Actual value	IST	VRE	REA	VRE
ASG	<MV LINE>	Mean value line	ASG			
BLK	<BLNKLINE>	Blank line	LEZ	LBL	LBR	LVA
BRA	<BLADE>	Blade rating	SKE			
DIS	<DISTANCE>	Distance	DIS	DCN	DCT	DCO
CMB		Command block	KMB	BCE	BCM	BCO
CRF	<CERTI>	Certificate	ZRT			
DEM	<DEVLARGE>	Deviation mode large	ABM	DEM	DEM	DEM
DEV	<DEVIAT>	Deviation	ABW	ECA	DSV	DES
FOR	<FORMAT>	Format	VDR	CAR	PIM	PIM
SPE	<SPEED>	Speed curve	GSW	VIT		
LDE	<LINDEV>	Linear plot of deviation	LAB	ECL		
LIF	<LIFTCURV>	Lift curve	HUB	LEV		
MVA	<MEAS VAL>	Measured value	MEW	VME	VME	NME
NOM	<NOMINAL>	Nominal value	SOL	VN	NOM	NOM
OFS	<OFFSET>	Offset	OFS	OFS	OFS	OFS
PAG	<PAGE>	Page	BLA	PAG	FLH	HOJ
PBI	<BENDING>	Probe bend	TBI	FLP	FLX	MEN
PIT	<PITCH>	Pitch	STG			
PLT	<PLOTTER>	Plotter	PLT	TRA	PLT	PLT
RAV	<RADIAL>	Deviation in radial direction	RAV	VRA		
RES	<RESULT>	Best fit result	ERG	RES	RES	RES
TOL	<TOLERANCE>	Tolerance	TOL	TOL	TOL	TOL
TXT	<TEXT>	Text	TXT	TXT	TXT	TXT

The action defines an action or a task with reference to the object (e.g. copy, list, plot etc.). The definition of the action can take place in plain text, as a softkey or in the form of command abbreviations. The following table gives an overview of the assignment between plain text, softkey and abbreviation.

Actions available			Foreign language abbreviation			
Abbrev.	**<Softkey>**	**Plain text for the action**	**Germ.**	**French**	**Port.**	**Span.**
BFT	**<BEST FIT>**	Best fit	**EIP**	**BAL**	**AJS**	**ADA**
BTR	**<BSTFITTR>**	Best fit transform	**ETR**			
CAL	**<CALCULATE>**	Calculate	**BER**	**CAL**	**CAL**	**CAL**
CHA	**<CHANGE>**	Change	**WEC**	**CHA**	**TRC**	**CAM**
CON	**<CONVERT>**	Convert	**UMR**	**CNV**	**CNV**	**CON**
COP	**<COPY>**	Copy	**COP**	**COP**	**COP**	**COP**
COR	**<CORRECT>**	Correct	**KOR**	**COR**	**COR**	**COR**
CST	**<CALCSTRK>**	Calculate stroke	**HBE**			
DEF	**<DEF>**	Define	**DEF**	**DEF**	**DEF**	**DEF**
DMS	**<DEMASK>**	Demask	**DMS**	**DMS**	**DMS**	**DEM**
DVL		Unwind	**AWI**	**DVP**	**DSN**	**DEN**
EDI	**<EDIT>**	Edit	**EDI**	**EDT**	**EDI**	**EDI**
ELO		Eliminate outliers	**AUS**	**ELM**		
END		End	**END**	**FIN**	**FIM**	**FIN**
ENV		Wind	**AFW**	**ENR**	**ENV**	**ENR**
FIL	**<FILTER>**	Filter	**FIL**	**TRI**		
GEN	**<GENERATE>**	Generate	**GEN**	**GEN**	**GER**	**GEN**
IDE	**<IDENTIFY>**	Identify	**IDE**			
INI	**<INITIAL>**	Initialize	**INI**	**INI**	**INI**	**INI**
LIS	**<LIST>**	List	**LIS**	**LIS**	**LIS**	**LIS**
LNK	**<LINK>**	Link	**VBI**	**REL**	**LIG**	**UNI**
CEN	**<CENTER>**	Calculate center	**MIT**			
MSK	**<MASK>**	Mask	**MSK**	**MSQ**	**MSC**	**ENM**
PLO	**<PLOT>**	Plot	**PLO**	**TRC**	**TCR**	**TRZ**
REA		Read	**LES**	**LIR**		
REV	**<REVERSE>**	Reverse	**UMK**	**INV**	**INV**	**INV**
RFT	**<REFORMAT>**	Reformat	**UFO**			
SCO	**<STATCORR>**	Static correction	**SKO**	**SZC**	**COS**	**SKO**
SET	**<SET>**	Set	**SET**			
SHI		Shift	**VES**	**DPL**		
TRA	**<TRANS>**	Transform	**TRA**	**TRF**	**TRA**	**TRA**

Parameters

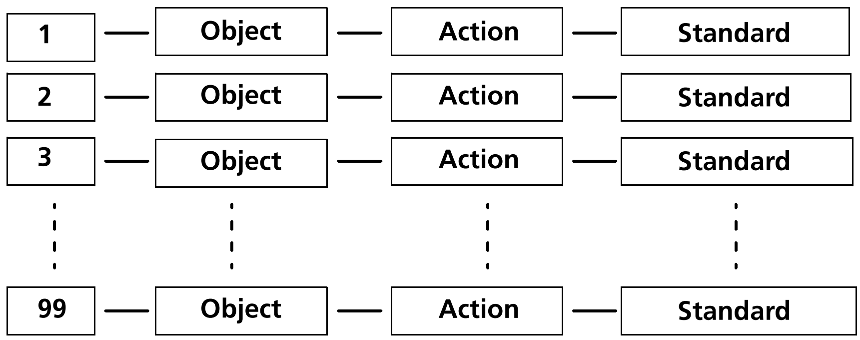
Parameters can be set for almost any command. By pressing the **<DEFINE>** key, the parameters belonging to the command are displayed. The parameters can be adapted to individual requirements.

Example: With the command **PLO** (plot) **DEV** (deviation) you can select which data is to be plotted: Protocol header and/or scale and/or graphics information etc..

Command line and command block

Command line

Each command line starts with a (consecutive) number. Then the (permissible) combination of object and action follows. If required, a standard can be appended at the end.



Standard

If you allocate a standard, you can use the same command line again.

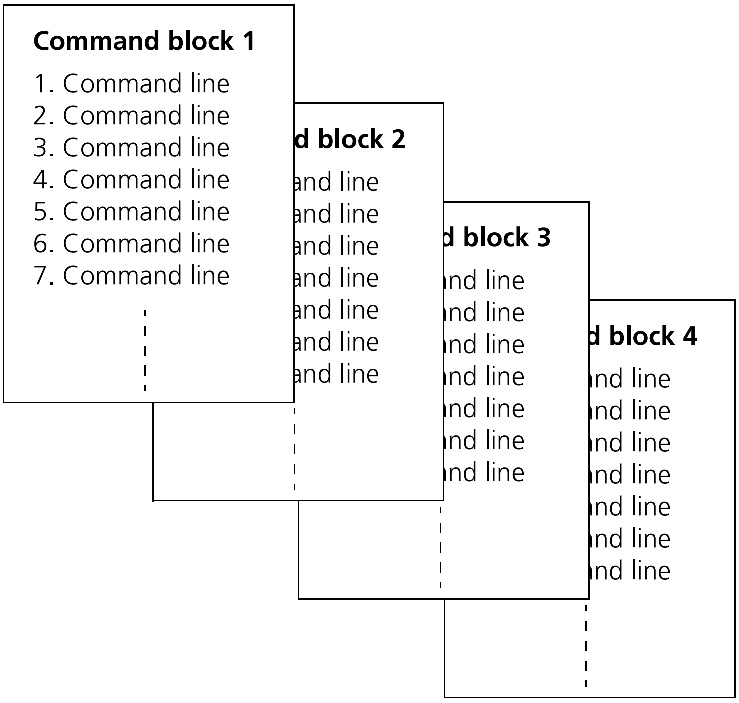
The name of the command line is entered in the standard. In this case, the command line is called a **standard command line**. It can be used in **all workpieces**.

The names may have up to 7 characters. They are made up of letters **and** numerals. Special characters (with the exception of the underline) are not allowed.

The parameters set are also transferred with the standard command line.

Command block

Objects and actions are comprised in a single or several command lines in a command block. In this way it is possible to repeat routine processes with the same task in a simple way. By storing command blocks (block identification) it is no longer necessary with repetitions to define the entire solution again for each curve.



Block identification

The name of the command block is entered in the block identification. Depending on the block identification, the command block can be locked or released for other workpieces.

The names may have up to 7 characters. They can be made up of letters and numerals. Special characters (with the exception of the underline) are not allowed. The numerals as well as the letters can be underlined. The following definitions are possible:

Command block = number

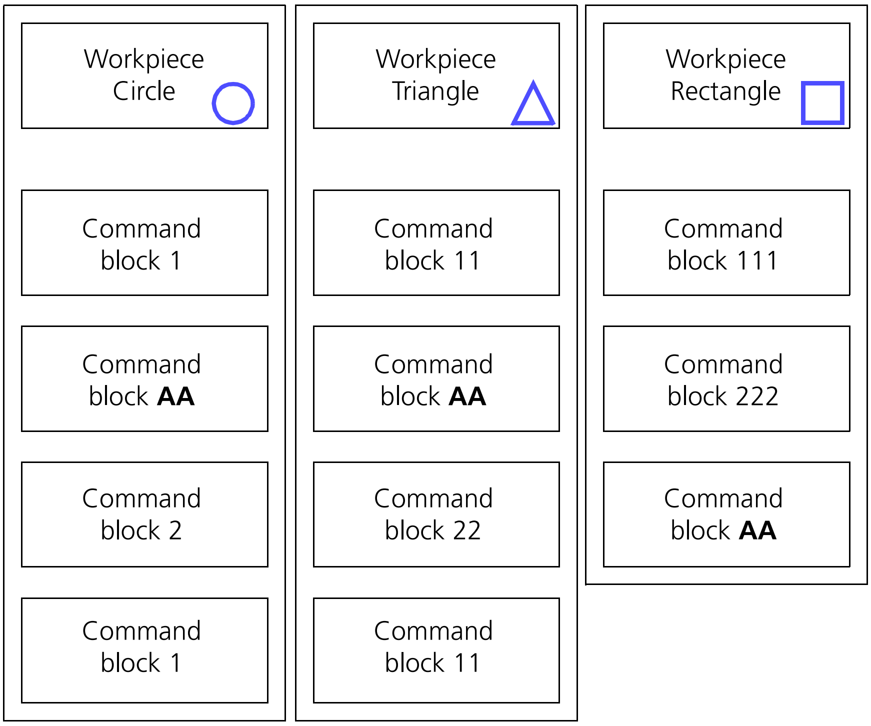
The command block only applies for the defined workpiece. It can be used several times within the workpiece. The command block is then known as a **workpiece-dependent command block**.

Command block = at least one letter

At least one character in the command block must be a letter. The command block can be used in all workpieces. The command block is then known as a **standard command block**.

NOTE

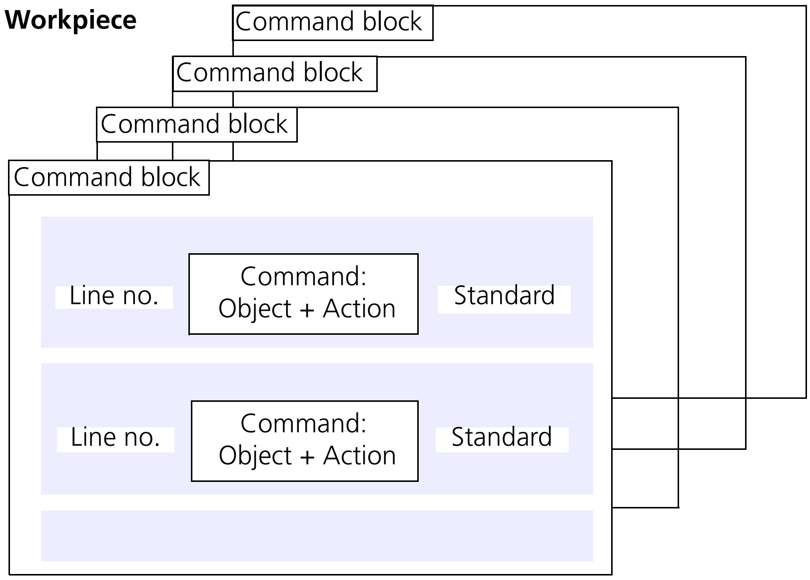
Please note that in this case, all the command lines in the standard command block have to have a standard (name).



Workpiece identification

For each workpiece which is measured, an identification must be defined under which the measuring tasks are to be defined or the data stored. The following hierarchy should be noted:

– several command blocks can be assigned to a workpiece,
– a command block can contain several command lines,
– a command line consists of line number, command and if appropriate standard,
– a command line is the combination of an object and an action.



Defining blank lines or deleting a command line

Defining blank lines

With the command **BLK DEF** a gap can be defined in the command block (blank line) ➤*"Command line input" on page 4-8*.

This command can also be produced by pressing the **<SHIFT + INSERT>** keys, if the **line** data box is activated.

Deleting a command line

It is also possible to delete the current command line by pressing the **<SHIFT + DELETE>** keys, if the line data box is activated.

Ending a command block

With the **CMB END** command, the rest of a command block from the line in which the current command has just been entered, can be deleted, ➤*"Command line input" on page 4-8*.

Command line input

NOTE

The commands, consisting of object and action, can be defined in three different ways in the assigned dialog window.

– Input of the KUM command as plain text, e.g. **UMESS VALUE <RETURN> CONVERT <RETURN>**

– Input of the abbreviation for object and action, e.g. **UMESS <RETURN> CON <RETURN>**

– Press the softkeys for object and action, e.g. **<MEAS VAL> <CONVERT>**

NOTE

A standard can then be input if required, ➤ *"Standard administration" on page 4-30*.

When the individual parameters have been entered, the line is concluded.

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.
– Enter the following information in the **object** and **action** data boxes. Select one of the three input options.

1. Input of the KUM command as plain text, e.g.
   Type **MEAS VAL** and press **<RETURN>**
   Type **CONVERT** and press **<RETURN>**
2. Input of the abbreviation for object and action, e.g.
   Type **MEA** and press **<RETURN>** Type **CON** and press **<RETURN>**
3. Press the softkeys for object and action, e.g. **<MEAS VAL> <CONVERT>**

– Enter a name in the standard data box if required.

DEFINE

– Press **<DEFINE>**.
  The dialog window is displayed. Enter the desired parameters.

L-TERMIN

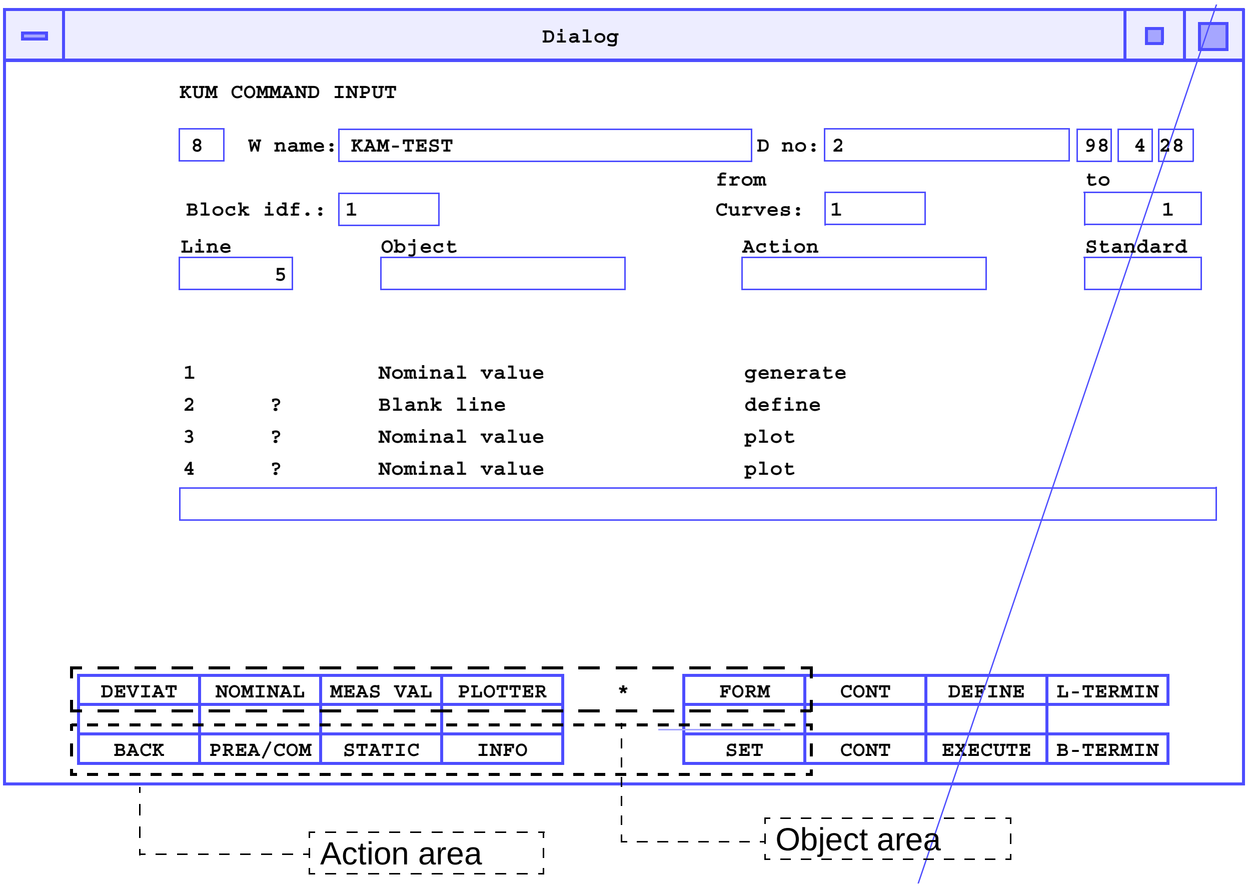
– Press **<L-TERMIN>.**
  You can enter the command input in the following lines.

B-TERMIN

– Press **<B-TERMIN>.**
  The window with the menu title **KUM MAIN MENU** is returned to.

NOTE

In the following text, only one of the three input options is described, for the sake of simplicity. You can however use one of the other alternatives, this has no influence on the program.



Softkey functions

DEVIAT
NOMINAL
MEAS VAL
PLOTTER
FORMAT

In the **Object area** there are various KUM object identifications. If the **Object** box is activated, the corresponding object can be entered in the box by pressing one of these softkeys. You can call further softkey levels each with five other object identifications, with **<CONT>** in the same row. There are 6 softkey levels altogether. After the sixth soft-key level is reached, the first level is displayed again.

CONT

Call up of the next softkey level (max. 6 levels) for displaying further KUM object identifications or KUM actions. Once the last level has been reached, the first level is returned to.

DEFINE

Display of the dialog window of the KUM command previously defined. However, the command itself is not executed.

ATTENTION!
No parameters have yet been defined for command lines beginning with a question mark.

L-TERMIN

The current command line is checked. If the line is incomplete, an error message is displayed–the line is not concluded.

If no parameters have been defined, a question mark is displayed in the line. If the command line is complete, then the next command line is displayed, or if you have reached the end of the command block then an empty command line is generated. Further KUM commands can now be entered or existing commands modified.

LIST
PLOT
EDIT
CONVERT
BEST FIT

There are various actions in the **Action area**. If the **Action** data box is activated, then the corresponding action can be entered in the box by pressing one of these softkeys. Further softkey levels with five other actions can be called with the **<CONT>** softkey in the same row. There are 6 softkey levels altogether. When the last level is reached, the first softkey level is displayed again.

BACK
PREA/COM
INFO

By pressing the **<CONT>** softkey again in the bottom row, the fourth softkey level is called. The user is offered additional options (see below).

BACK

A current command input can be canceled with **<BACK>**.

The previous status is then retained.

PREA/COM

<PREA/COM> enables the command block to be preassigned with a standard command block. A comment can also be entered.

INFO

Help pages for the command input can be called with **<INFO>**.

EXECUTE
DEFINE

Execution of the KUM command line previously defined with the exception of the two KUM commands **NOM EDI** and **MVA EDI.** This is clarified by question marks. These two commands are executed automatically by pressing **<DEFINE>**.

B-TERMIN

The command block is concluded. End of the command input and return to the KUM Main Menu ➤*"Calling the KUM Main Menu" on page 1-7*.

Notes on the input and display boxes

Line

If this box is activated, the KUM command cannot be ended with **<DEFINE>** or **<EXECUTE>** and would lead to a corresponding error message. In this box the following functions are possible:

– Selection of a command line by entering the required line number. The line becomes active by pressing **<ENTER>**.

– Scrolling the command lines up or down on the screen. Press the **<SHIFT>** key and hold down. Press the ↓ or ↑ key.
  The previous or next line becomes active.

– Inserting or deleting the current command line. Press the **<SHIFT>** key and hold down. Press **<INSERT>** or **<DELETE>**. A line is added or deleted.

Object

If this data box is activated, the KUM object desired can be specified. There are three ways of doing this:

– Input of the plain text (e.g. **Measured value**) and confirm with **<Return>**

– Input as abbreviation (e.g. **MVA**) and confirm with Return,

– or press the corresponding object softkey (e.g. **<MEAS VAL>**)

Action

If this data box is activated, the KUM action desired can be specified. There are three ways of doing this:

– Input of the plain text (e.g. **Convert**) and confirm with **<Return>**,

– Input as abbreviation (e.g. **CON**) and confirm with **<Return>**,

– or press the corresponding action softkey (e.g. **<CONVERT>**)

Standard

PLTA3 (Special symbols e.g. "****" are not permitted!

The following ASCII_symbols "**A-Z**, **0-9**, _") are permitted

Preassigning a command block

The inputs for the command blocks can be preassigned in the assigned dialog window.

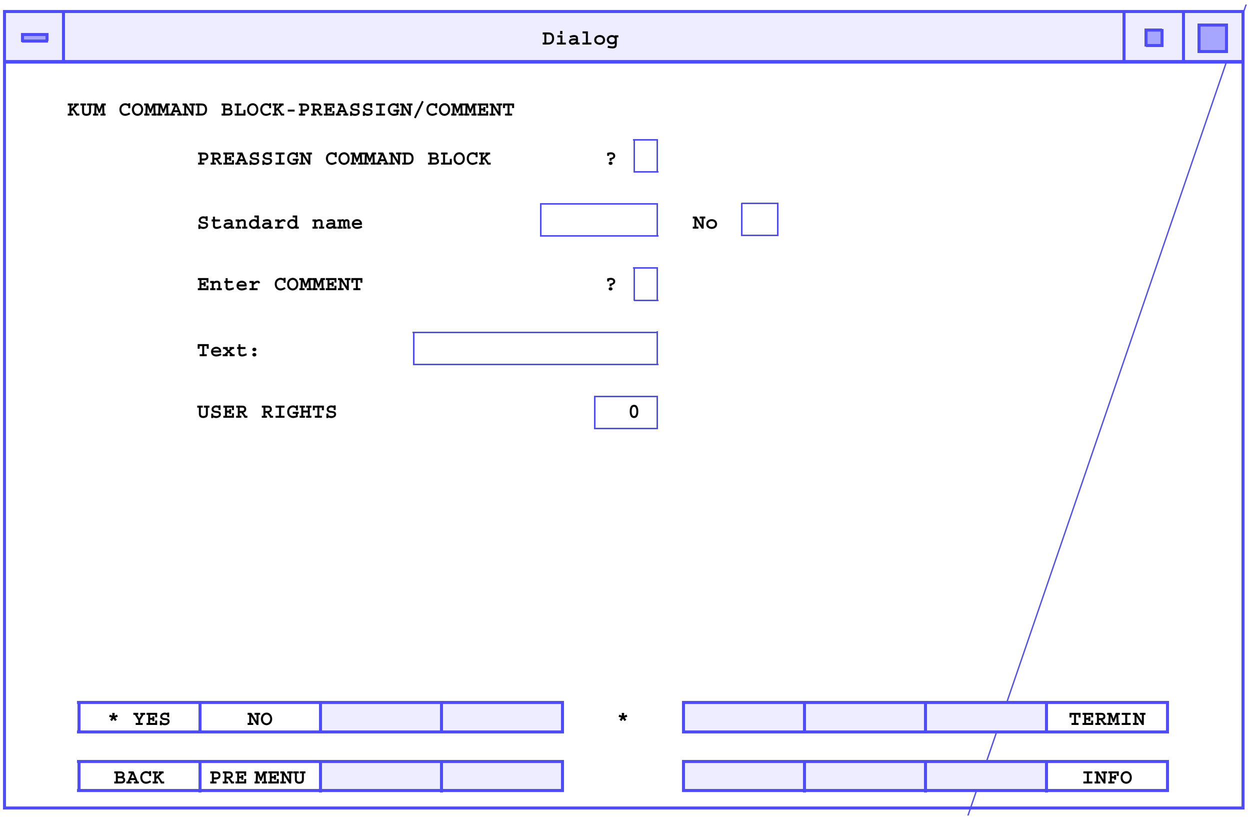
Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **< DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

PREA/COM

– Press **<PREA/COM>**
  The dialog window with the menu title **KUM COMMAND BLOCK PREASSIGNMENT/COMMENT** is displayed.



Softkey functions

BACK

TERMIN

INFO

YES

NO

PRE MENU

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

PREASSIGN COMMAND BLOCK	Answer data box with **<YES>** or **<NO>**.
Standard name	Data box for the current standard name.
No	Number of the standard in the catalog.
Enter COMMENT	If this box is answered with **<YES>**, a text can be entered.
Text	Input of the comment text.
USER RIGHTS	Display box for the user rights code. **0** is preassigned for KUM, i.e. the user right is not checked here.

Administration

The following are managed

- in the administration:
- command blocks
- standard command blocks

standard command lines.

There are two masks available for each of these three points.

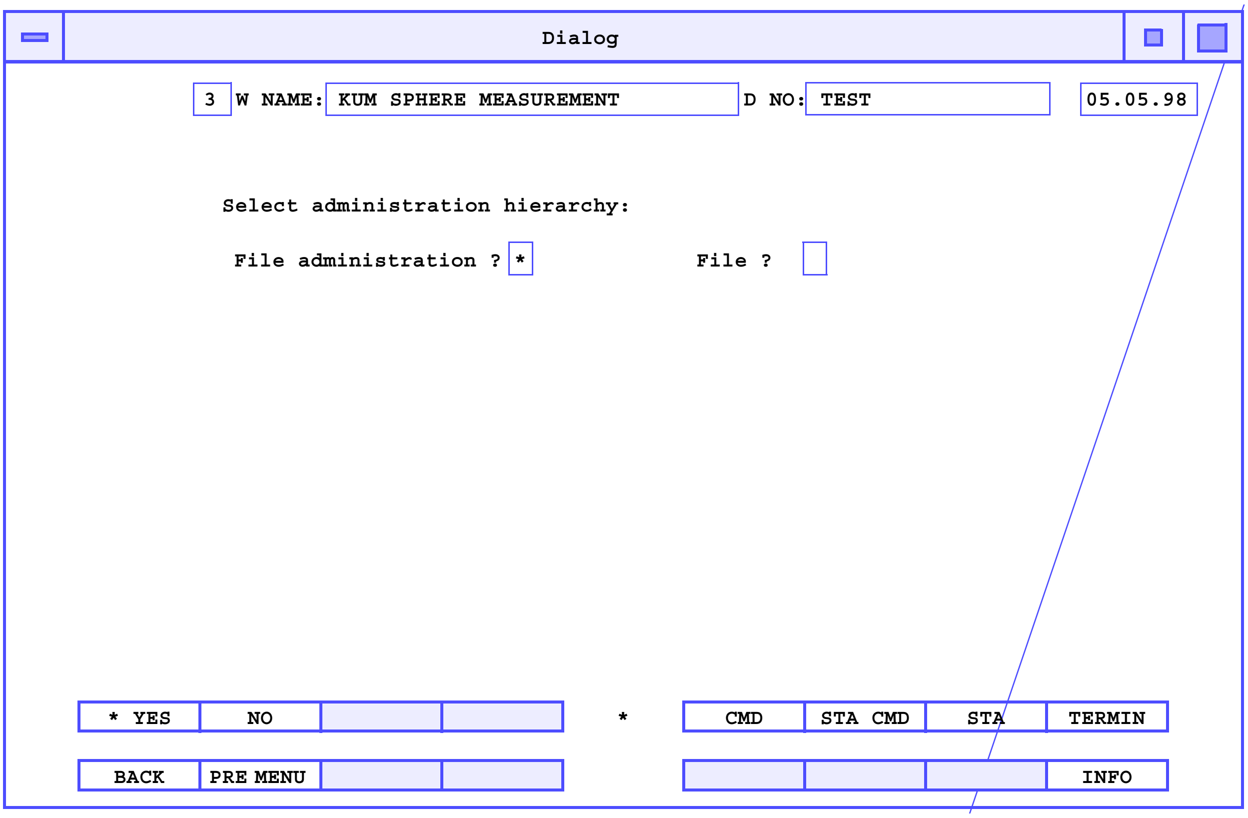
Section	**Administration of**	**Action**
➤ *Chapter 4 „Command block administration" on page 4-18*	Command blocks	Output administration catalog Delete command blocks Copy command blocks
➤ *Chapter 4 „Command block/Parameter" on page 4-21*	Command blocks	Output command block Pack command block
➤ *Chapter 4 „Administration of standard command blocks" on page 4-24*	Standard command blocks	Output administration catalog Delete standard command blocks Copy standard command blocks Pack administration catalog
➤ *Chapter 4 „Standard command block/Parameters" on page 4-27*	Standard command blocks	Output standard command block Pack standard command block
➤ *Chapter 4 „Standard administration" on page 4-30*	Standard command lines	Output administration catalog Delete standard command lines Copy standard command lines Pack administration catalog
➤ *Chapter 4 „Standard" on page 4-33*	Standard command lines	Output standard command lines Pack standard command lines

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

CMD ADM

Press **<CMD ADM>**.

The dialog window with the menu title **COMMAND BLOCK/STANDARD ADMINISTRATION** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

CMD

Depending on the selection of the data boxes **File administration** or **File**, the applicable menu for the administration or for the parameters of the command blocks are called, ➤*"Command block administration" on page 4-18*, ➤*"Command block/Parameter" on page 4-21*.

STA CMD

Depending on the selection of the data boxes **File administration** or **File**, the applicable menu for the administration or for the parameters of the standard command blocks are called, ➤*"Administration of standard command blocks" on page 4-24*, ➤*"Standard command block/Parameters" on page 4-27*.

STA

To output, delete or pack standard command lines, ➤*"Standard administration" on page 4-30*, ➤*"Standard" on page 4-33*.

Notes on the input and display boxes

File administration

Here complete command blocks or standard command blocks and standard command lines are administered. Here you can e.g.

- list names
- copy blocks and lines
- delete blocks and lines

  (➤*"Command block administration" on page 4-18*, ➤*"Administration of standard command blocks" on page 4-24*, ➤*"Standard administration" on page 4-30*).

File

Here the contents (command lines) of a defined command block or of a standard command block or of standard command lines are administered. Here you can e.g.

- list names
- copy contents
- delete contents

  (➤*"Command block/Parameter" on page 4-21*, ➤*"Standard command block/Parameters" on page 4-27* and ➤*"Standard" on page 4-33*).

Command block administration

Section	Administration of	Action
➤ *Chapter 4 „Command block administration" on page 4-18*	Command blocks	Output administration catalog Delete command blocks Copy command blocks
➤ *Chapter 4 „Command block/Parameter" on page 4-21*	Command blocks	Output command block Pack command block
➤ *Chapter 4 „Administration of standard command blocks" on page 4-24*	Standard command blocks	Output administration catalog Delete standard command blocks Copy standard command blocks Pack administration catalog
➤ *Chapter 4 „Standard command block/Parameters" on page 4-27*	Standard command blocks	Output standard command block Pack standard command block
➤ *Chapter 4 „Standard administration" on page 4-30*	Standard command lines	Output administration catalog Delete standard command lines Copy standard command lines Pack administration catalog
➤ *Chapter 4 „Standard" on page 4-33*	Standard command lines	Output standard command lines Pack standard command lines

The following functions can be executed in the command block administration:

- Output administration catalog (listing of all command blocks in a workpiece)
- Delete command block
- Copy command block.

NOTE

Command blocks are workpiece-dependent. Only those command blocks belonging to the workpiece selected can be listed, deleted or copied.
The output, deletion or copying of **standard command blocks** is described in ➤ *"Administration of standard command blocks" on page 4-24*..

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

CMD ADM

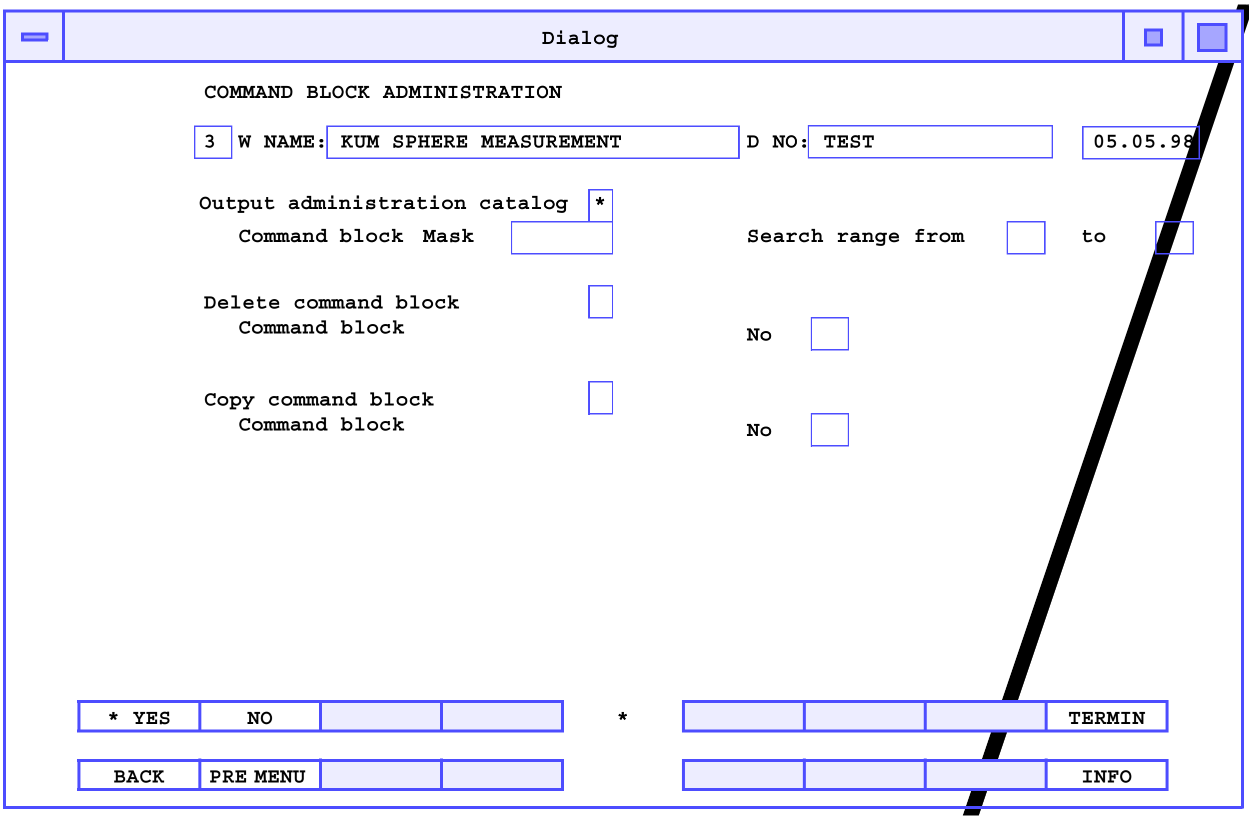
– Press **<CMD ADM>**.
The dialog window with the menu title **COMMAND BLOCK/STANDARD ADMINISTRATION** is displayed.

YES

– Answer **FILE ADMINISTRATION** with **<YES>**.

CMD

– Press **<CMD>**.
The dialog window with the menu title **COMMAND BLOCK ADMINISTRATION** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Output administration catalog

NOTE

By answering **<YES>** or **<NO>** you can specify whether the contents of the administration catalog are to be listed on the screen or not. The texts are entered with **Define command block** ➤*"Preassigning a command block" on page 4-13*.

Command block Mask To enter the search mask for the command block, e.g. AA. All command blocks with the letters AA are listed.

Search range from to To enter the search range desired, e.g. from 3 to 10. The command blocks with line numbers 3 to 10 are listed.

Delete command block By answering **<YES>**, the number of the command block to be deleted can be entered.

Command block No Input (number) of the command block to be deleted.

Copy command block. By answering **<YES>**, the number of the command block to be copied can be entered. This command block is created after the last command block which exists.

Command block No Input (number) of the command block to be copied.

Command block/Parameter

Section	Administration of	Action
➤ *Chapter 4 „Command block administration" on page 4-18*	Command blocks	Output administration catalog Delete command blocks Copy command blocks
➤ *Chapter 4 „Command block/Parameter" on page 4-21*	Command blocks	Output command block Pack command block
➤ *Chapter 4 „Administration of standard command blocks" on page 4-24*	Standard command blocks	Output administration catalog Delete standard command blocks Copy standard command blocks Pack administration catalog
➤ *Chapter 4 „Standard command block/Parameters" on page 4-27*	Standard command blocks	Output standard command block Pack standard command block
➤ *Chapter 4 „Standard administration" on page 4-30*	Standard command lines	Output administration catalog Delete standard command lines Copy standard command lines Pack administration catalog
➤ *Chapter 4 „Standard" on page 4-33*	Standard command lines	Output standard command lines Pack standard command lines

The following functions can be executed in this section:

– Output of command block (listing of all command lines in a command block)

– Packing a command block (gaps which have arisen in command blocks as a result of deleting can be closed (packed)).

NOTE

Command blocks are workpiece-dependent. Only command blocks belonging to the workpiece selected can be output or packed.
The output or packing of **standard command blocks** is described in ➤*"Administration of standard command blocks" on page 4-24*..

NOTE

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

CMD ADM

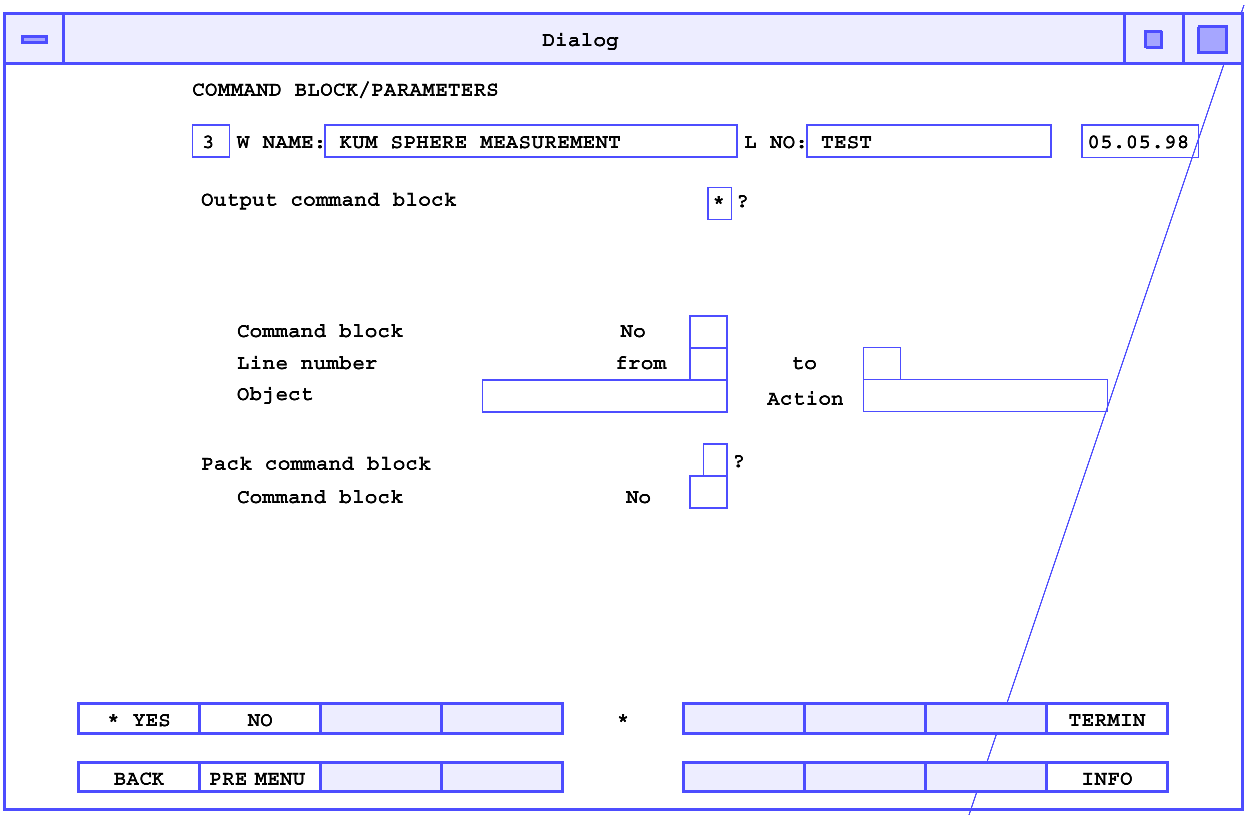
– Press **<CMD ADM>**.
The dialog window with the menu title **COMMAND BLOCK/STANDARD ADMINISTRATION** is displayed.

YES

– Answer the **FILE** data box with **<YES>**.

CMD

– Press **<CMD>**.
The dialog window with the menu title **COMMAND BLOCK/PARAMETERS** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Command block output
By answering **<YES>** or **<NO>** you can decide whether the command block should be output on the screen or not.

Command block No.
Input of the command block to be output.

If neither a line number nor an action or object is entered, all command lines in the command block are displayed.

Line number from to
Input of the range of the command lines of interest.

Object:
With the object selection, certain objects in the command block can be searched for and listed.

Action
With the action selection, certain actions in the command block can be searched for and listed.

Pack command block
By answering **<YES>** or **<NO>**, you can specify whether the gaps which occurred in the command block during deletion are to be closed or not.

Command block no.
Input of the number of the command block to be packed.

Administration of standard command blocks

Section	Administration of	Action
➤ *Chapter 4 „Command block administration" on page 4-18*	Command blocks	Output administration catalog Delete command blocks Copy command blocks
➤ *Chapter 4 „Command block/Parameter" on page 4-21*	Command blocks	Output command block Pack command block
➤ *Chapter 4 „Administration of standard command blocks" on page 4-24*	Standard command blocks	Output administration catalog Delete standard command blocks Copy standard command blocks Pack administration catalog
➤ *Chapter 4 „Standard command block/Parameters" on page 4-27*	Standard command blocks	Output standard command block Pack standard command block
➤ *Chapter 4 „Standard administration" on page 4-30*	Standard command lines	Output administration catalog Delete standard command lines Copy standard command lines Pack administration catalog
➤ *Chapter 4 „Standard" on page 4-33*	Standard command lines	Output standard command lines Pack standard command lines

The following functions can be executed in the standard command block:

– Output administration catalog (listing of all standard command blocks)

– Delete standard command block

– Copy standard command block

– Pack administration catalog (gaps which have arisen between command blocks as a result of deleting can be closed (packed)).

NOTE

Standard command blocks are workpiece-independent.
The output, deletion, copying or packing of workpiece-specific **command blocks** is described in ➤*"Command block administration" on page 4-18*..

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

CMD ADM

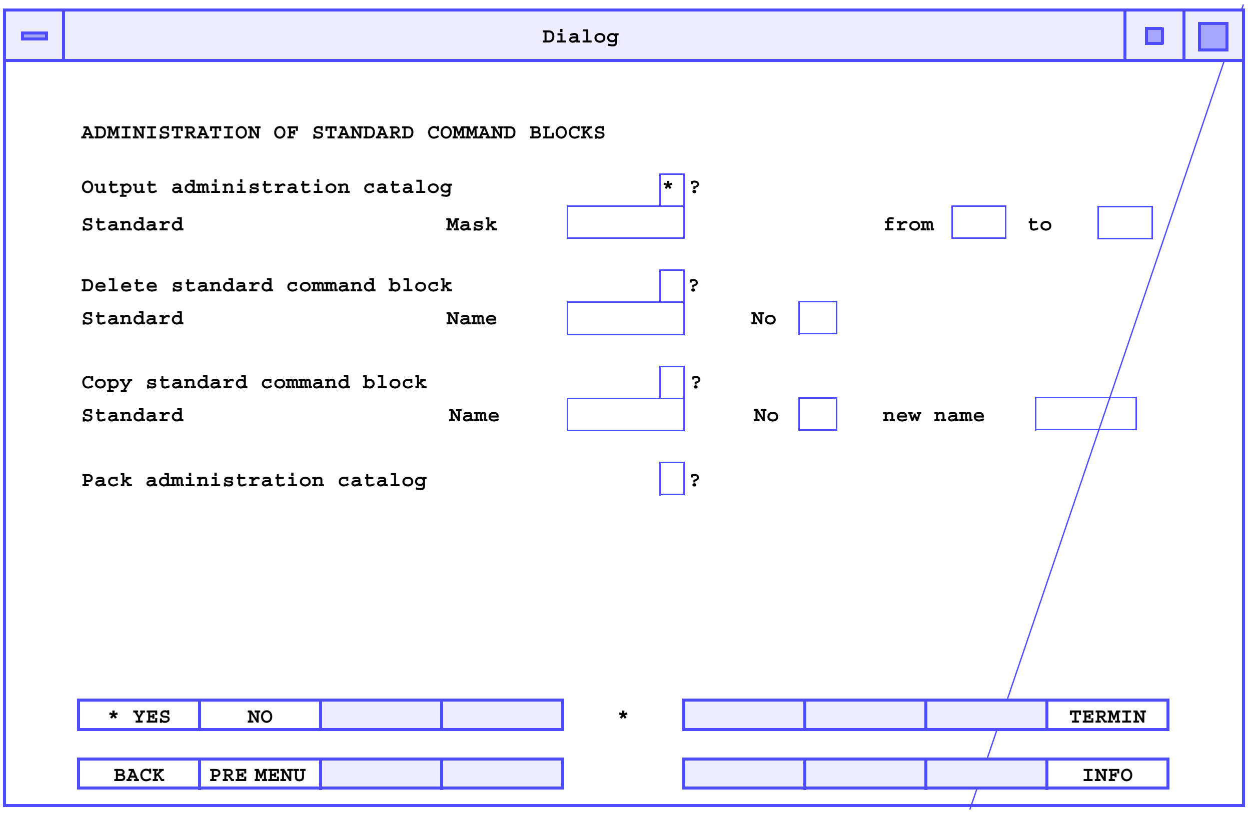
– Press **<CMD ADM>**.
  The dialog window with the menu title **COMMAND BLOCK/STANDARD ADMINISTRATION** is displayed.

YES

– Answer the **FILE ADMINISTRATION** data box with **<YES>**.

STA CMD

– Press **<STA CMD>**.
  The dialog window with the menu title **ADMINISTRATION OF STANDARD COMMAND BLOCKS** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

BACK

See general softkey functions, ➤*“General softkey functions” on page 1-10*.

Notes on the input and display boxes

Output administration catalog

By answering with **<YES>** or **<NO**>, you can specify whether the administration catalog is to be output on the screen or not.

The texts are entered with Define command block ➤*“Preassigning a command block” on page 4-13*.

Standard Mask/from/to

Enter the search mask for the command block e.g. **AA**. All command blocks with the letters AA are listed.

Delete standard command block

By answering with **<YES>**, the name and number of the standard command block to be deleted can be entered.

Standard Name/No

Enter the name and number of the standard command block to be deleted

Copy standard command block

By answering with **<YES>**, the name and number of the command block to be copied can be entered.

Standard Name/No/New name

Input of the name and number of the standard command block to be copied. Input of the name of the new standard command block.

Pack administration catalog

By confirming with **<YES>**, the gaps created during deletion in the administration catalog are closed.

Standard command block/Parameters

Section	Administration of	Action
➤ *Chapter 4 „Command block administration" on page 4-18*	Command blocks	Output administration catalog Delete command blocks Copy command blocks
➤ *Chapter 4 „Command block/Parameter" on page 4-21*	Command blocks	Output command block Pack command block
➤ *Chapter 4 „Administration of standard command blocks" on page 4-24*	Standard command blocks	Output administration catalog Delete standard command blocks Copy standard command blocks Pack administration catalog
➤ *Chapter 4 „Standard command block/Parameters" on page 4-27*	Standard command blocks	Output standard command block Pack standard command block
➤ *Chapter 4 „Standard administration" on page 4-30*	Standard command lines	Output administration catalog Delete standard command lines Copy standard command lines Pack administration catalog
➤ *Chapter 4 „Standard" on page 4-33*	Standard command lines	Output standard command lines Pack standard command lines

The following functions can be executed in this section:

– Output of standard command block (listing of all command lines in a standard command block)

– Packing a standard command block (the gaps which have arisen within the command blocks as a result of deletion can be closed (packed)).

NOTE

Standard command blocks are workpiece-independent. The output, deletion, copying or packing of workpiece-specific **command blocks** is described in ➤*"Command block administration" on page 4-18*.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

CMD ADM

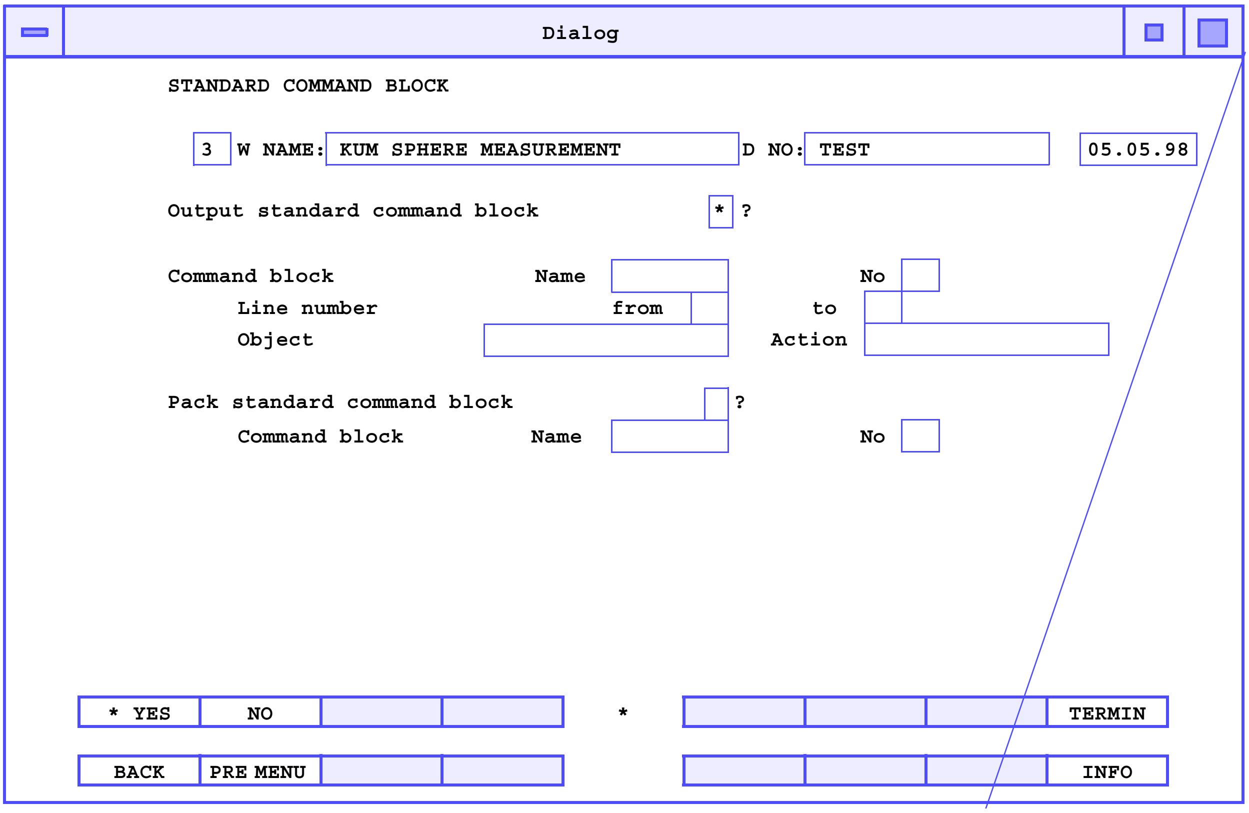
– Press **<CMD ADM>**.
The dialog window with the menu title **COMMAND BLOCK/STANDARD ADMINISTRATION** is displayed.

YES

– Acknowledge the **file** data box with **<YES>**.

STA CMD B

– Press **<STA CMD B>**.
The dialog window with the menu title **STANDARD COMMAND BLOCK** appears.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Output standard command block

By answering with **<YES>** or **<NO>**, you can specify whether the standard command block is to be output on the screen or not. If no line number, no action and no object are entered, only the command block contents are displayed.

Command block Name/No

Input of the name or number of the standard command block of interest.

Line number from/to

Input of the range of command lines of interest.

Object:

With the object selection certain objects in the command block can be searched for and listed.

Action

With the action selection certain actions in the command block can be searched for and listed.

Pack standard command block

By answering with **<YES>** or **<NO>** you can specify whether the gaps which occurred when deleting in the standard command block are to be closed or not.

Command block Name/No

Input of the name or number of the command block to be packed.

Standard administration

Section	Administration of	Action
➤ *Chapter 4 „Command block administration" on page 4-18*	Command blocks	Output administration catalog Delete command blocks Copy command blocks
➤ *Chapter 4 „Command block/Parameter" on page 4-21*	Command blocks	Output command block Pack command block
➤ *Chapter 4 „Administration of standard command blocks" on page 4-24*	Standard command blocks	Output administration catalog Delete standard command blocks Copy standard command blocks Pack administration catalog
➤ *Chapter 4 „Standard command block/Parameters" on page 4-27*	Standard command blocks	Output standard command block Pack standard command block
➤ *Chapter 4 „Standard administration" on page 4-30*	Standard command lines	Output administration catalog Delete standard command lines Copy standard command lines Pack administration catalog
➤ *Chapter 4 „Standard" on page 4-33*	Standard command lines	Output standard command lines Pack standard command lines

The following functions can be executed in this section:

– Output of administration catalog (listing of all standard command lines in a workpiece)

– Deletion of standard command line

– Copying of standard command line

– Packing of administration catalog (gaps which have arisen within the command line as a result of deletion can be closed (packed)).

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

CMD ADM

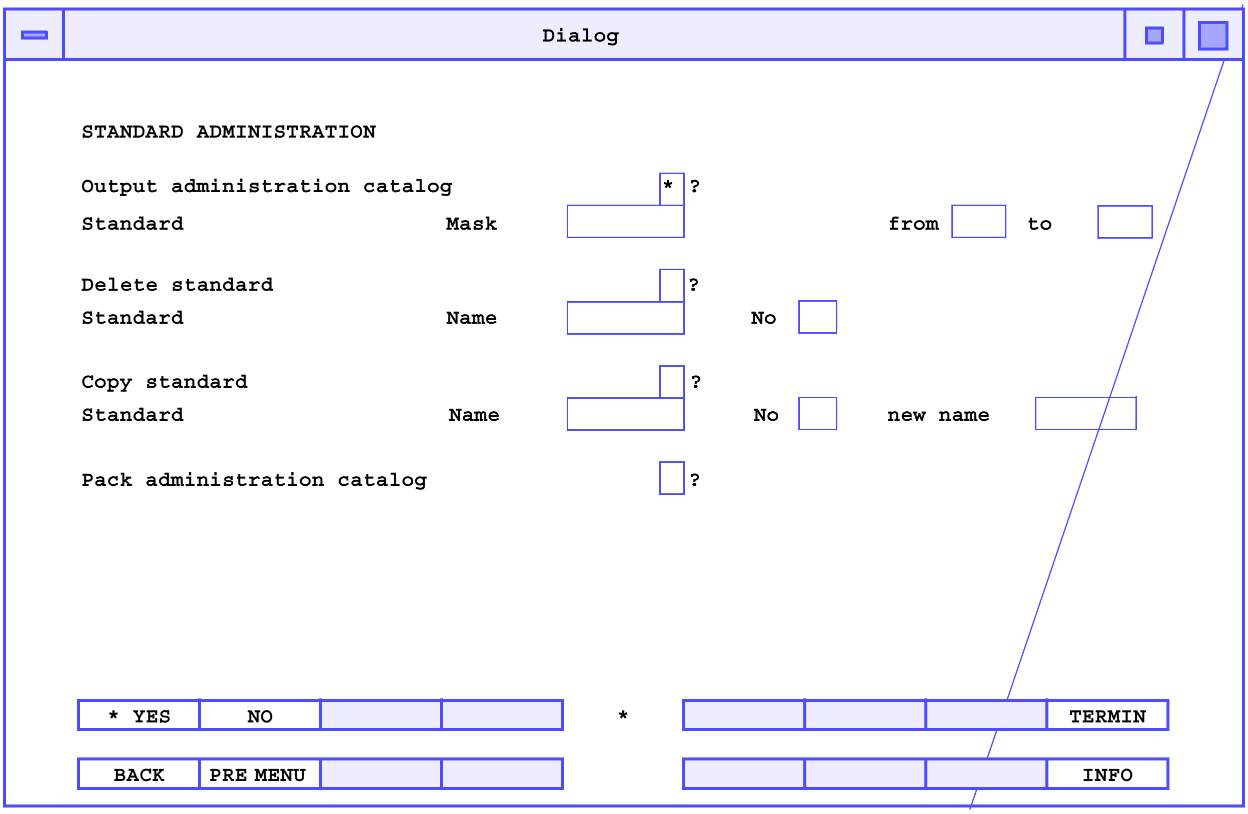
– Press **<CMD ADM>**.
The dialog window with the menu title **COMMAND BLOCK/STANDARD ADMINISTRATION** is displayed.

YES

– Answer the data box **FILE ADMINISTRATION** with **<YES>**.

STA

– Press **<STA>**.
The dialog window with the menu title **STANDARD ADMINISTRATION** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Output administration catalog
By answering with **<YES>** or **<NO>** you can specify whether the administration catalog should be output on the screen or not.

Standard Mask/from/to
Input the search mask for the standard command line e.g. **AA**. All standard command lines with the letters AA are listed.

Delete standard
By answering with **<YES>**, the name and number of the standard command line to be deleted can be entered.

Standard Name/No
Enter the name and number of the standard command line to be deleted.

Copy standard
By answering with **<YES>**, the name and number of the standard command line to be copied can be entered. Only standards within KUM can be copied.

Standard Name/No/new name
Input of the name and number of the standard command line to be copied and the new name of the standard command line.

Pack administration catalog
By confirming with **<YES>** the gaps which occurred in the administration catalog during deletion are closed.

Standard

Section	Administration of	Action
➤ *Chapter 4 „Command block administration" on page 4-18*	Command blocks	Output administration catalog Delete command blocks Copy command blocks
➤ *Chapter 4 „Command block/Parameter" on page 4-21*	Command blocks	Output command block Pack command block
➤ *Chapter 4 „Administration of standard command blocks" on page 4-24*	Standard command blocks	Output administration catalog Delete standard command blocks Copy standard command blocks Pack administration catalog
➤ *Chapter 4 „Standard command block/Parameters" on page 4-27*	Standard command blocks	Output standard command block Pack standard command block
➤ *Chapter 4 „Standard administration" on page 4-30*	Standard command lines	Output administration catalog Delete standard command lines Copy standard command lines Pack administration catalog
➤ *Chapter 4 „Standard" on page 4-33*	Standard command lines	Output standard command lines Pack standard command lines

The following functions can be executed in this section:

- Output of standard command lines
- Partial or complete deletion of standard command lines
- Packing of standard command lines (gaps which have arisen within the standard command lines as a result of deletion can be closed (packed)).

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

CMD ADM

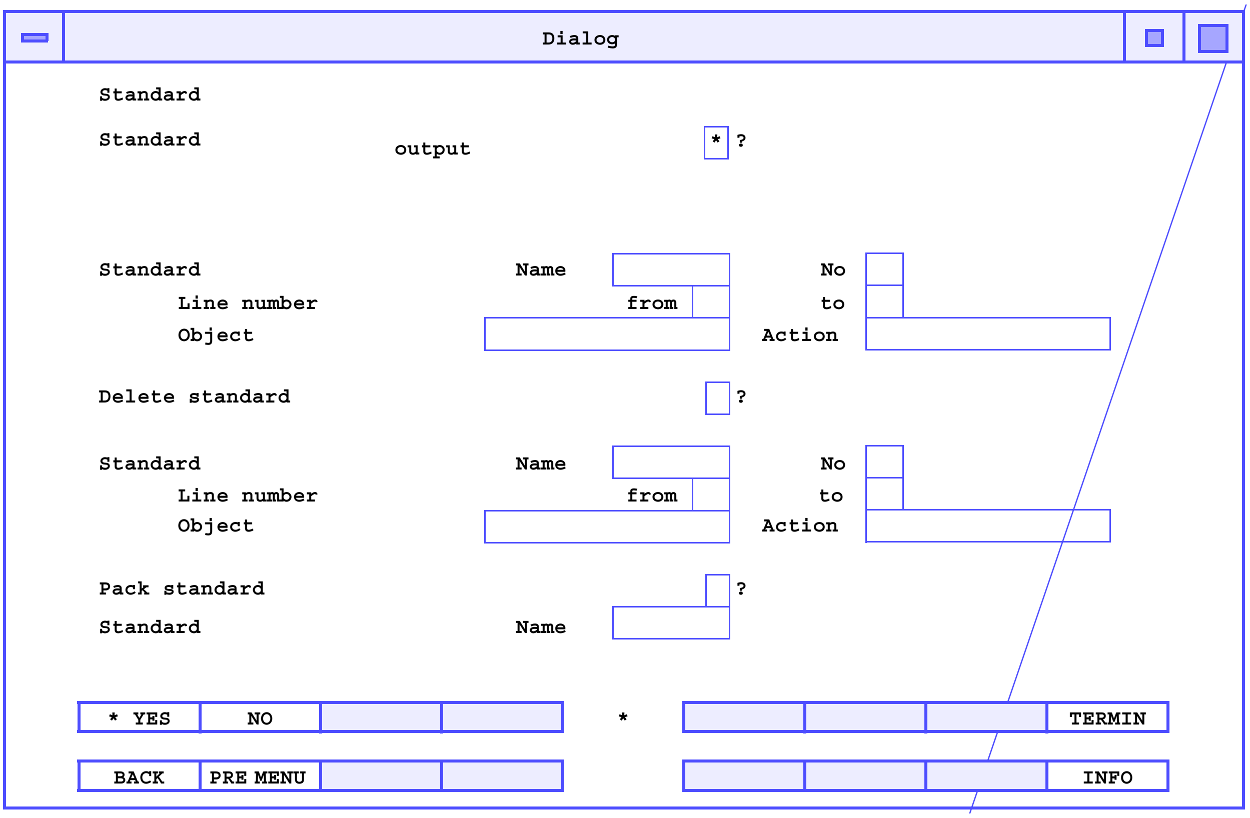
- Press **<CMD ADM>**.
  The dialog window with the menu title **COMMAND BLOCK/STANDARD ADMINISTRATION** is displayed.

YES

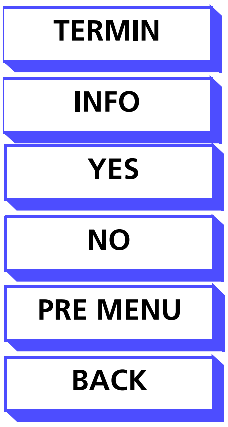
- Acknowledge the **FILE** data box with **<YES>**.

STA

- Press **<STA>**.
  The dialog window with the menu title **STANDARD** is displayed.



Softkey functions



See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Standard output

By confirming with **<YES>**, all standard command lines are listed. For example, by specifying "Standard: SMITH" the following standard command lines can be comprised: **PLT INI, FOR PLO, NOM PLO, MVA PLO** and **DEV PLO**

Standard Name/No

Input of the name or number of the standard command line of interest.

Line number from/to Input of the range of the standard command lines of interest.

Object: With the object selection, certain objects in the standard command lines can be searched for and listed.

Action With the action selection certain actions in the standard command lines can be searched for and listed.

Delete standard If this box is answered with **<YES>**, individual standard command lines can be deleted by specifying the action and object (e.g. the command **NOM PLO**).

If only the action or the object is given, then all standard command lines for this action or object are deleted. For example, the action **PLO** in the "Standard: PLT DIN 3" includes the following command performance specifications: **FOR PLO, NOM PLO, MVA PLO** and **DEV PLO**

And deletion of the object **NOM** simultaneously includes **NOM PLO** and **NOM LIS**

Standard Name/No Input of the name or number of the standard command line to be deleted.

Line number from/to Input of the range of the command lines to be deleted.

Object: With the object or action selection certain objects or actions can be looked for in the standard catalog.

Pack standard By answering with **<YES>** or **<NO>** you can specify whether the gaps which arose during deletion should be closed or not in the standard command lines which are defined next.

Standard Name Input of the name of the standard command line to be packed.

Chapter 5

Nominal Values

This chapter contains:

Nominal input main menu

The following section explains how nominals can be entered or changed.

– Editing new curves, ➤*"Editing new curves (nominal values)" on page 5-5*.

– Entering nominals point by point, ➤*"Entering nominals point by point" on page 5-7*.

– Modifying the input mode, ➤*"Changing curve-specific data" on page 5-10*.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line with **<ENTER>**.

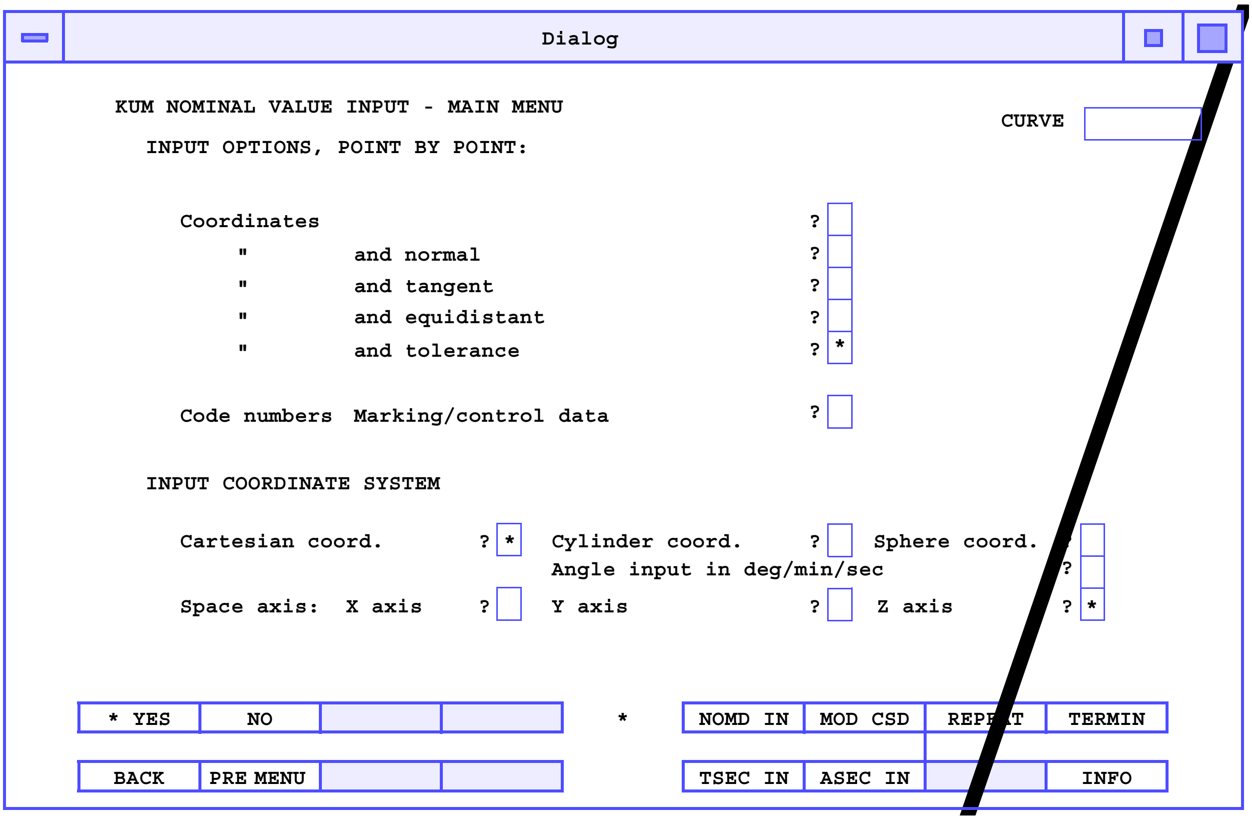
– Enter the KUM command in the data boxes.
Object: **NOM**
Action: **EDI**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM NOMINAL VALUE INPUT - MAIN MENU** is displayed.

NOTE

If the following mask is not displayed, then you have a new curve. See Editing new curves, ➤*"Editing new curves (nominal values)" on page 5-5.*



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

NOMD IN

Point by point nominal value input for the type of data selected, ➤ *"Entering nominals point by point" on page 5-7*.

MOD CSD

Modification of the curve specific data, ➤ *"Changing curve-specific data" on page 5-10*.

TSEC IN

Input of the tolerances (sector by sector), ➤ *"Entering tolerance for the entire curve" on page 5-13* , ➤ *"Entering tolerances sector by sector" on page 5-16*.

ASEC IN

Sector by sector input of the equidistants, ➤*"Entering equidistants sector by sector" on page 5-21*

Notes on the input and display boxes

Coordinates

By confirming with **<YES>** it is possible to input point by point or correct coordinates. This input must be concluded with **<NOMD IN>**.

If **<NO>** is entered, one of the four combinations can be selected (i.e. coordinates with normal, tangent, equidistants or tolerances).

... and normal/ and tangent/ and equidistant and tolerance

Alternative possibility for entering the coordinates in combination with one of the four parameters offered.

If normals, tangents or equidistants are to be entered for the first time for an existing curve (this additional data does not yet exist for the curve), for the control of nominal value input in the dialog window **Curve specific input CHANGE MODE** the corresponding box must be answered with **<YES>**, ➤*"Changing curve-specific data" on page 5-10*. After the required selection with **<TSEC ON>** or **<ASEC ON>**, the corresponding data can be entered sector by sector.

Code numbers Marking/Control data

No function in this software version.

Cartesian cord./ Cylinder coord./ Sphere coord.

Select which of the three coordinate systems is to be used for value input

Angle input in degrees/min/sec

By confirming with **<YES>**, the angle inputs can be entered in degrees/minutes/seconds–otherwise in degrees with decimal places

Space axis: X axis/ Y axis/Z axis

Selection of the space axis with cylinder or sphere coordinates

Editing new curves (nominal values)

This menu is activated with the nominal value input for a new curve and is used for the preselection of the data which is to be defined later.

NOTE

To create a new curve, you first have to enter a new curve in the KUM Main Menu. This is done automatically when entering a new workpiece.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*, a new curve must have been selected.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

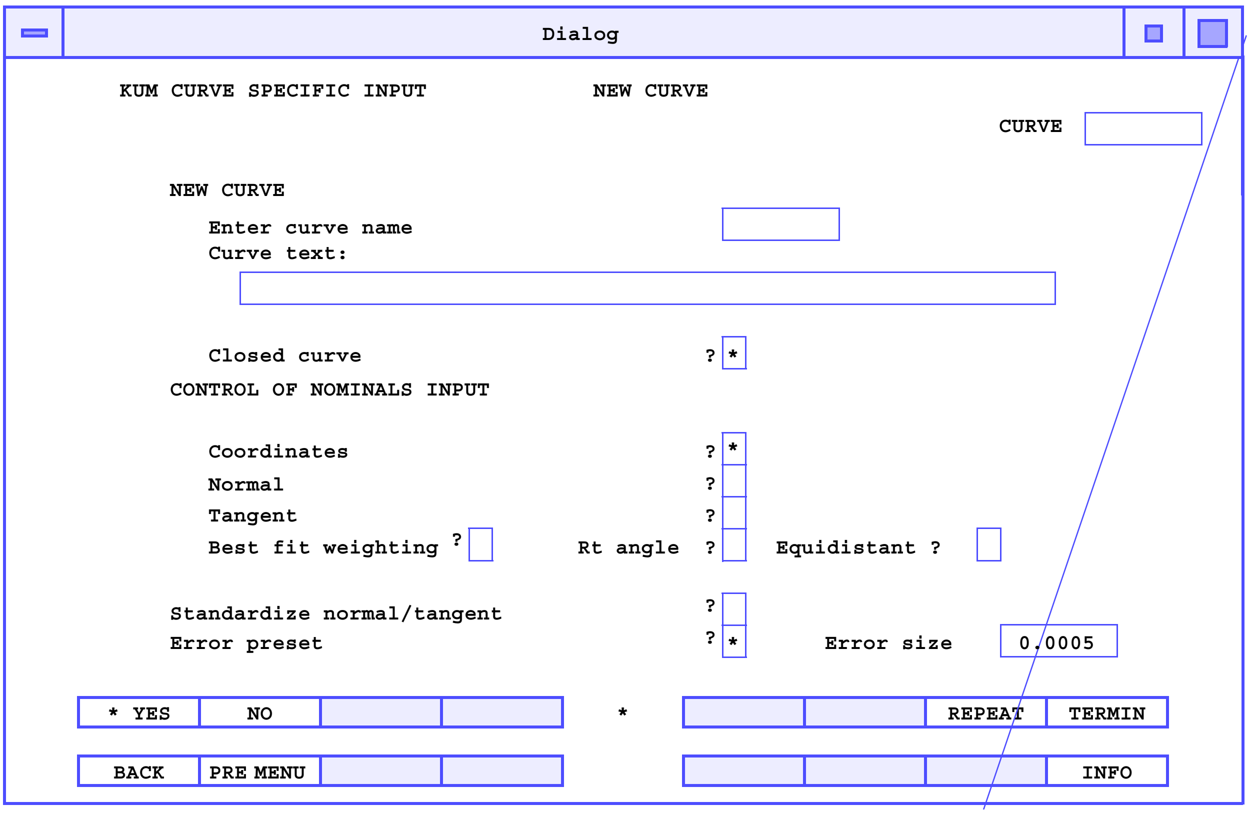
ENTER

– Acknowledge the displayed line with **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM** ; Action: **EDI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM CURVE SPECIFIC INPUT NEW CURVE** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

CURVE
The previous curve name is displayed in this data box.

Enter curve name
Any name can be entered for the curve. The name is output with the curve administration.

Curve text
A comment can be entered here. This text is output after the record header.

Closed curve
This data box must be answered with **<YES>** or **<NO>**.

Coordinates/Normal/ Tangent
The type of data to be entered later manually must be selected here. Additive input is possible.

If data not selected is to be entered later, the message **Input code not set** appears in the main menu of the nominal value input.

Best fit weighting
Data box not activated in this software version.

Rt angle
Data box not activated in this software version.

Equidistant
This data box must be answered with **<YES>** or **<NO>**.

Standardize normal/tangent
This data box must be answered with **<YES>** or **<NO>**.

Error preset
The sum of the squares of the direction cosines must be equal to 1.

Error size
Input of the value about which the sum of the squares of the direction cosine is allowed to deviate from the theoretical value **1**.

Entering nominals point by point

Input

This program is used for entering the input data offered in the nominal main menu (➤"*Nominal input main menu" on page 5-2*). The following data can be entered point by point or modified.

- Coordinates
- Normal
- Tangents
- Tolerances
- Equidistants

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

- Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

- Acknowledge the displayed line with **<ENTER>**.
- Enter the KUM command in the data boxes.
  Object: **NOM**
  Action: **EDI**

DEFINE

- Press **<DEFINE>**.
  The dialog window with the menu title **KUM NOMINAL VALUE INPUT MAIN MENU** is displayed.
- Enter the desired data ➤*"Nominal input main menu" on page 5-2*.

NOMD IN

- Press **<NOMD IN>**.
  The dialog window with the relevant menu title e.g. **KUM COORDINATES & NORMAL** is displayed.

Dialog

KUM COORDINATES & NORMAL

CURVE

Pt No	X-Nom	Y-Nom	Z-Nom	Nx	Ny	Nz
1	-3.0000	-3.0000	0.0000	0.0000	0.0000	1.0000
2	-3.0000	-4.0000	0.0000	0.0000	0.0000	1.0000
3	-3.0000	-6.1500	0.0000	0.0000	0.0000	1.0000
4	-3.0000	-8.1650	0.0000	0.0000	0.0000	1.0000
5	-3.0000	-8.1950	0.0000	0.0000	0.0000	1.0000

*YES	NO	MODIFY	STORE *	INSERT	MASK	SELECT L	TERMIN
BACK	RESTART	MOVE	DELETE	COPY	DEMASK	COLUMN	UNDO

Softkey functions

TERMIN

BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

NOTE

On exiting this dialog window, a check is made for each point to see if the data is complete, based on the curve-specific data. If this is not the case, an error code is set, which can be output with the **List nominals** function.

YES

NO

These softkeys have no function in this dialog window.

MODIFY

Re-enter or modify nominals.

To change data or enter new data, first press **<MODIFY>** and then enter the data. End each line with **<Shift>** + <↑>; Exit modify mode with **<MODIFY>**.

To change just one column, first press <**COLUMN**> and then <**MODIFY>**. The cursor jumps to the column selected. Conclude each line with **<Shift>** + **<**↑**>**; Exit modify mode with **<MODIFY>**.

STORE

Store nominals.

INSERT

Insert line(s).

MASK

Mask line(s). The masking causes a reduced best fit; it has no influence on the measured value or evaluation process. When plotting, you can select whether the masked points are to be displayed. With **List deviations** the text **Point number xxx is masked** appears in the deviation protocol.

SELECT L

Line selection. The line to which you want to go can be entered in the data box.

RESTART

To restart the nominal value input. All inputs or modifications are not accepted.

SHIFT

To move line(s).

DELETE

To delete line(s).

COPY

To copy line(s).

DEMASK

To unmask line(s).

COLUMN

1st activation: To switch to column by column input

2nd activation: To switch back to line by line input.

To change just one column, first press the **<COLUMN>** softkey and then press **<MODIFY>**. The cursor jumps to the column selected. Conclude each line with **<Shift>** + **<**↑**>**; Exit modify mode with the **<MODIFY>** softkey.

UNDO

The last function call is canceled.

Changing curve-specific data

This menu is only activated for an **existing curve** and enables the **input** and **correction** of:

- Curve name
- Curve comment
- Curve specific data

NOTE

The presetting of the curve-specific nominals depend on which data is available for the curve. The input of further data is only possible if the corresponding code is set. Otherwise, in the main menu of the KUM nominal input the following message appears: **Input code not set**.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

- Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

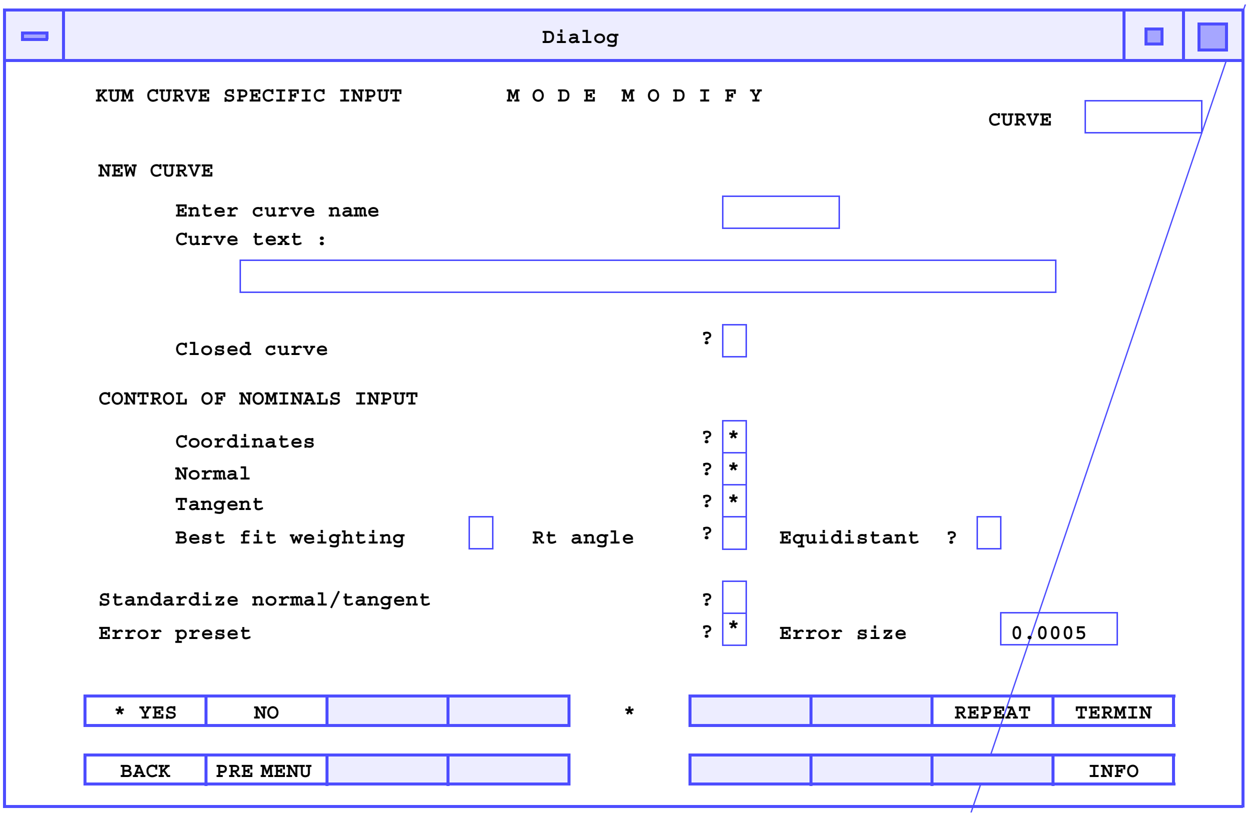
- Acknowledge the displayed line with **<ENTER>**.
- Enter the KUM command in the data boxes.
  Object: **NOM**
  Action: **EDI**

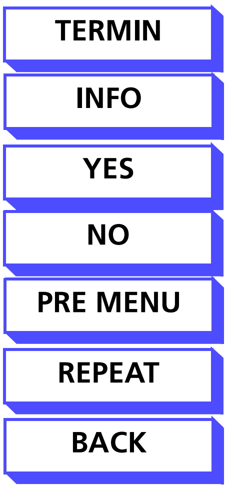
DEFINE

- Press **<DEFINE>**.
  The dialog window with the menu title **KUM NOMINAL VALUE INPUT MAIN MENU** is displayed.
- Enter the desired data ➤*"Nominal input main menu" on page 5-2*.

MOD CSD

- Press **<MOD CSD>**.
  The dialog window with the menu title **MODIFY KUM CURVE SPECIFIC INPUT MODE** is displayed.





Softkey functions

See general softkey functions, ➤*"General softkey functions" on page 1-10.*

Notes on the input and display boxes

CURVE The previous curve name is displayed in this data box.

Enter curve name Any name can be entered for the curve. The name is output with the curve administration.

Curve text A comment can be entered here. This text is output after the record header.

Closed curve This data box must be answered with **<YES>** or **<NO>**.

Coordinates/Normal/Tangent The type of data to be entered later manually must be selected here. Additive input is possible.

If data not selected is to be entered later, the message **Input code not set** appears in the main menu of the nominal value input.

Best fit weighting Data box not activated in this software version.

Rt angle Data box not activated in this software version.

Equidistant This data box must be answered with **<YES>** or **<NO>**

Standardize normal/tangent This data box must be answered with **<YES>** or **<NO>**.

Error preset The sum of the squares of the direction cosines must be equal to 1.

Error size Input of the value about which the sum of the squares of the direction cosines is allowed to deviate from the theoretical value "**1**".

Input of tolerance and equidistants

The start menu for the input of tolerance and equidistants is the window **KUM NOMINAL VALUE INPUT MAIN MENU**, ➤*“Nominal input main menu” on page 5-2*.

Tolerance

With the tolerance input, the tolerances for the **entire curve** are entered first ➤*“Entering tolerance for the entire curve” on page 5-13*; a **tolerance input for sectors** is then possible, ➤*“Entering tolerances sector by sector” on page 5-16*.

Equidistants

➤*“Entering equidistants sector by sector” on page 5-21* shows how the **equidistants can be entered sector by sector**.

Calculate tolerance

Tolerances are calculated point by point from three nominal curves, ➤*“Calculating the tolerance” on page 5-24*.

Entering tolerance for the entire curve

This dialog window is used for point by point tolerance input. It enables input of tolerances for the entire curve.

There are two ways of calling the dialog window.

1st option

Start menu: KUM Main Menu, ➤*“Calling the KUM Main Menu” on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line with **<ENTER>**.
– Enter the KUM command in the data boxes.
Object: **NOM**
Action: **EDI**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM NOMINAL VALUE INPUT MAIN MENU** is displayed. If the menu title **KUM CURVE-SPECIFIC INPUT NEW CURVE** is displayed, then refer to ➤*“Editing new curves (nominal values)” on page 5-5*. After exiting the window, you can continue with the remaining points.

– Enter the desired data ➤*"Nominal input main menu" on page 5-2* .

TSEC IN

– Press **<TSEC IN>**.
  The dialog window with the menu title **KUM TOLERANCE INPUT** is displayed.

2nd option

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

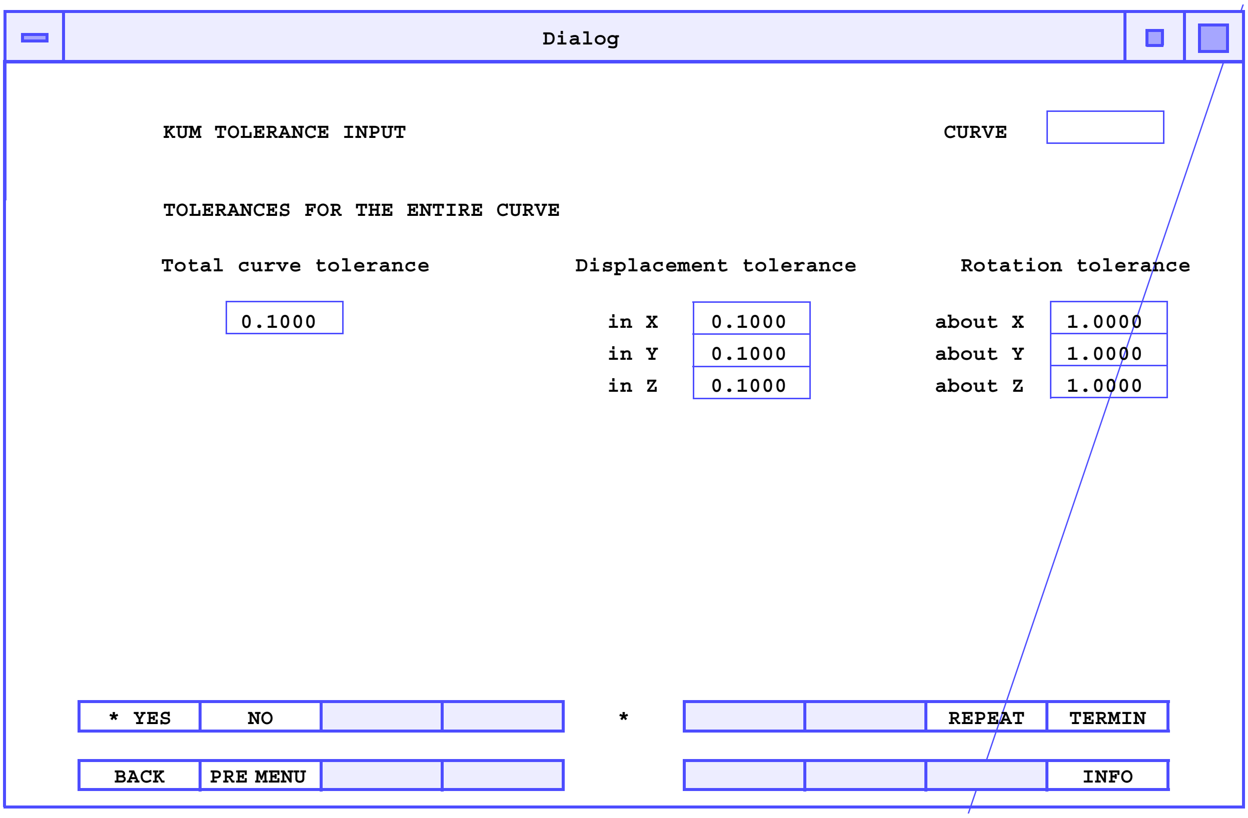
ENTER

– Acknowledge the displayed line with **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **TOL**
  Action: **EDI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM TOLERANCE INPUT** is displayed.



Softkey functions

INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

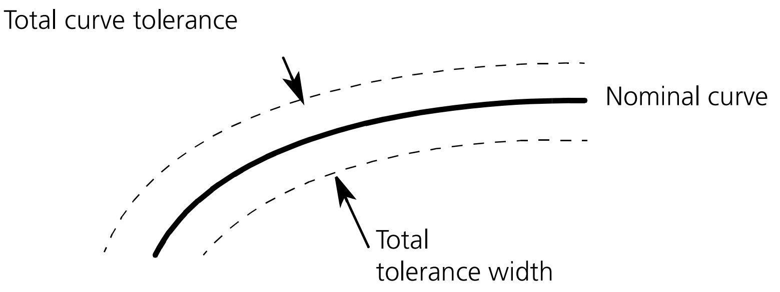
TERMIN

After concluding this dialog window, a follow-on window is called up in which the tolerances can be entered sector by sector, ➤*"Entering tolerances sector by sector" on page 5-16*.

Notes on the input and display boxes

Total curve tolerance

Input of the total tolerance width (in mm). This input applies for the nominal-actual comparison, but does not limit the best fit.



Displacement tolerance in X, in Y, in Z

Input of the permissible displacement distance with the translational best fit (in mm). This value applies as reference for the nominal-actual comparison with the output of the results in the deviation record and the blade rating (no max. value for permissible displacement value with the best fit).

Rotation tolerance about X, about Y, about Z

Input of the permissible rotation angle with the rotational best fit (in degrees). This value applies as reference for the nominal-actual comparison with the output of the results in the deviation record and the blade rating (no max. value for permissible rotation angle with the best fit).

Nominal curves from measuring run

NOTE

With the **TOL EDI** command, standards can be preassigned with defined tolerance values. These tolerances are assigned to the nominal curves selected.
This command can also be used in the CNC run. This then enables the subsequent input of tolerances if nominal curves are produced during a measuring run.

Example of a command block:

Object, Action: NOM CAL or TOL EDI

Entering tolerances sector by sector

This dialog window is the follow-on window of the tolerance input described above for the entire curve (➤*"Entering tolerance for the entire curve" on page 5-13*) and enables an additional tolerance input for sectors.

If no data is entered, the tolerances for the entire curve (➤*"Entering tolerance for the entire curve" on page 5-13*) are transferred.

The tolerances for the entire curve (➤*"Entering tolerance for the entire curve" on page 5-13*) are also transferred if certain areas are not assigned with a new tolerance.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

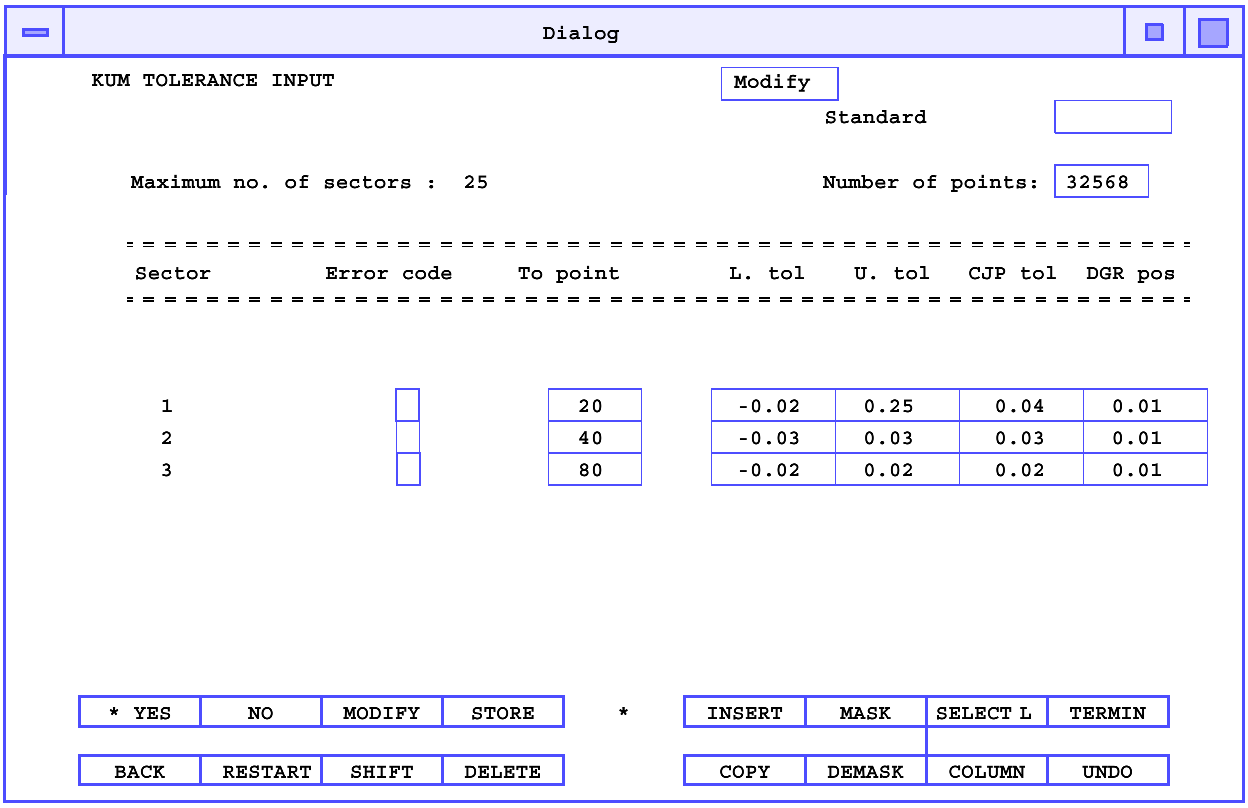
– Acknowledge the displayed line with **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **TOL**;
  Action **EDI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM TOLERANCE INPUT** is displayed.
– Enter the desired data ➤*"Entering tolerance for the entire curve" on page 5-13*.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **KUM TOLERANCE INPUT** is displayed.



Softkey functions

TERMIN **BACK**	See general softkey functions, ➤ *"General softkey functions" on page 1-10.*
YES **NO**	Confirmation or negation of the values entered
MODIFY	To re-enter or modify tolerances
STORE	To store tolerances
INSERT	To insert line(s)
MASK	To mask line(s) Masking results in a reduced best fit; it has no influence on the measuring or evaluation process.
SELECT L	Line selection. The line to which you want to go can be entered in the data box.

RESTART	To restart the tolerance input (with the initial data)
SHIFT	To move line(s)
DELETE	To delete line(s)
COPY	To copy line(s)
DEMASK	To unmask line(s)
COLUMN	1st activation: To switch to column by column input 2nd activation: To switch back to line by line input To change just one column, first press **<COLUMN>** and then **<MODIFY>**. The cursor jumps to the column selected. Conclude each line with **<Shift>** + <↑>; Exit the change mode with **<MODIFY>**.
UNDO	The last function call can be canceled with this softkey.

Notes on the input and display boxes

No. of points
The number of points of the curve is displayed.

Sector
The sector number is automatically incremented with the input of tolerances.

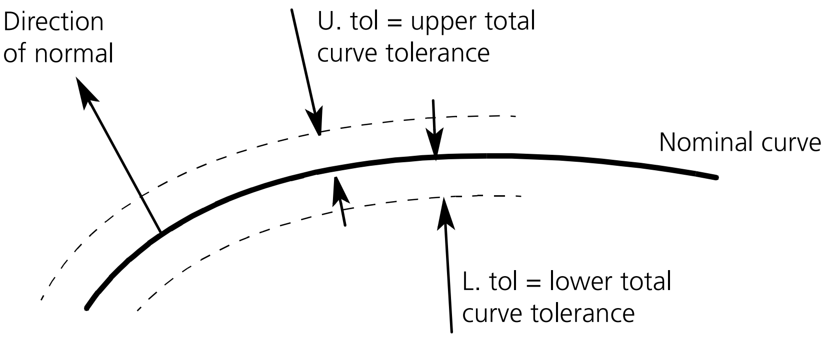
Error code
Check for logical errors in the input. A possible error is displayed when the page is concluded with **<TERMIN>**.

To point
Up to 25 different tolerance sectors can be defined.

If only one sector is required for the entire curve, then the number of curve points is specified here.

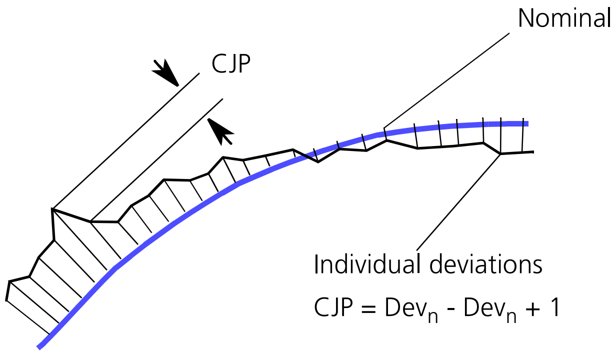
L. tol, u. tol

Information on the lower and upper tolerance.



CJP tol

Input of the curve jump tolerance, i.e. the permissible change between two neighboring curve points.



DGR pos

Definition of the diagram display, scaling of the histogram.

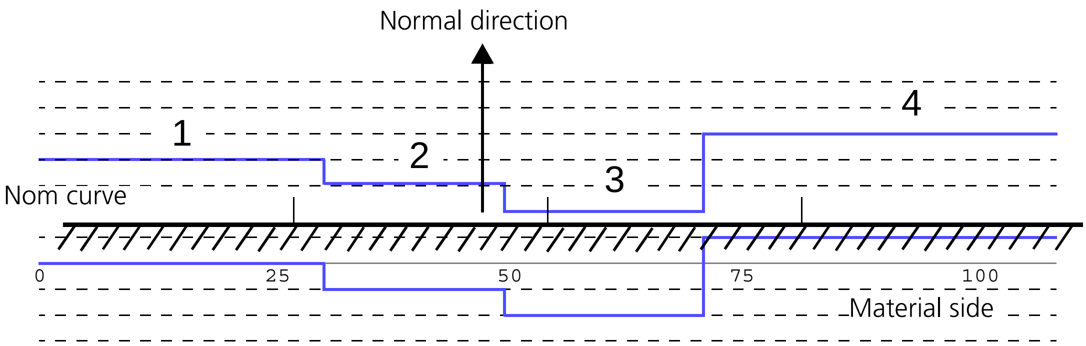
Example: DGR pos = 0.01 means a "–" character per 0.01 mm deviation.

Example

The following list shows the division of a curve into four sectors (tolerance zones) with individual data on the respective tolerances.

The curve itself consists of 100 points, whereby the sector boundaries of the four sectors have been defined by entering the corresponding point numbers.

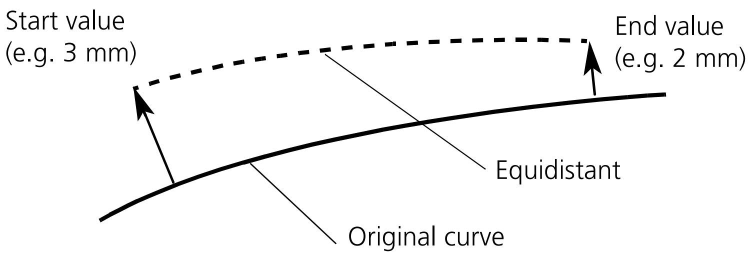
```
Maximum no. of sectors :  25                              No. of points :  100

= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
 Sector          Error code      To point         L. tol     U. tol    CJP tol   DGR pos
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =


   1                               30           -0.0200    0.0200    0.0400    0.0100
   2                               40           -0.0300    0.0100    0.0400    0.0050
   3                               65           -0.0400    0.0000    0.0400    0.0100
   4                              100           -0.0100    0.0300    0.0400    0.0100
```



Entering equidistants sector by sector

Definition

This program is used for sector by sector input or modification of equidistants. An equidistant nominal curve can be calculated with **NOM TRA**, ➤*"Changing equidistants" on page 7-72* (Coordinate transformation: equidistant).



Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line with **<ENTER>**.

– Enter the KUM command in the data boxes.
Object: **NOM**
Action: **EDI**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM NOMINAL VALUE INPUT - MAIN MENU** is displayed. If the menu title **KUM CURVE SPECIFIC INPUT NEW CURVE** is displayed, then refer to ➤*"Editing new curves (nominal values)" on page 5-5*. After exiting the window, you can continue with the remaining points.

– Enter the desired data ➤*"Nominal input main menu" on page 5-2*.

MOD CSD

– Press **<MOD CSD>**.
The dialog window with the menu title **KUM CURVE SPECIFIC INPUT MODE MODIFY** is displayed ➤*"Changing curve-specific data" on page 5-10*.

YES

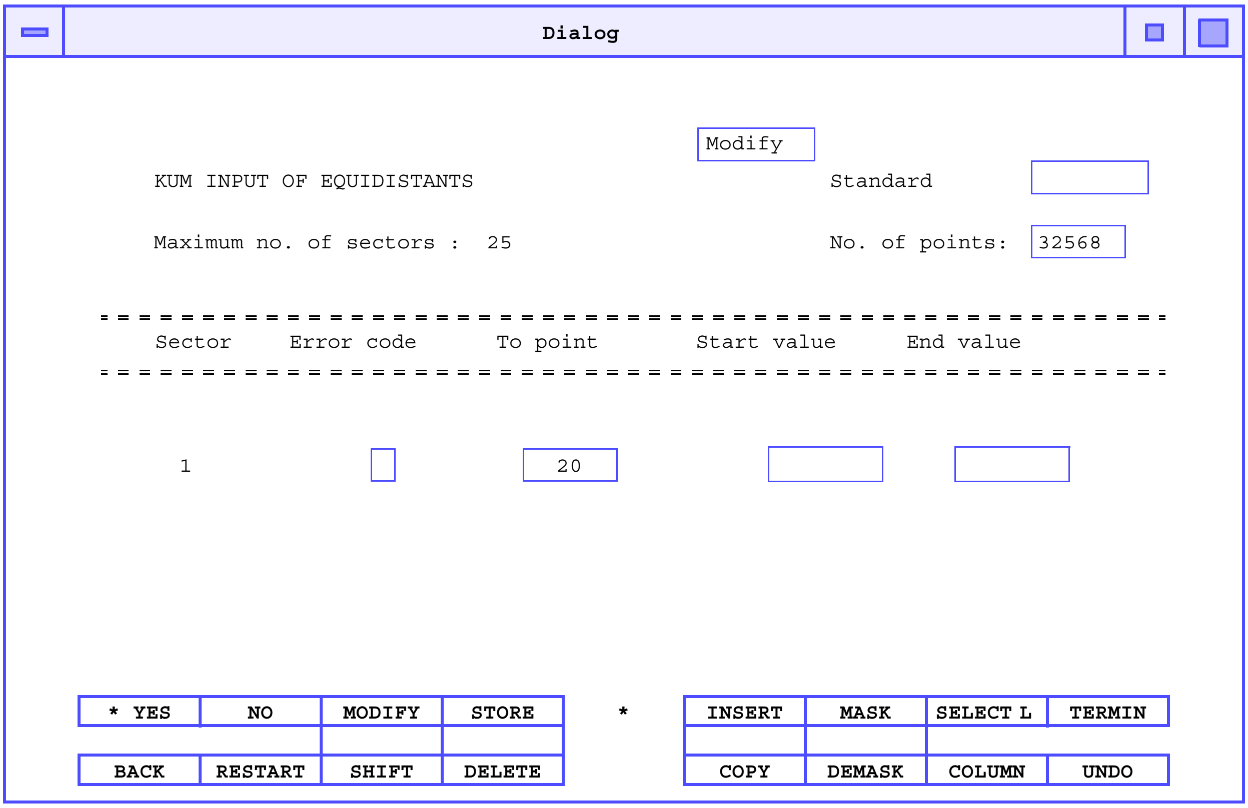
– Answer the Equidistant data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
The dialog window with the menu title **KUM NOMINAL VALUE INPUT MAIN MENU** is displayed.

ASEC IN

– Press **<ASEC IN>**.
The dialog window with the menu title **KUM INPUT OF EQUIDISTANTS** is displayed.



Softkey functions

TERMIN
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

YES
NO

Confirmation or negation of preceding values.

MODIFY

Re-enter equidistant; this mode is automatically selected when the page is called up.

STORE

Store equidistant.

INSERT	Insert line(s).
MASK	Mask line(s).
SELECT L	Line selection. The line to which you want to go can be entered in the data box.
RESTART	Input of the equidistants (with the initial data).
SHIFT	Move line(s).
DELETE	Delete line(s).
COPY	Copy line(s).
DEMASK	Demask line(s).
COLUMN	1st activation: To switch to column by column input 2nd activation: To switch back to line by line input.
UNDO	The last function call is canceled.

Notes on the input and display boxes

Sector
The sector number is automatically incremented with the input of the tolerances.

Error code
Check for logical errors in the input. Possible errors are displayed when the page is concluded with **<TERMIN>**.

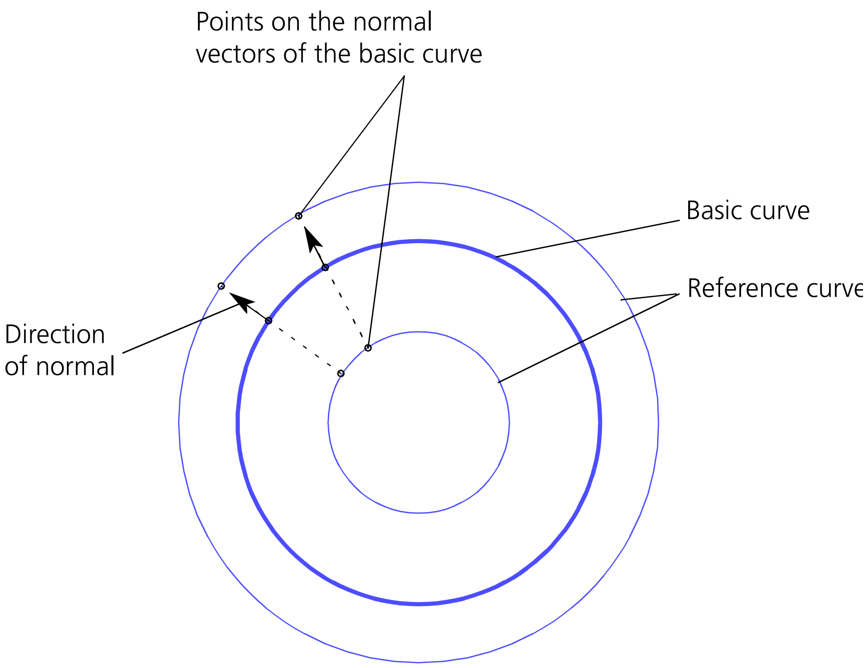
To point
Up to 25 different sectors can be defined. If only one sector is required for the entire curve, then the number of curve points is specified here.

Start value, end value
Input of the start and end value of the equidistants (data in mm).

Calculating the tolerance

Definition

Tolerances can be calculated point by point from three nominal curves. One of the 3 curves is the **basic curve**, to which the tolerances are stored. The two other curves **(reference curves)** contain the *upper* or *lower* tolerance curve.



Point by point tolerance

The distance between the points of the basic curve and the points of the respective tolerance curve is saved as point by point tolerance to the basic curve.

ATTENTION!

- All 3 nominal curves must have the same number of points!
- The points of the tolerance curves must be on the normal vectors of the basic curve!

If the normals of the basic curve are available, the **distances** to these normals are **projected**. Minor deviations of the points of the tolerance curve from the normal vectors of the basic curve (e.g. different intersection height) are thus compensated.

Nominal normals

If when plotting the nominal curve *no* nominal normals are available, then *no tolerances are plotted*.

Errors

As no curve jump tolerances can be calculated with the **TOL CAL** command, be aware, when listing deviations **DEV LIS**, output only if tolerance exceeded, of the option of controlling the calculation of the tolerances exceeded with the column **Curve jump tolerance exceeded** (Cj).

Recommendation

Combine the two commands **TOL EDI** and **TOL CAL** as follows:

First with the **TOL EDI** command, enter the total curv tolerance, off-set tolerances, rotation tolerances as well as up to 25 sectors curve jump tolerances and diagram positions.

Then with the **TOL CAL** function, the lower and upper tolerances are calculated, as well as the tolerances transferred sector by sector.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

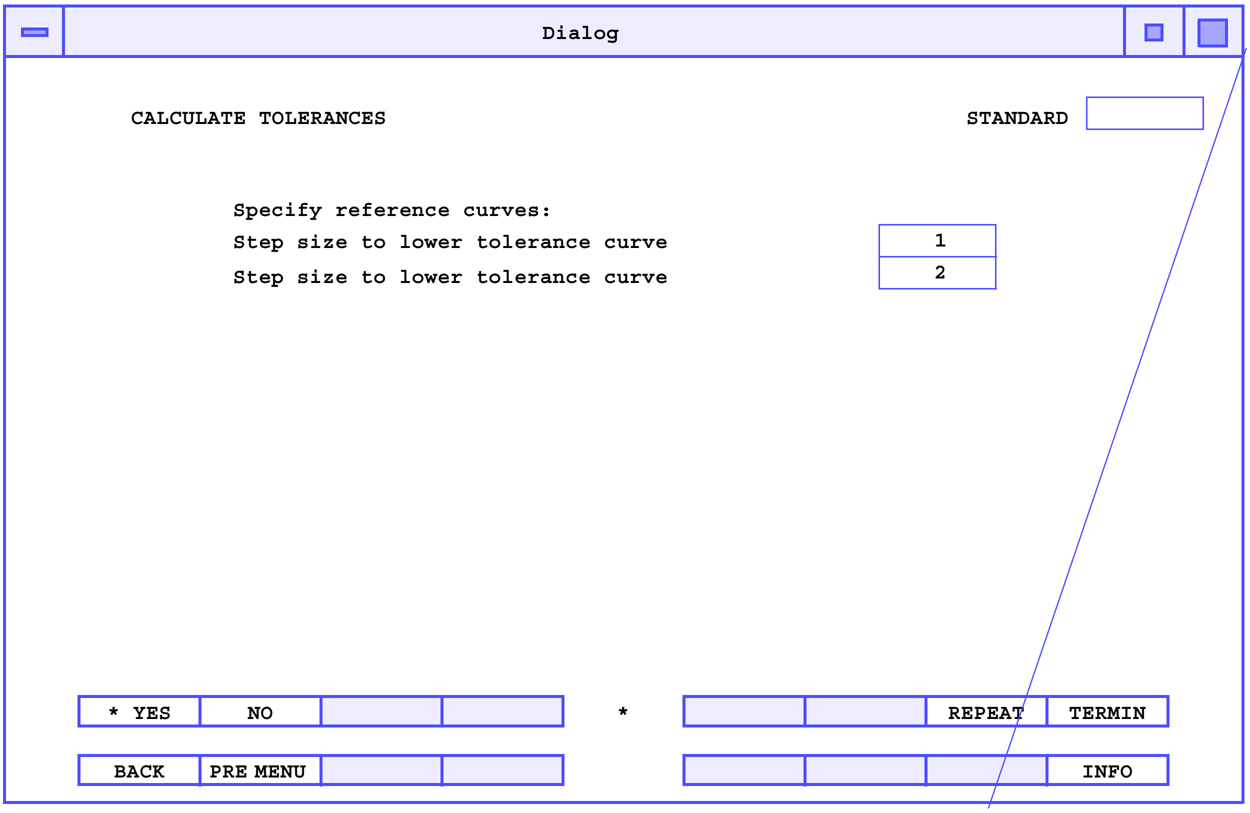
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line with **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **TOL**
  Action: **CAL**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **CALCULATE TOLERANCES** is displayed.



Softkey functions

TERMIN

INFO

YES

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Step size to upper tolerance curve

Input of the step size from the current curve number to the upper tolerance curve (reference curve)

Step size to lower tolerance curve

Input of the step size from the current curve number to the lower tolerance curve (reference curve)

Example

Current curve number 2,
Upper tolerance curve 5 - > step size = 3

Current curve number 2,
Lower tolerance curve 6 - > step size = 4

NOTE

- Negative values are allowed for the step size.
- A loop can be programmed by entering different values for “from curve” and “to curve” (= current curve number) in the KUM main menu when calling up a command block.

Data generation

This dialog window is used for preselecting the geometry element to be generated.

Selection takes place either with the assigned softkeys or be entering the corresponding number of the geometry element (see explanation of the softkey assignment).

ATTENTION!
When generating closed curves, neither overlaps nor identical points are allowed to occur. Generation of nominal data takes place in three steps:
1. Generation of nominals (coordinates)
2. Conversion of nominals
   (coordinates, normal, tangent, center of gravity, arc lengths)
3. Transformation of nominals (rotation, translation, scaling)

There are two ways of calling up the dialog window. Nominal data are generated with the command **NOM GEN**. Measured data are generated with the command **MVA GEN**.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

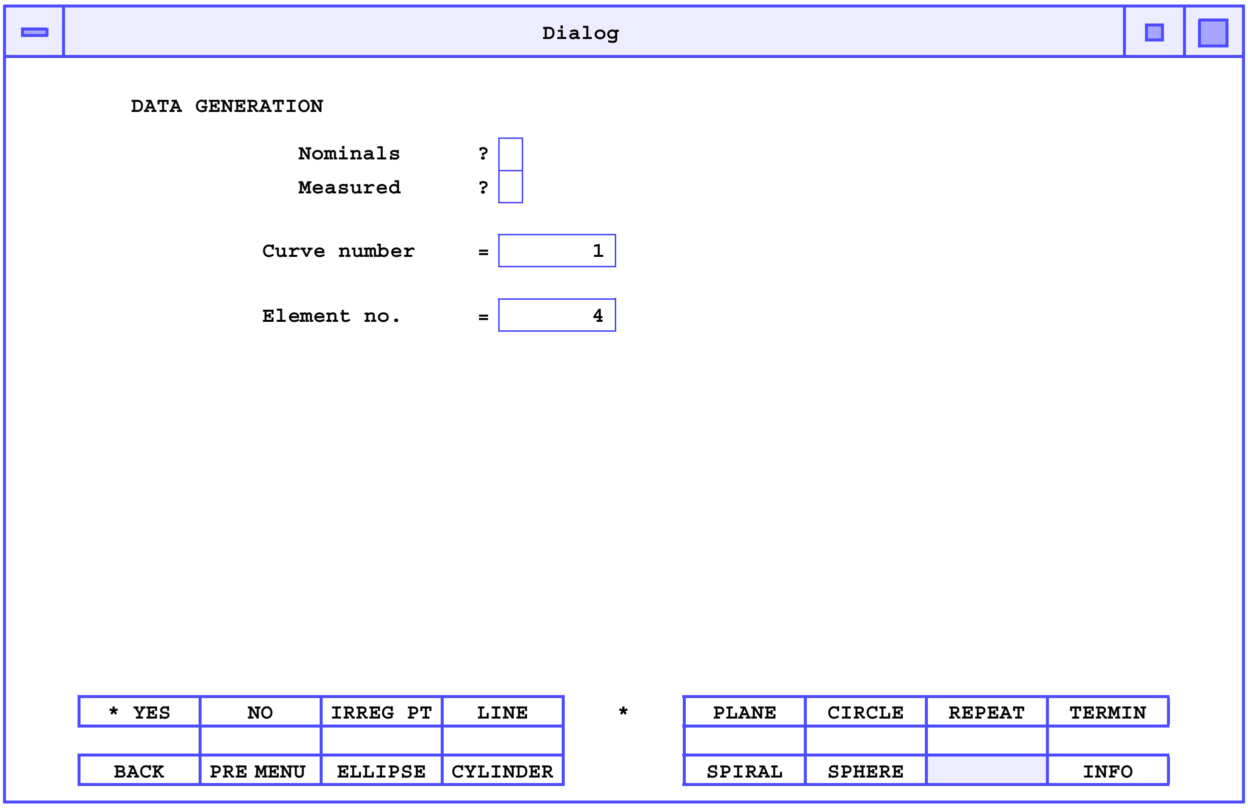
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values), Action: **GEN**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **DATA GENERATION** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*“General softkey functions” on page 1-10*.

IRREG PT

Element no. 1: Generation of an (irregular) point aggregation, ➤*“Element no. 1: Irregular point aggregation” on page 5-31*.

LINE

Element no. 2: Generation of points on a line, ➤*“Element no. 2: Line” on page 5-33*.

PLANE

Element no. 3: Generation of points in a 2D square, ➤*“Element no. 3: Plane” on page 5-36*.

CIRCLE Element no. 4: Generation of points on a circle surface, ➤*"Element no. 4: Circle or circle section" on page 5-38*.

ELLIPSE Element no. 5: Generation of points on an elliptical surface, ➤*"Element no. 5: Ellipse" on page 5-41*.

CYLINDER Element no. 6: Generation of points on a cylinder surface, ➤*"Element no. 6: Cylinder" on page 5-43*.

SPIRAL Element no. 7: Generation of points on a spiral, ➤*"Element no. 7: Spiral" on page 5-45*.

SPHERE Element no. 8: Generation of points on a spherical surface, ➤*"Element no. 8: Sphere" on page 5-48*.

TERMIN Conclusion of this menu and branch to dialog window of the element previously selected

Notes on the input and display boxes

Nominals/Meas data/ Curve number

Inputs in these three display boxes are made by the program and are depending on two pre-inputs:

– Type of data in the command line **NOM GEN** or **MVA GEN**, ➤*"Data generation" on page 5-28*.

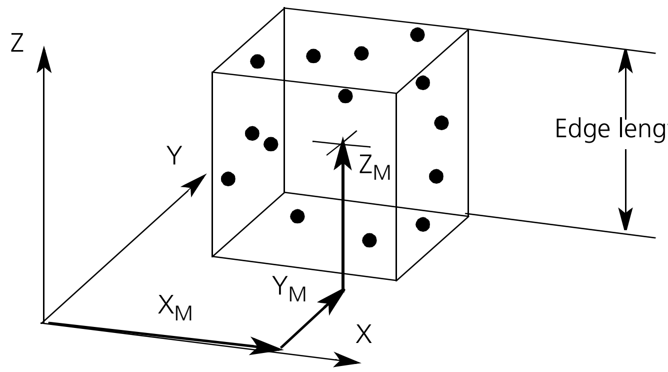
– Curve number in the KUM main menu, ➤*"General softkey functions" on page 1-10*.

Element no.

If you select one of the above elements with the corresponding softkey, the corresponding element number is entered by the program in this box. The required element number can, however, also be entered directly by the user via the keyboard.

Element no. 1: Irregular point aggregation

With this program, random coordinate points can be generated within any cube which is located parallel to the workpiece coordinate system.



There are two different ways of calling up the dialog window. The **NOM GEN** command allows you to generate nominal data. The **MVA GEN** command allows you to generate measured data.

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line with **<ENTER>**.

DEFINE

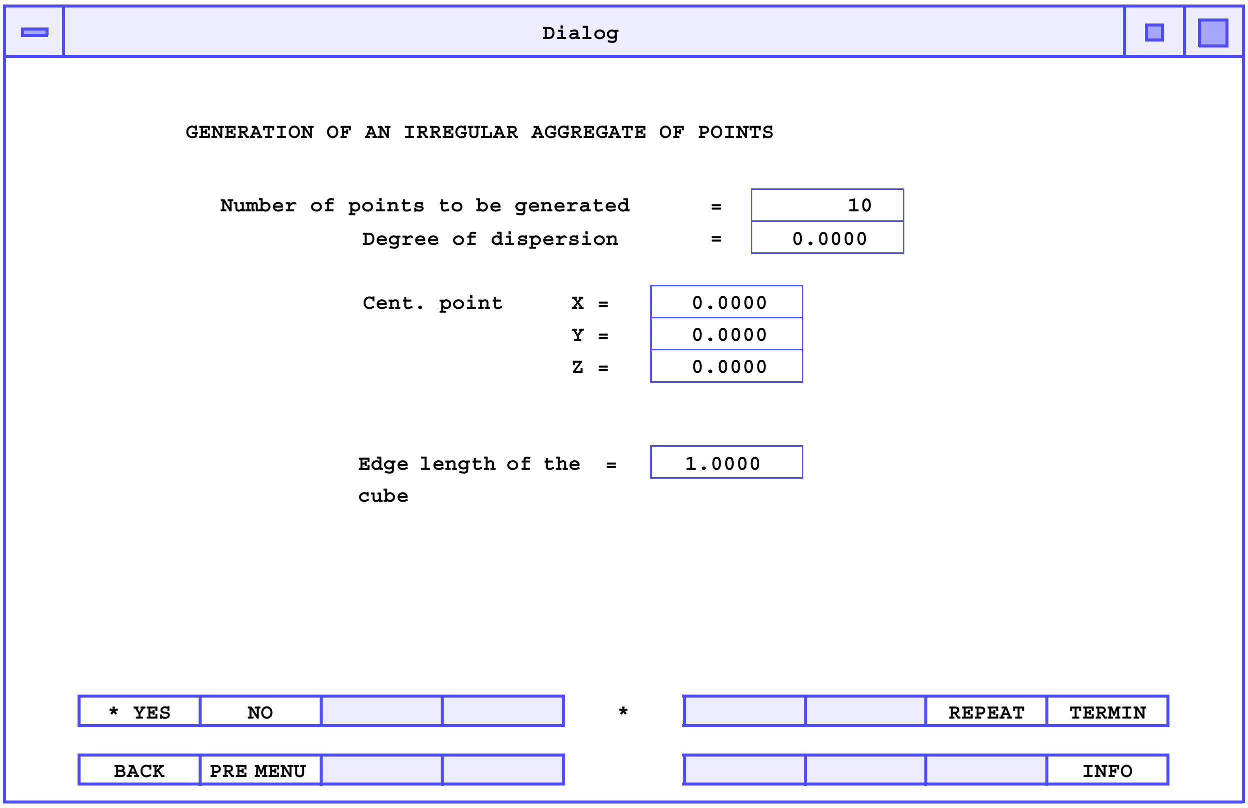
– Press **<DEFINE>**.
The dialog window with the menu title **DATA GENERATION** is displayed.
– Enter the KUM command in the data boxes.
Object: **NOM** (nominal values) or **MVA** (measured values), Action: **GEN**

IRREG PT

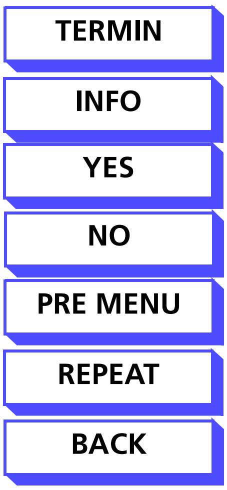
– Press **<IRREG PT>**.

TERMIN

– Press **<TERMIN>**.
The dialog window with the menu title **GENERATION OF AN IRREGULAR AGGREGATE OF POINTS** is displayed.



Softkey functions



See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Number of points to be generated

Input of the required number of points (1 to 32 000 points allowed).

Degree of dispersion

Input of the dispersion range of the values generated (in mm). For example, if 10,0000 points are entered for each coordinate, a random number is added which is in the value range of ±10 mm.

Central point X Y Z Input of the coordinates of the cube center point.

Edge length of the cube Input of the edge length in mm.

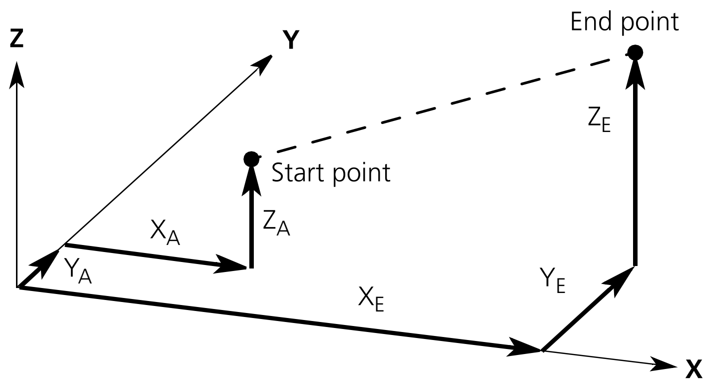
Element no. 2: Line

With this program a line can be generated with any number of nominal points. You can define the line in two ways:

Two point form and point direction form.

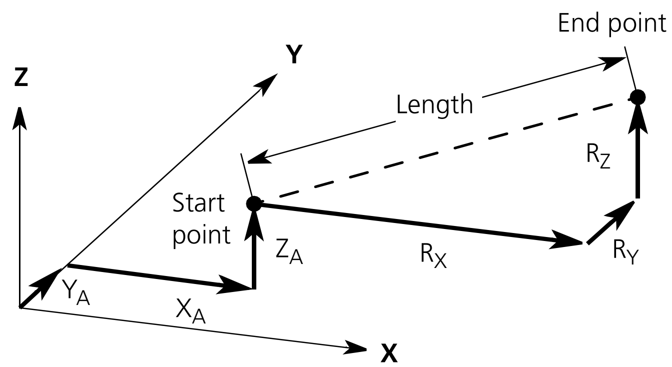
Two point form

Only the start and end point need to be entered to define the line.



Point direction form

In this case, the start point, the direction and length of the line must be entered.



There are two different ways of calling up the dialog window. The **NOM GEN** command allows you to generate nominal data. The **MVA GEN** command allows you to generate measured data.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values), Action: **GEN**

DEFINE

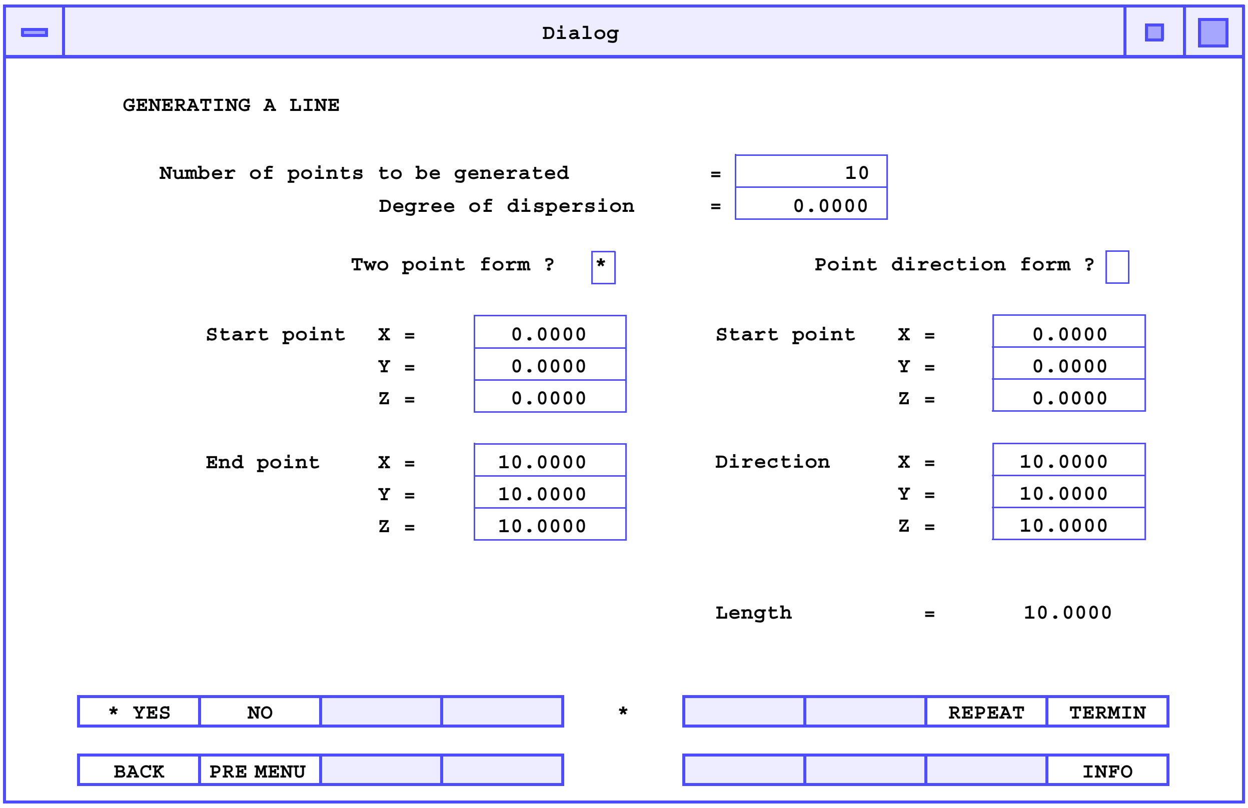
– Press **<DEFINE>**.
  The dialog window with the menu title **DATA GENERATION** is displayed.

LINE

– Press **<LINE>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **GENERATING A LINE** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Number of points to be generated

Input of the number of points required (1 to 32 000 points permitted).

Degree of dispersion

Input of the dispersion range of the values generated (in mm). For example, if 10,0000 points are entered for every coordinate, a random number is added in the value range ±10 mm.

Two point form

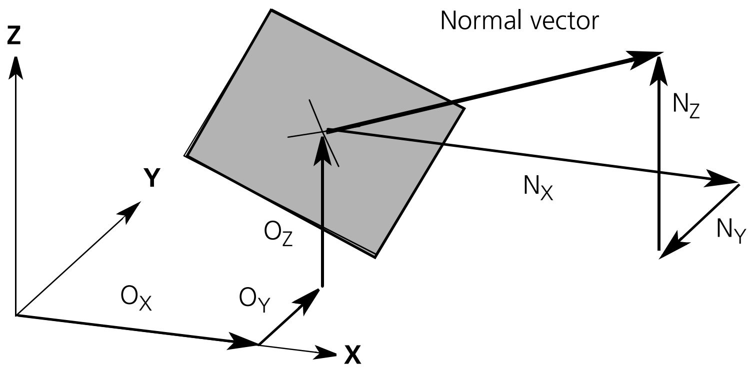
If this data box is confirmed with **<YES>**, the start and end point of the line can be entered. By entering **<NO>** the next data box (point direction form) is activated.

Point direction form

Alternative data box to the two point form, see above. If this box is confirmed with **<YES>**, the start point, direction and length of the line can be entered. Make sure when making the inputs that the sum of the direction components squared results in "**1**".

Element no. 3: Plane

With this program, coordinate points can be generated in a plane. To do this, the center of a square plane in space is defined and the direction of the normal vector specified.



There are two different ways of calling up the dialog window. The **NOM GEN** command allows you to generate nominal data. The **MVA GEN** command allows you to generate measured data.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values), Action: **GEN**

DEFINE

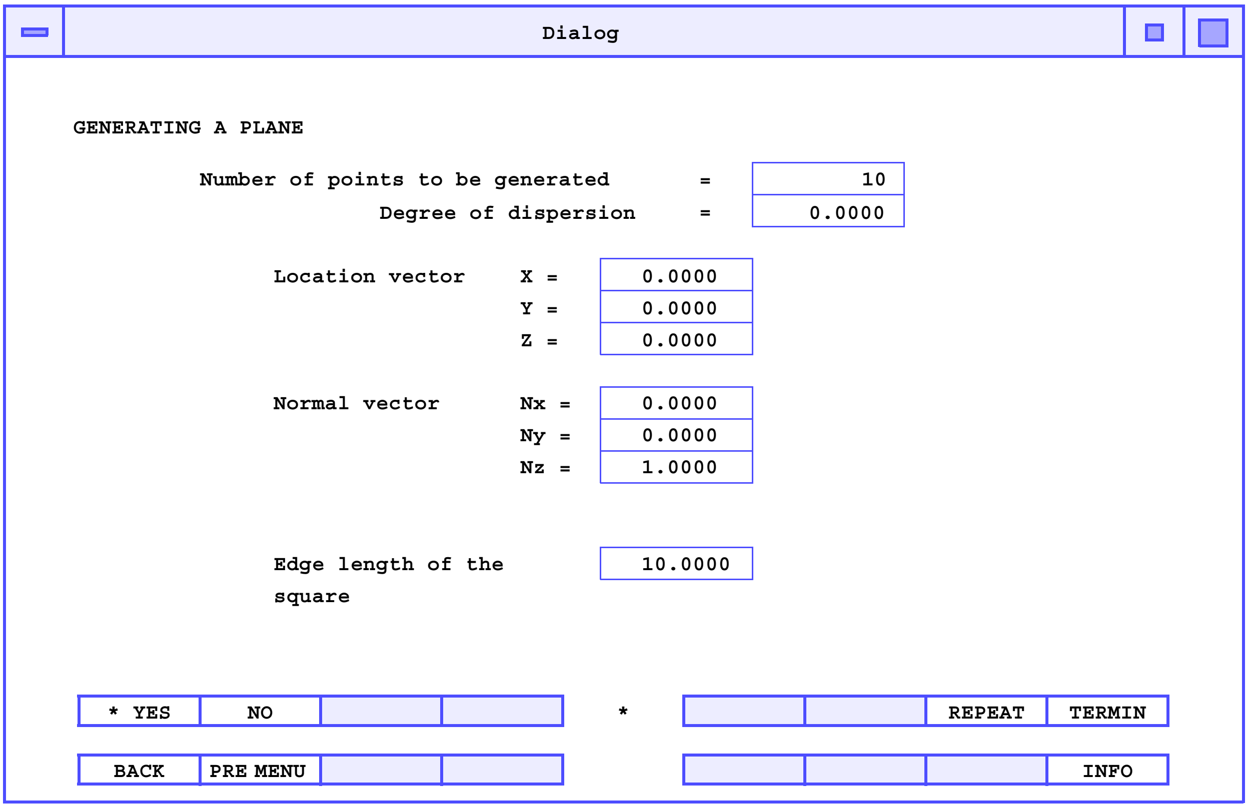
– Press **<DEFINE>**.
  The dialog window with the menu title **DATA GENERATION** is displayed.

PLANE

– Press **<PLANE>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **GENERATING A PLANE** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Number of points to be generated

Input of the required number of points (1 to 32 000 points permitted)

Degree of dispersion

Input of the dispersion range of the values generated (in mm). For example, if 10,0000 points are entered for every coordinate, a random number is added in the value range of ±10 mm.

Location vector X, Y, Z Input of the coordinates of the surface center point.

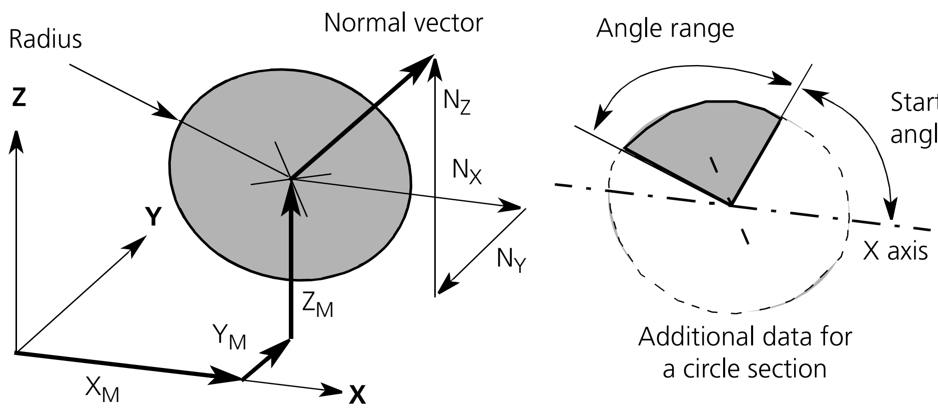
Normal vector Nx, Ny, Nz Input of the direction coordinates of the surface normal.

Edge length of the square Input of the edge length of the square (in mm).

Element no. 4: Circle or circle section

With this program, coordinate points can be generated within a circle or circle section at regular intervals. The circle is generated in the X/Y plane first of all and then rotated in the plane given by the normal vector. Two additional pieces of information are required for defining circle sections:

Start angle (referring to the X axis) and the angle range required.



There are two different ways of calling up the dialog window. With the **NOM GEN** command you generate nominal data. The **MVA GEN** command allows you to generate measured data.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values), Action: **GEN**

DEFINE

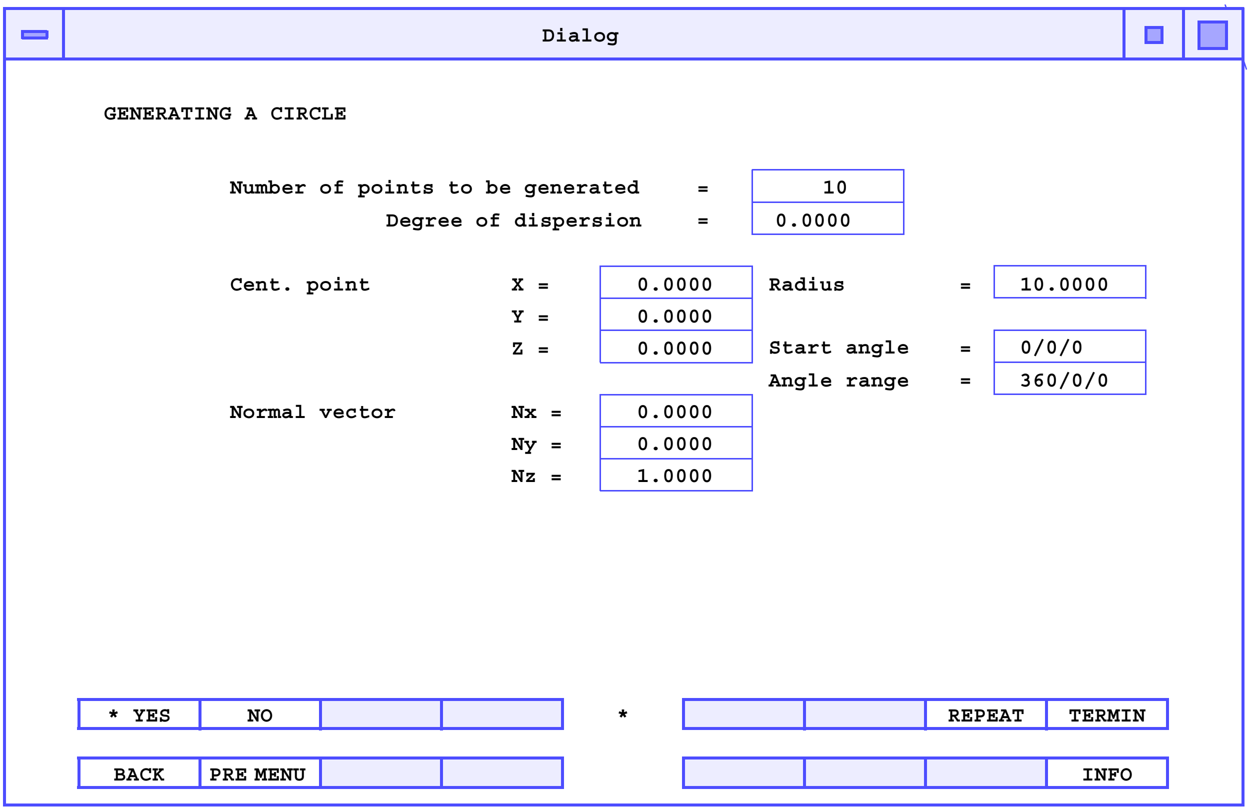
– Press **<DEFINE>**.
  The dialog window with the menu title **DATA GENERATION** is displayed.

CIRCLE

– Press **<CIRCLE>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **GENERATING A CIRCLE** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Number of points to be generated
Input of the required number of points (1 to 32 000 points permitted).

Degree of dispersion
Input of the dispersion range of the values generated (in mm). For example, if 10,000 points are entered for every coordinate, a random number is added in the value range ±10 mm.

Center point
Input of the coordinates of the circle center point.

Normal vector Nx, Ny, Nz
Input of the three coordinate values for the normal vector.

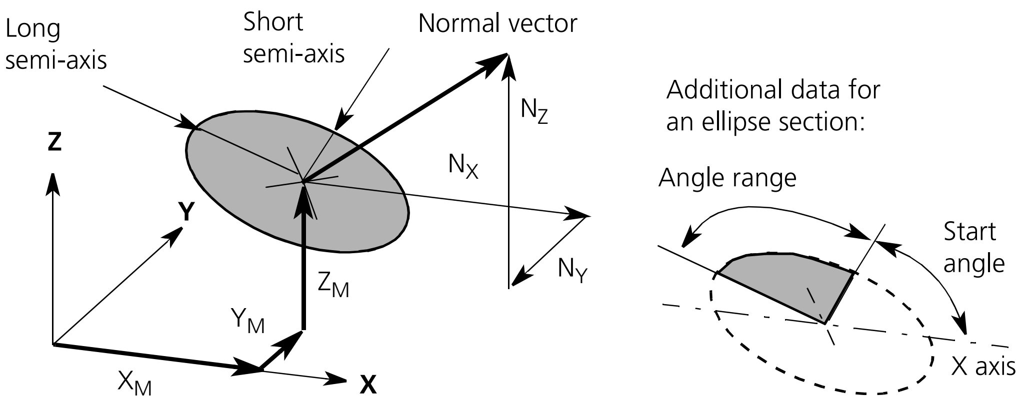
Radius
Input of the radius of the circle or circle section (in mm).

Start angle
With a circle section the start angle can entered here (angle data with reference to the positive X axis).

Angle range
Only with a circle section: Input of the angle range to be determined.

Element no. 5: Ellipse

With this program coordinate points can be generated within an elliptical surface. The ellipse is produced in the X/Y plane first of all, whereby the long semi-axis lies parallel to the X axis and the short semi-axis parallel to the Y axis. The ellipse is then rotated in the plane given by the normal vector.



There are two different ways of calling up the dialog window. The **NOM GEN** command allows you to generate nominal data. The **MVA GEN** command allows you to generate measured data.

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

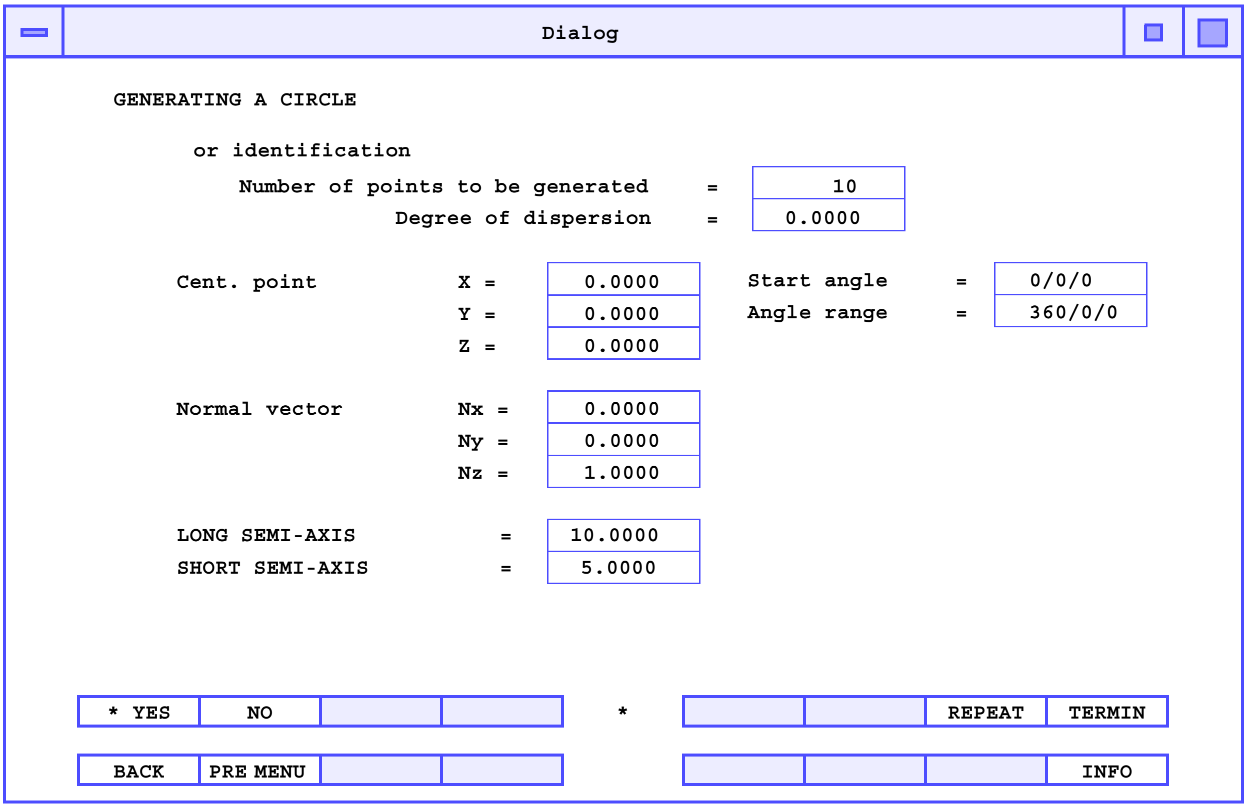
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values), Action: **GEN**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **DATA GENERATION** is displayed.

ELLIPSE

– Press **<ELLIPSE>**.
– Press **<TERMIN>**.
  The dialog window with the menu title **GENERATING AN ELLIPSE** appears.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Number of points to be generated

Input of the desired number of points (1 to 32 000 points permitted).

Degree of dispersion

Input of the dispersion range of the values generated (in mm). For example, if 10,0000 points are entered for every coordinate, a random number is added in the value range ±10 mm.

Center point X, Y, Z Input of the coordinates of the ellipse center point.

Normal vector Nx, Ny, Nz Input of the direction coordinates of the surface normals.

Long semi-axis Input of the long semi-axis (in mm).

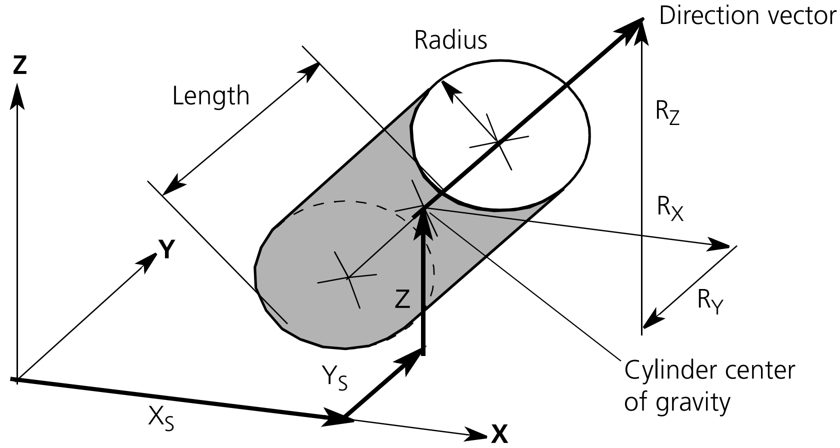
Short semi-axis Input of the short semi-axis (in mm).

Start angle If an elliptical section is desired, the start angle must be entered here (referring to the positive X axis).

Angle range Input of the angle range to be determined with an ellipse section.

Element no. 6: Cylinder

This program is used for generating coordinate points on a cylinder surface or the outer surface of a cylinder segment. The generated values are distributed randomly on the surface. A defined sequence is not observed for assignment of the points.



There are two different ways of calling up the dialog window. The **NOM GEN** command allows you to generate nominal data. The **MVA GEN** command allows you to generate measured data

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values), Action: **GEN**

DEFINE

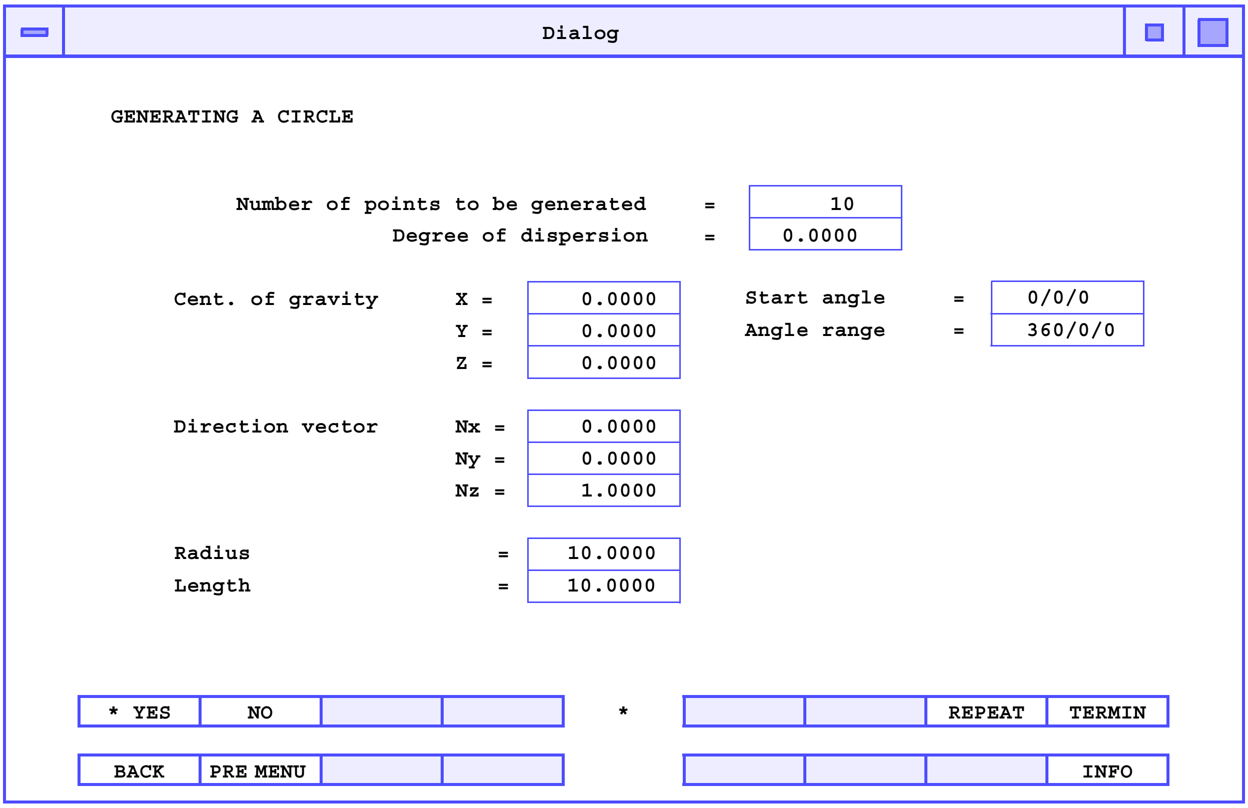
– Press **<DEFINE>**.
  The dialog window with the menu title **DATA GENERATION** is displayed.

CYLINDER

– Press **<CYLINDER>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **GENERATING A CYLINDER** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Number of points to be generated
Input of the desired number of points (1 to 32 000 points permitted).

Degree of dispersion
Input of the dispersion range of the values generated (in mm). For example, if 10,0000 points are entered for every coordinate, a random number is added in the value range ±10 mm.

Cent. of gravity X, Y, Z
Input of the coordinates of the cylinder center of gravity.

Direction vector Rx, Ry, Rz
Input of the direction coordinates of the cylinder axis.

Radius
Input of the radius (in mm).

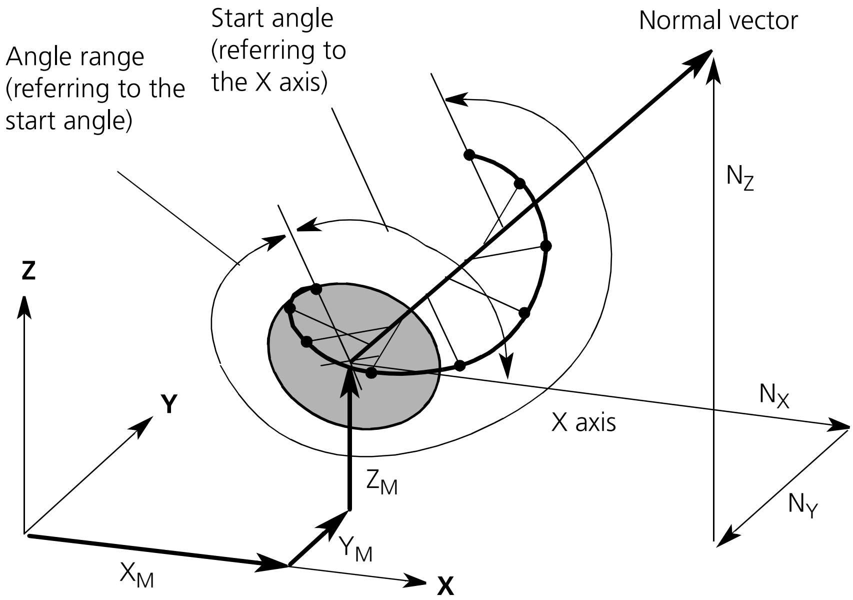
Length
Input of the length of the cylinder (in mm).

Start angle
If a cylinder segment is to be defined, the start angle must be entered here (referring to the positive X axis).

Angle range
Input of the angle range for the cylinder segment.

Element no. 7: Spiral

With this program, coordinate points can be generated on a spiral. The spiral is produced on the base circle in the X/Y plane first of all. The start angle refers to the positive X axis; angle ranges over 360° are allowed. The spiral is then rotated in the direction determined by the normal vector.



There are two different ways of calling up the dialog window. The **NOM GEN** command allows you to generate nominal data. The **MVA GEN** command allows you to generate measured data.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values), Action: **GEN**

DEFINE

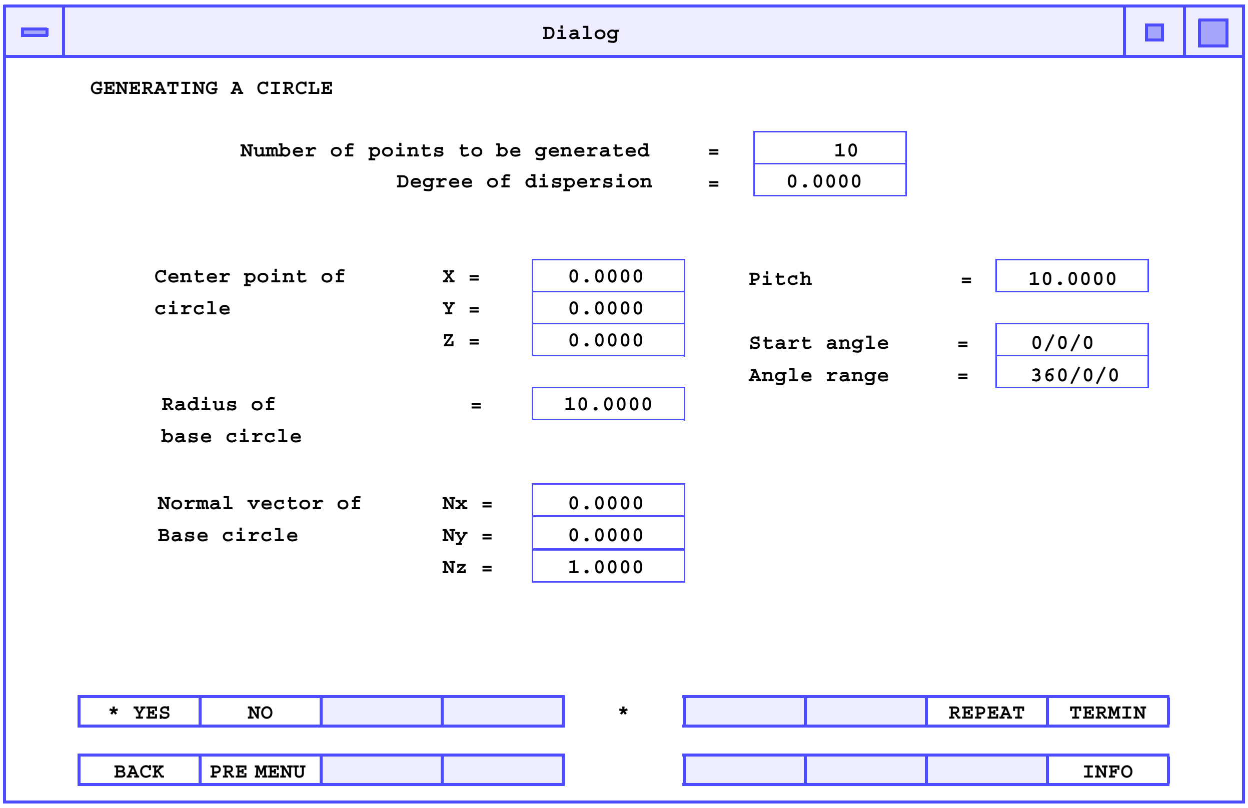
– Press **<DEFINE>**.
  The dialog window with the menu title **DATA GENERATION** is displayed.

SPIRAL

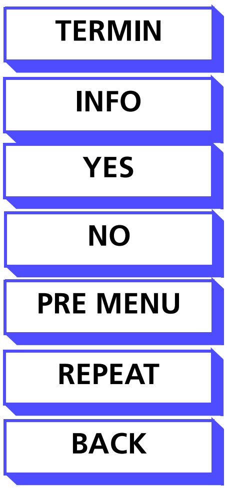
– Press **<SPIRAL>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **GENERATING A SPIRAL** is displayed.



Softkey functions



See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Number of points to be generated

Input of the desired number of points (1 to 32 000 points permitted).

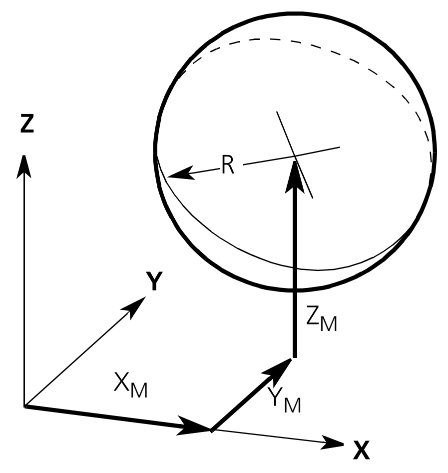
Degree of dispersion

Input of the dispersion range of the values generated (in mm). For example, if 10,0000 points are entered for every coordinate, a random number is added in the value range ±10 mm.

Center point of base circle	Input of base circle center point.
Radius of base circle	Input of base circle radius (in mm).
Normal vector of base circle NX, NY, NZ	Input of vector coordinates of base circle.
Pitch	Input of spiral pitch (in mm).
Start angle	Input of the start angle of the spiral in deg/min/sec (referring to the positive X axis of the workpiece coordinate system).
Angle range	Input of the angle range for the spiral.

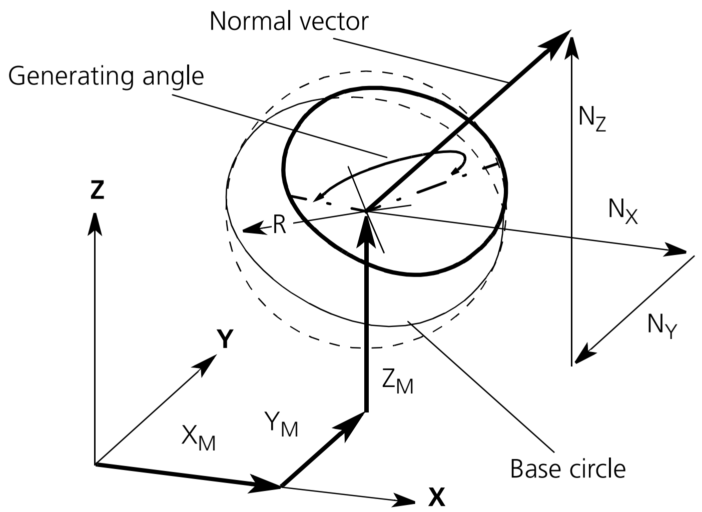
Element no. 8: Sphere

With this program coordinate points on a sphere surface or a sphere cap can be generated. The generated coordinate points are distributed randomly on the surface. No special sequence is kept to here.



Sphere

For the sphere, only the sphere center point and the radius need to be specified.



Sphere cap

To define the sphere cap the normal vector and the generating angle need to be specified in addition to the sphere center point and the radius

There are two different ways of calling up the dialog window. The **NOM GEN** command allows you to generate nominal data. The **MVA GEN** command allows you to generate measured data.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values), Action: **GEN**

DEFINE

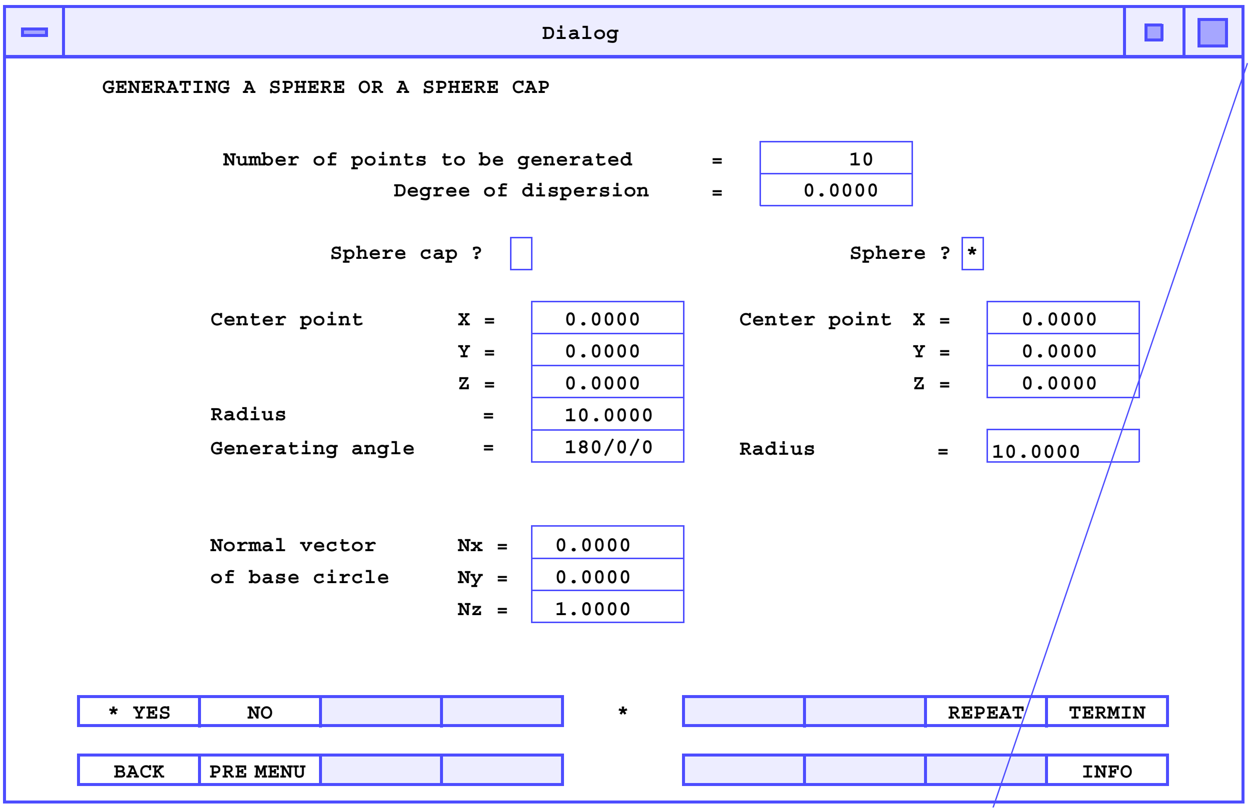
– Press **<DEFINE>**.
  The dialog window with the menu title **DATA GENERATION** is displayed.

SPHERE

– Press **<SPHERE>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **GENERATING A SPHERE OR A SPHERE CAP** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Number of points to be generated
Input of the desired number of points (1 to 32 000 points permitted).

Degree of dispersion
Input of the dispersion range of the values generated (in mm). For example, if 10,0000 points are entered for every coordinate, a random number is added in the value range ±10 mm.

Sphere cap
If this data box is confirmed with **<YES>**, the parameters for the sphere cap can then be entered.
By entering **<NO>** the input of the sphere parameters is enabled.

Center point X, Y, Z
Input of the center point of the sphere cap or sphere.

Sphere
If this data box is confirmed with **<YES>**, the sphere center point, the radius and the generating angle can be entered.

Radius
Input of the sphere radius (in mm).

Generating angle
Input of the generating angle for the sphere cap (in deg/min/sec).

Normal vector of base circle Nx, Ny, Nz
Input of the normal vector for the base circle.

Editing nominals

This chapter describes how **nominal curves** can be **modified** and **edited**. The following possibilities are available:

– Linking nominals, ➤*"Linking nominals" on page 5-51*.

– Preassignment of the performance specification by standard specifications with corresponding comment, ➤*"Standard preassignment/comment" on page 5-54*.

– Copying nominals and measured values, ➤*"Copying nominals or measured values" on page 5-56*.

– Identifying nominals and measured values, ➤*"Identifying nominals or measured values" on page 5-58*.

– Masking and unmasking nominals, ➤*"Masking and unmasking nominals" on page 5-62*.

Linking nominals

With this program the **end point** of the first curve can be linked with the **start point** of the second curve and stored under a **new number**.

ATTENTION!

– If the number of one of the two initial curves is specified as the target curve, the original initial data is overwritten with the values of the linked curves. If no data is to be overwritten, then a new curve number must be selected as the target curve.

– When linking curves, make sure that no points overlap. The target curve must not have any points the same in succession. This applies particularly at the position where the two curves are linked. Identical points lead to errors when further calculations are made.

– With nominal curves, a nominal conversion with the target curve must be executed after the linking.

– With measured curves make sure that with measured values not converted (coordinates of the sphere center point) both curves are measured with the same probe sphere radius. If you do not do this, then a jump will occur in the curve.

– The new curve has max. 32000 points. This number cannot be exceeded.

There are two different ways of calling up the dialog window. The **NOM LNK** command allows you to generate nominal data. The **MVA LNK** command allows you to generate measured data.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

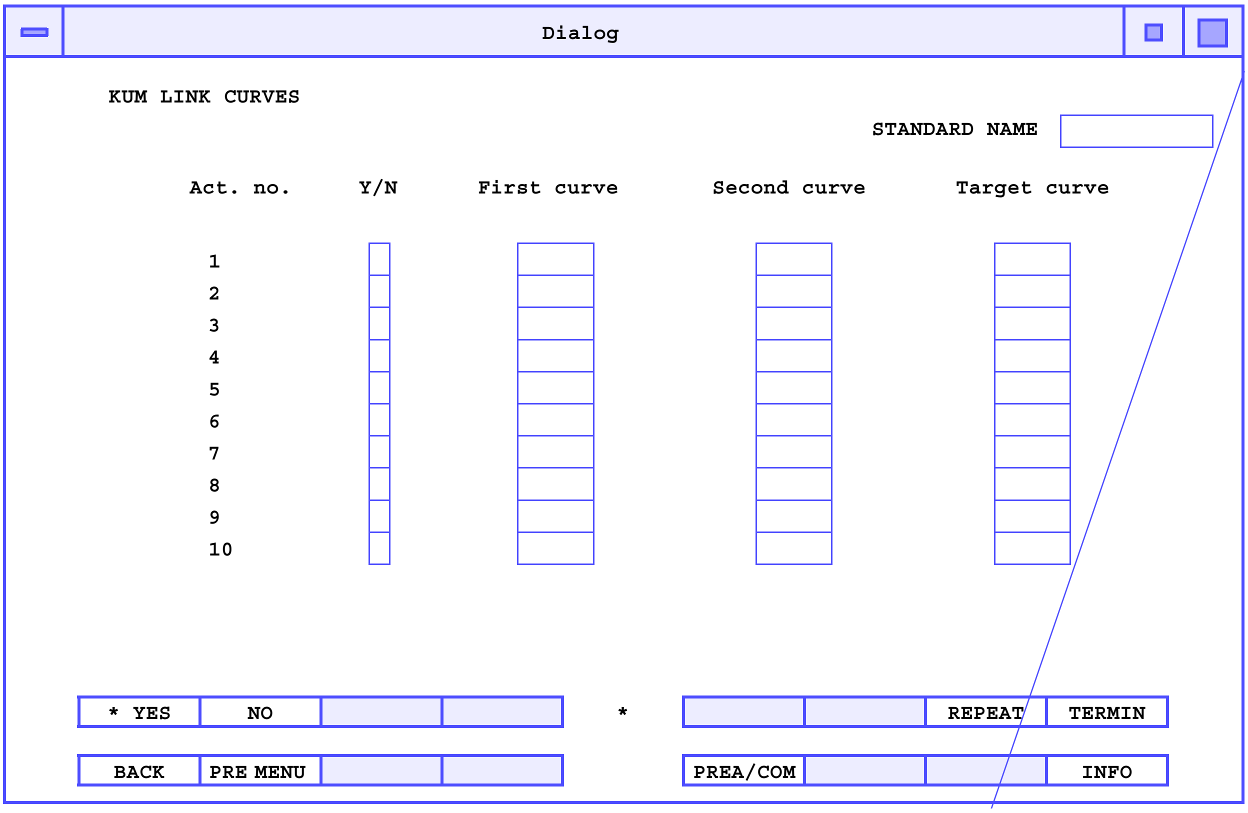
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values), Action: **LNK**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM LINK CURVES** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

PREA/COM

KUM standard preassignment/comment, ➤ *"Standard preassignment/comment" on page 5-54*.

Notes on the input and display boxes

Act. no.

Consecutive line number.

Y/N

Depending on whether **<YES>** or **<NO>** is entered here, the line contents are executed or ignored.

First curve, Second curve, Target curve

Input of the curves to be linked and the number of the target curve.

Examples

– Curves no. 1 and no. 3 are to be linked and then stored again under the old no. 3. The following input is required in the dialog window:

First curve: 1	Second curve: 3	Target curve: 3

– In another example, curves no. 1 to no. 4 are to be linked and stored as a new curve under no. 5. In this case, several input lines must be defined, e.g.

First curve: 1	Second curve: 2	Target curve: 5
First curve: 5	Second curve: 3	Target curve: 5
First curve: 5	Second curve: 4	Target curve: 5

Standard preassignment/comment

The current command line can be preassigned with a standard. The comment is used to describe the command line.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values), Action: **LNK**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM LINK CURVES** is displayed.

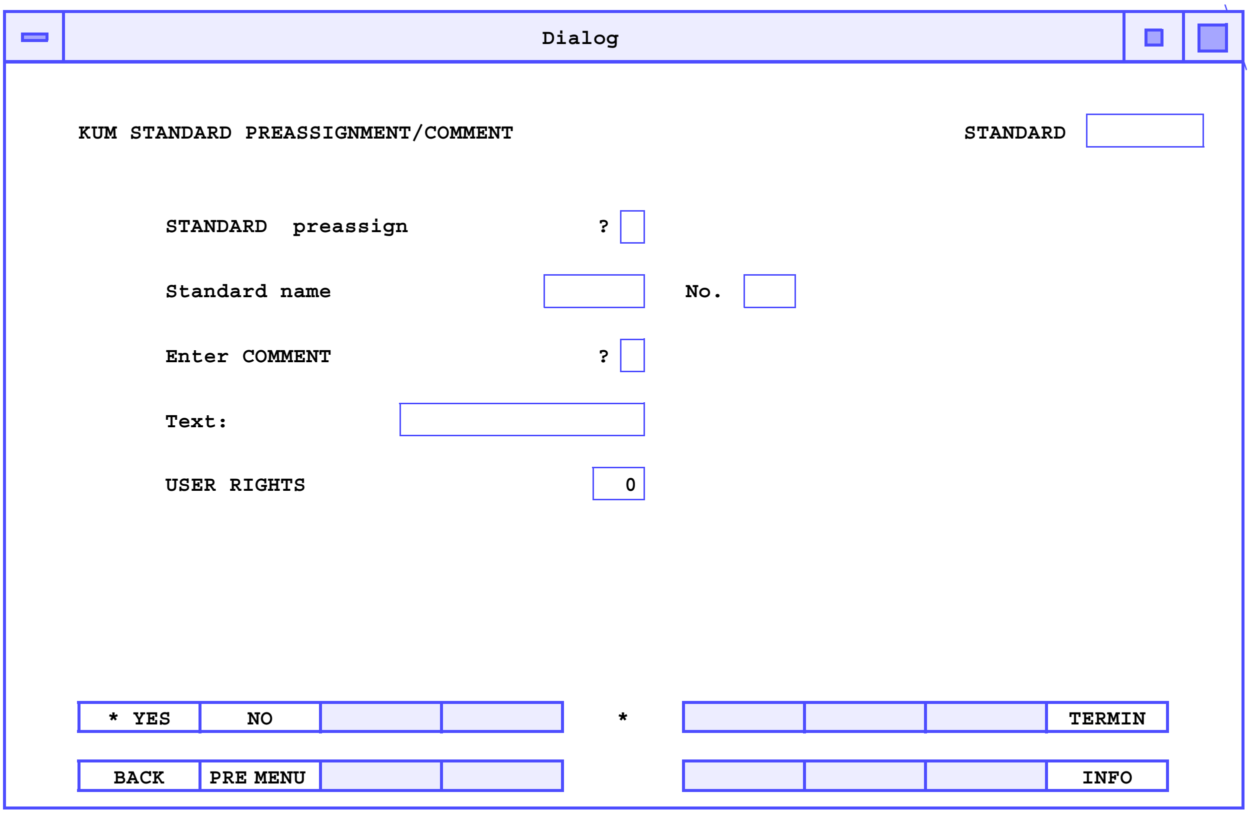
PREA/COM

– Press **<PREA/COM>**.
  The dialog window with the menu title **KUM STANDARD PREASSIGNMENT/COMMENT** is displayed.

Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.



Notes on the input and display boxes

STANDARD preassign Answer data box with **<YES>** or **<NO>**.

Standard name Data box for the current standard name.

No. Number of the standard in the catalog.

Enter COMMENT If **<YES>** is entered here, a text input can follow.

Text Input of a comment text.

USER RIGHTS Display box for the user rights code. **0** is preassigned for KUM, i.e. the user right is not checked here.

Copying nominals or measured values

This program allows nominals to be copied from individual or several curves.

ATTENTION!
Please note that if curves occur twice, the old curves are overwritten.

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

DEFINE

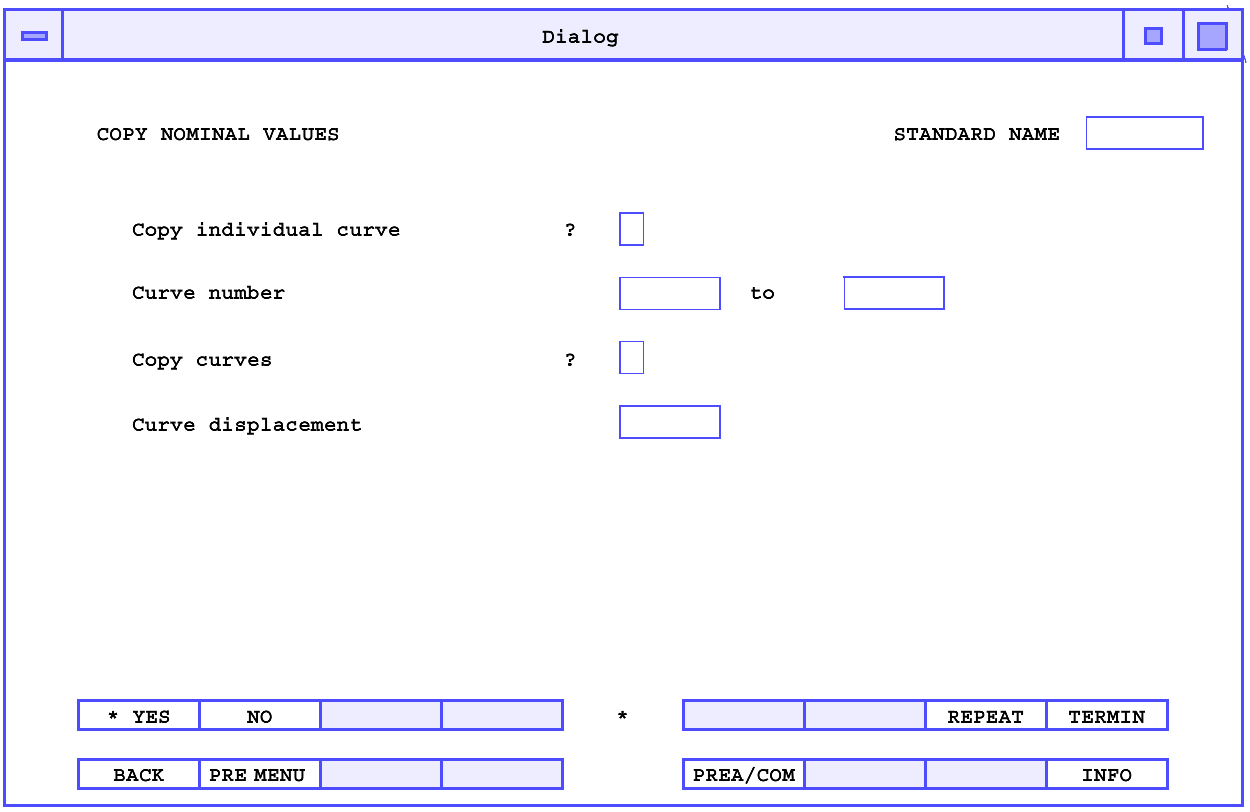
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM** (nominal values) or **MVA** (measured values)
  Action: **COP**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **COPY NOMINALS** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

PREA/COM

KUM standard preassignment/comment, ➤*"Standard preassignment/comment" on page 5-54*.

Notes on the input and display boxes

Copy individual curves

If this box is answered with **<YES>**, a single curve can be copied. The curve numbers are then entered in the following boxes.

Curve numbers from to

When copying individual curves, only the start and target curve need be entered. Copying takes place independent of the curve number which is entered in the KUM main menu.

Copy curves

If this box is answered with **<YES>**, several curves can be copied. Note that you first have to specify in the main menu from which curve number to which curve number the copying is to take place. The step size is always +1 or -1.

Curve displacement

The new curve numbers cannot be specified directly, but the old curve numbers are increased by a value which can be specified.

Example

individual curve

Task: Curve 5 is to be copied to curve 6. Input in input menu: Curve number from 5 to 6.

Execute: Execute in the KUM main menu with any curve number.

several curves

Task: Curves no. 1 to 4 are to be copied to curves no. 5 to 8. Inputs in input menu: Copy curves and curve displacement = 4.

Execution: Execute in KUM main menu with curve no. 1 to 4.

Identifying nominals or measured values

Function

For a nominal or measured curve, 4 areas (sectors) can be defined by the **NOM IDE** or **MVA IDE** command, which are important, for example, for turbine blades:

- Inlet area,
- Pressure side,
- Outlet area,
- Suction side.

These areas are needed by the functions **NOM MSK**, ➤*"Masking and unmasking nominals" on page 5-62* **MVA MSK** and **BRA LIS** ➤*"Listing blade parameters" on page 8-25*.

Nominal curve

The areas in a nominal curve are identified by entering the **start** and **end point number** of the respective area.

Measured curve

For a measured curve, these areas can either be *entered* or *calculated* using the areas of the nominal curve. If a best fit has been performed on the measured values, then the measured values are transformed **temporarily**, before the calculation, using the best fit values . A check is made in the direction of the nominal normal as to which points of the measured data fit the nominal point. However, the measured data originally stored is retained.

Error

If a calculation is not possible (e.g. because the nominal and measured curve lie *too far* apart, or because the dimension of the measured curve compared to the nominal curve is *too small*) an error message is output and the areas can be entered manually.

Gaps between the areas and overlapping of areas is allowed. As the blade profile involves a closed curve, one area can protrude over the end of a curve.

Example

For the inlet area:

Number of points: 50, Start point number: 36, End point number: 15

Result

The inlet area comprises the points 36 to 50 as well as 1 to 15.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

- Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

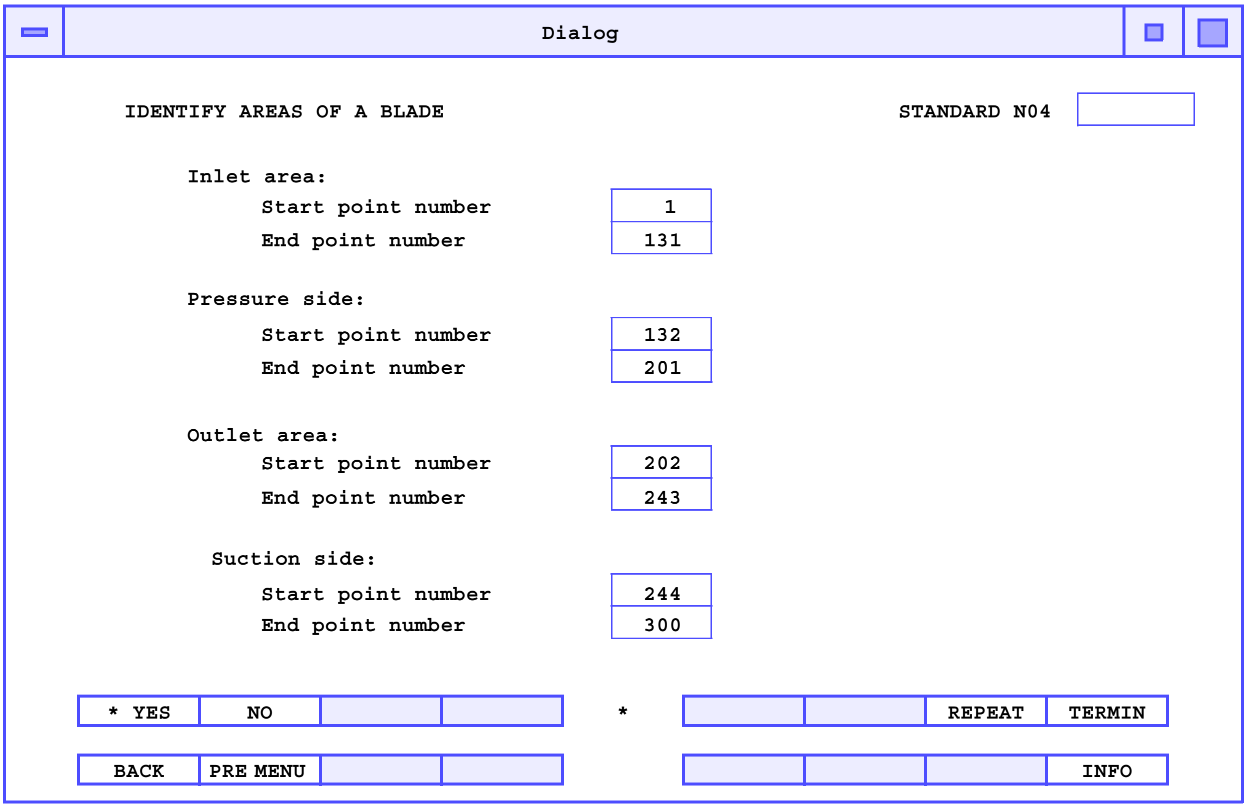
ENTER

- Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM** *or* **MVA**; Action: **IDE**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **IDENTIFY AREAS OF A BLADE** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Inlet area Start point number
Point number of the nominal point where the inlet area for the blade starts.

Inlet area End point number
Point number of the nominal point where the inlet area for the blade ends.

Pressure side Start point number
Point number of the nominal point where the pressure side of the blade starts.

Pressure side End point number
Point number of the nominal point where the pressure side of the blade ends.

Outlet area Start point number
Point number of the nominal point where the outlet area of the blade starts.

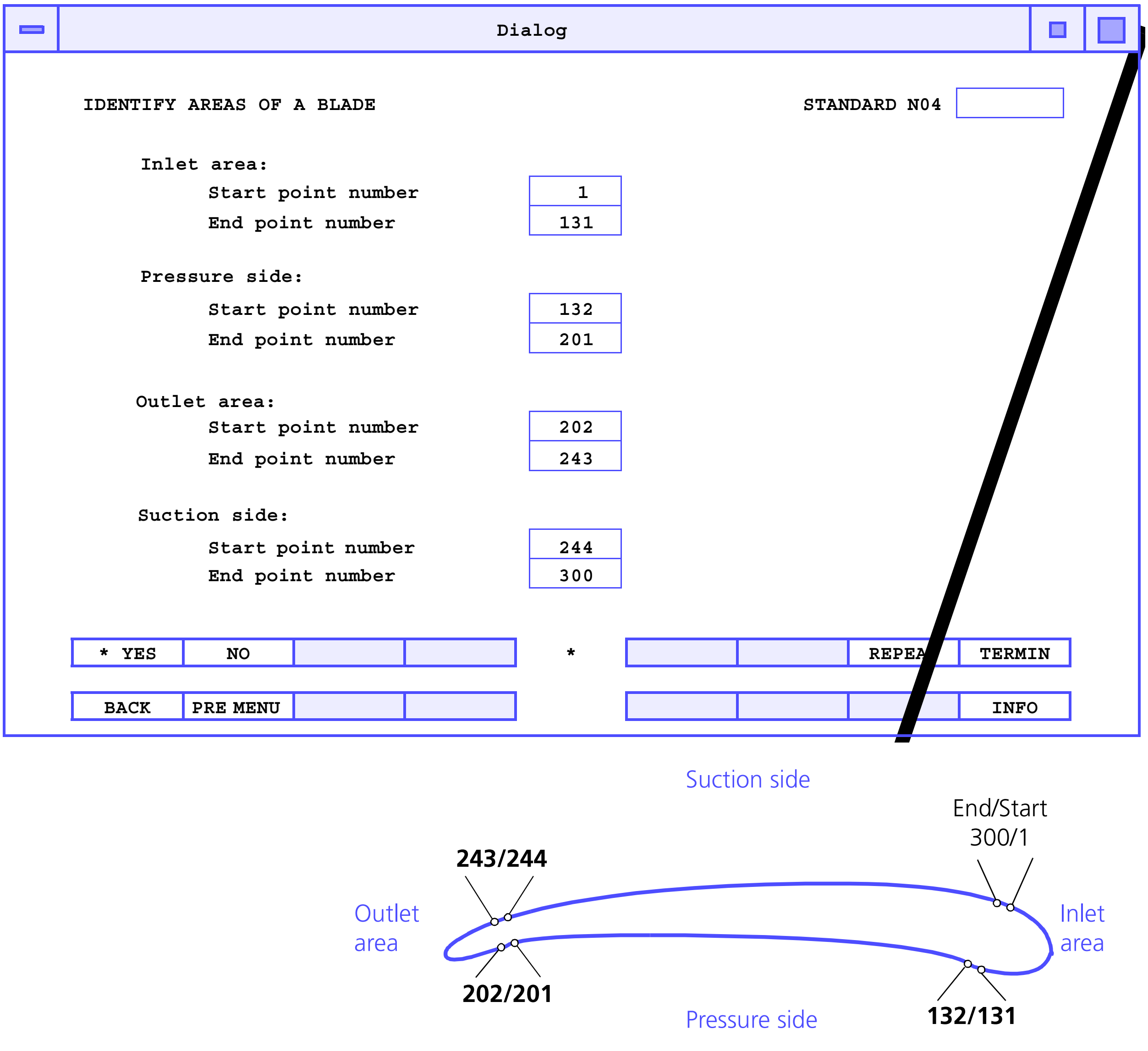
Outlet area End point number
Point number of the nominal point where the outlet area of the blade ends.

Suction side Start point number
Point number of the nominal point where the suction side of the blade starts.

Suction side End point number
Point number of the nominal point where the suction side of the blade ends.

Example

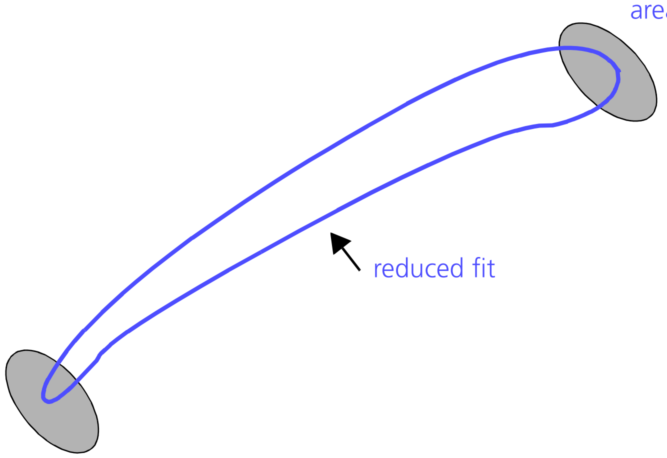
Example with the point numbers from the dialog window with the menu title **IDENTIFY AREAS OF A BLADE**



Masking and unmasking nominals

Function

All nominals are unmasked with the Unmask nominals function **NOM DMS**.



If the nominals have been divided into areas (sectors) with the **Identify nominals** function➤*"Identifying nominals or measured values" on page 5-58*, the points of the **inlet** and **outlet area** can be masked with the Mask nominals function.

The masking causes a reduced fit; it has no influence on the measuring or evaluation process. When **plotting** you can select whether the masked points are to be displayed. When the **List deviations** function is performed, the text **Point number xxx is masked** is displayed in the deviation protocol.

Example

The function is needed for a reduced fit.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

REPEAT

– Press **<DEFINE>**.

The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

REPEAT

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.

Object: **NOM**

Action: **MSK** (mask) or **DMS** (unmask)

REPEAT

– Press **<DEFINE>**.

No input dialog follows. You return to the dialog window with the menu title **KUM COMMAND INPUT**.

Chapter 6

Measurements

This chapter contains:

Introduction

Measurements can only be performed in KUM if you are in the **Measure** or **DSE** dialog window, ➤*"Remarks on measuring known curves" on page 6-7*.

If you are in an illegal window and try to make a probing, an error message will be output.

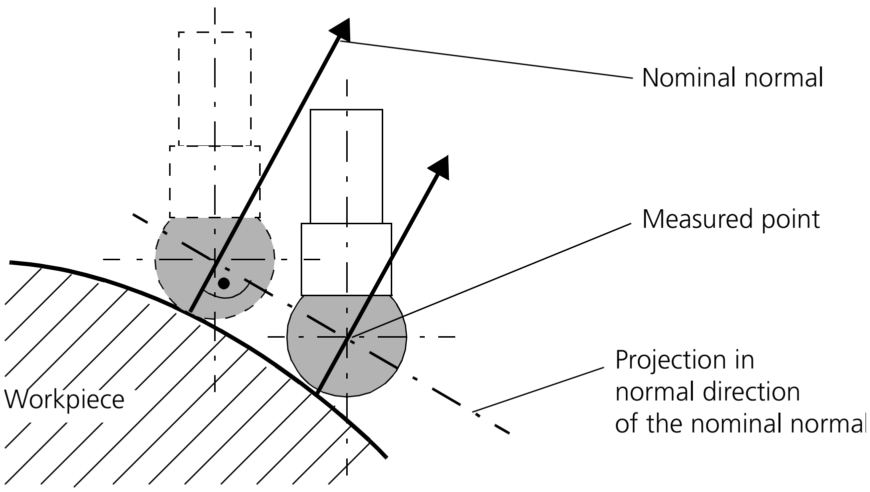
Please note the following points during the measurement:

ATTENTION!

- If a curve consists of 2 points, a line is calculated. If a polynomial is to be calculated, the curve must consist of at least 5 points.
- All measured values are probe sphere center points.
- If the measured curve is "longer" than the nominal curve, it is better if you subsequently calculate the nominal-actual comparison with polynomials.
- With the KUM probing routines, a differentiation is made between **Measuring according to nominals** and **Scanning according to nominals**.
- With the function **<DI 1100>**, measured points can first be buffered in a points collection file. In this way, the individual probing points are saved and can be used later for further calculations.
- If a nominal-actual comparison is to take place later, please note the direction of travel of the curve and its position (see below). If the direction of travel of nominal and measured values is opposite to each other, then you must later reverse the measured values (**MVA REV**)

ATTENTION!

- If during the nominal-actual comparison (**DEV CAL**) you select the data box **with projection in normal direction** and you measure on a (slightly curved) slant, then the intersection height does not need to be kept to exactly. In this case, the deviations are projected at right angles to the normal direction onto the intersection height.



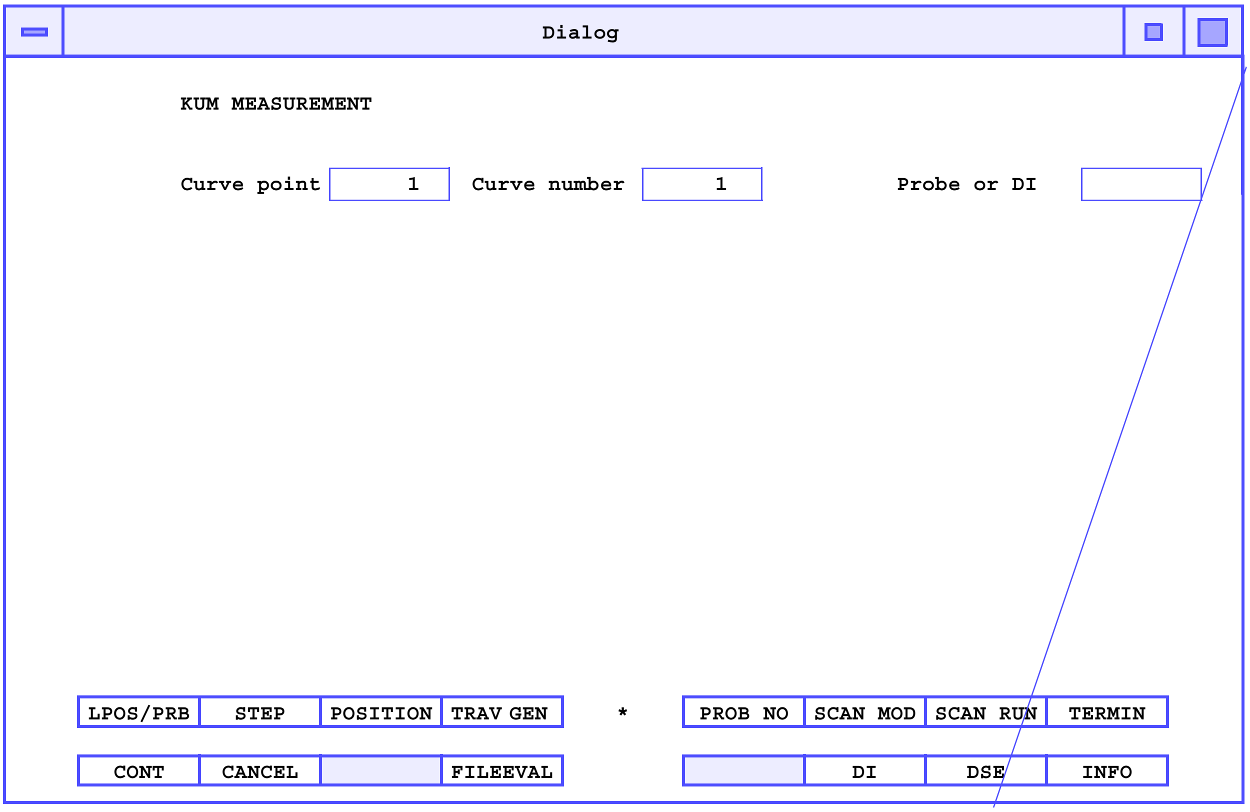
“MEASUREMENT” dialog window

In the KUM main menu, those curve numbers under which the measured data is to be subsequently stored must be entered in the **from curve** box. **<MEASURE>** takes you to the dialog window displayed below. Points can now be collected on a curve until the window is exited with **<TERMIN>** or **<CANCEL>**.

Start menu: KUM Main Menu, ➤*“Calling the KUM Main Menu” on page 1-7*.

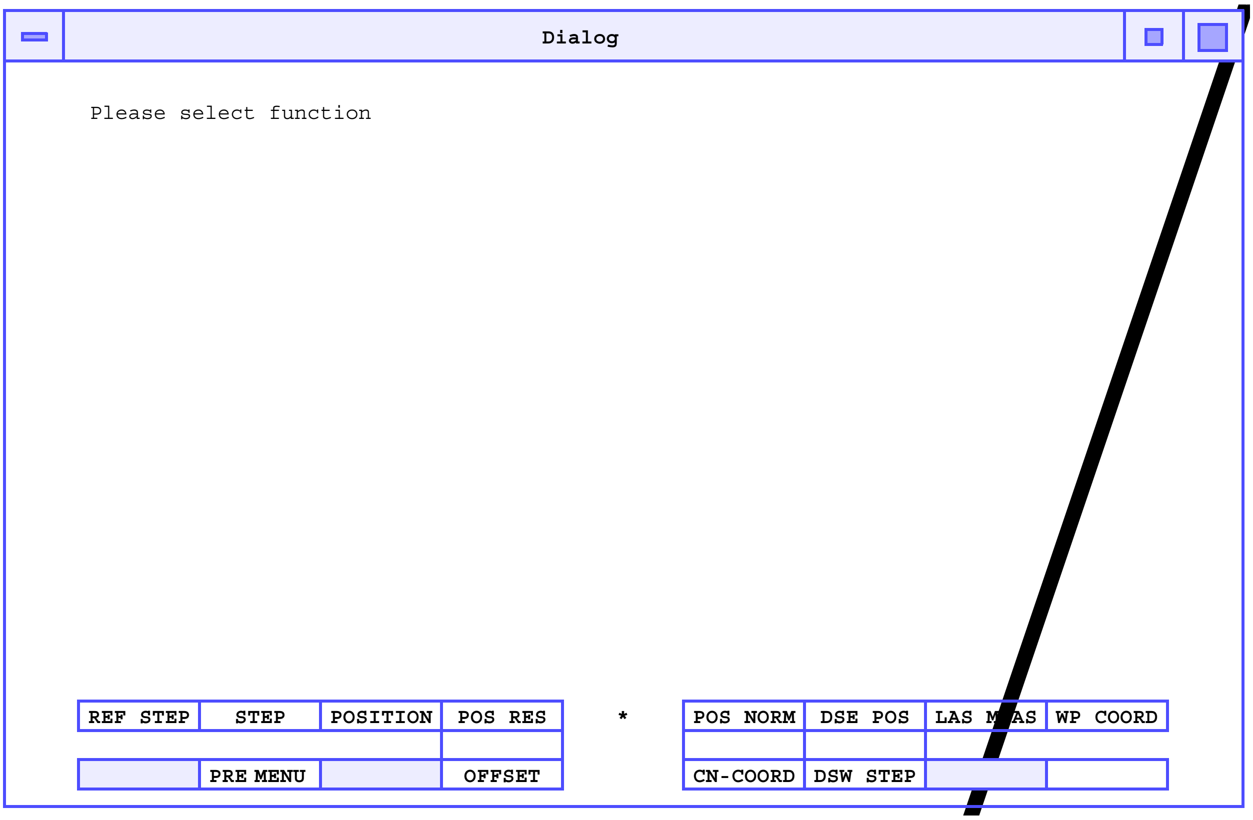
MEASURE

– Press **<MEASURE>**.
  The dialog window with the menu title **KUM MEASUREMENT** is displayed.



Softkey functions

TERMIN **INFO** **CONT**	See general softkey functions, ➤*“General softkey functions” on page 1-10*.
LPOS/PRB	In conjunction with the measuring probe head, measured points can be accepted with the probe in contact by pressing this softkey.
STEP	Move to the next measured point or the next intermediate position.
POSITION	The next probing point or next intermediate position is moved to with the **<POSITION>** function.
TRAV GEN	Call up travel path generation (only ACE).
PROB NO	Selection of the active probe no., see UMESS operating manual.
SCAN MOD	Definition of the required scanning mode.
SCAN RUN	Start of the scanning run.
TERMIN	End of measurement. The measuring coordinates are stored in the current workpiece coordinate system. You then return to the KUM Main Menu.
CANCEL	Measurement canceled.
FILEEVAL	File evaluation; i.e. transfer to KUM of the measured data which has previously been measured in UMESS with **<DI 1100>** (collect points in file).
DI	Direct call up of CMM or UMESS functions without exiting KUM, ➤*“Direct input of CMM or UMESS functions” on page 1-13*
DSE	Jump to DSE dialog window, see below. Apart from the functions for the XYZ positioning, this window contains the functions needed for setting the two DSE sensor axes (see separate description in the UMESS or DSE operating manual).



RTZEROPT The rotary table position is set to 0°, see UMESS manual.

RT POS Rotation of the rotary table to a defined angle position.

RTSTEP The current position of the rotary table is displayed, and an adjustment about a specific angle position can be entered, see UMESS manual.

RT PITCH The current position of the rotary table is displayed and the rotary table can be rotated about an angular pitch, see UMESS manual.

RTANG To align the rotary table parallel to the machine coordinates, see UMESS manual.

CANCEL Exit the window without starting the function, see UMESS operating manual.

Remarks on measuring known curves

When measuring known curves, it is assumed that the nominals of the curve already exist. The nominals can be generated by digitization (➤*“Remarks on measuring unknown curves” on page 6-8*); in some cases, a conversion of the nominals with **NOM CON** is also required (➤*“Conversion main menu” on page 7-2*).

The digitized or converted nominals can be printed with **NOM LIS** or displayed graphically with **NOM PLO**.

Criteria for the measuring run

– If the normal direction is not clearly defined, this must be specified with the command **MVA TRA**. In the relevant dialog window there are several possibilities available for the normal transformation (➤*“Transforming nominal and measured values” on page 7-61*).

– The direction of travel must correspond to the workpiece to be measured. A differentiation is made here between inner and outer contour, see Explanatory notes ➤*“Direction of travel” on page 2-8*

– Depending on whether the start point coincides with the end point during a measuring run, a differentiation is made between open and closed curves, ➤*“Open curve - closed curve” on page 2-2*. The dialog window for curve-specific data contains a corresponding data box which must be answered with **<YES>** or **<NO>**, ➤*“Editing new curves (measured values)” on page 6-19*.

Acquiring measured values

The measuring run is usually started in the dialog window KUM Main Menu ➤*“Calling the KUM Main Menu” on page 1-7* with **<MEASURE>** (➤*“Remarks on measuring known curves” on page 6-7*). The measuring run corresponds to the inputs for the **Measurement according to nominals**.

Notes on evaluation

Measurement and evaluation are two different processes in KUM which are executed independently of one another. On the topic of evaluation, please see Chapter 7 “Calculations”.

Remarks on measuring unknown curves

Digitizing measured values

When measuring unknown curves, the nominals do not exist initially. Therefore, the primary measured values must first be acquired on the workpiece or **master part** and digitized. Measurement of the nominals is started in the KUM Main Menu (➤*"Calling the KUM Main Menu" on page 1-7*) with **<MEASURE>**. Further notes:

– All measuring functions in UMESS are also available in KUM.

– Measurement is possible in both single point mode and in scanning mode.

– With 3D spatial curves, an auxiliary curve must also be defined and measured.

Calculating nominals

For the nominal calculation the relevant nominal values are calculated from the measured values. The probe sphere radius is taken into account. No measured value conversion may be executed beforehand, as the **NOM CAL** function already contains the nominal value conversion.

– The following dimensions are calculated with the **NOM CAL** command:

  – Normals

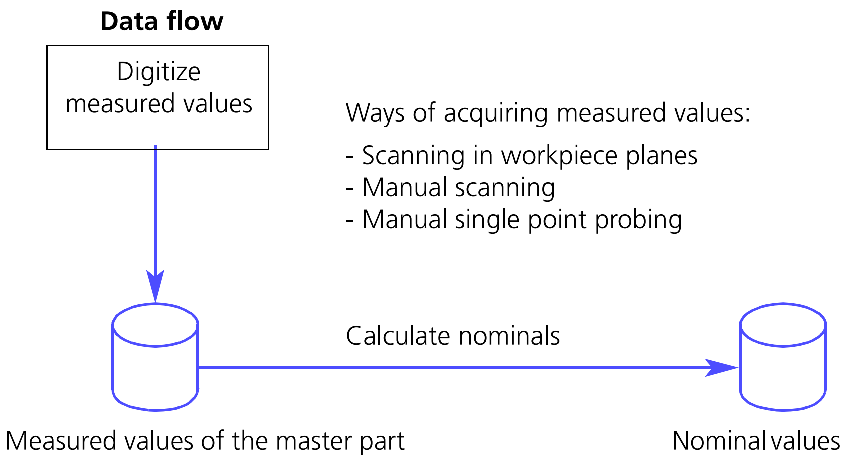
  – Tangents

  – Arc lengths

  – Curve center of gravity

– The primary or converted nominal values can be printed with **NOM LIS** or displayed graphically with **NOM PLO**.

– With 3D spatial curves, the 3D normals have to be calculated (if necessary with tip simulation).



Measuring unknown curves

After the nominals have been calculated from the digitized measured values of a master part, the measuring run can be performed for the unknown curve in the same way as previously when measuring a known curve, ➤*"Remarks on measuring known curves" on page 6-7*.

2D measurement

Known curve

If nominal values exist (e.g.: X/Y; Z = const.), for each nominal point the program calculates (**NOM CON, 2D normal**) the direction normal which lies in the specified measuring plane.

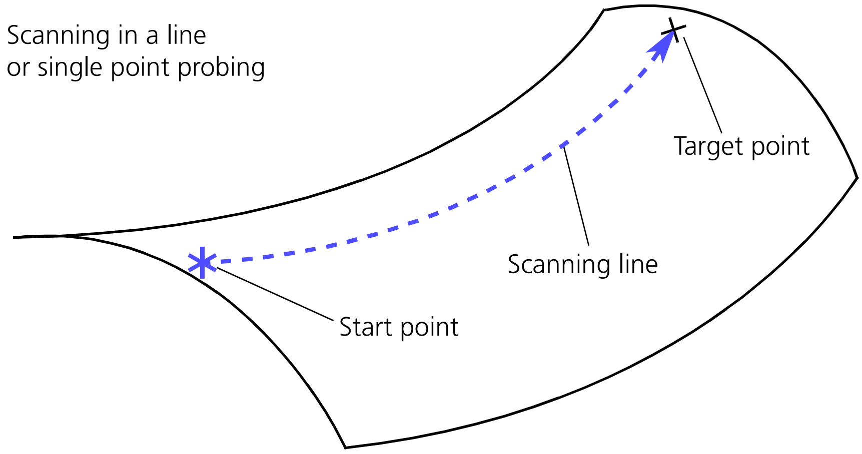
The deviation of the nominal-actual curve is output in the direction of this normal (**DEV CAL, Deviations in normal direction**).

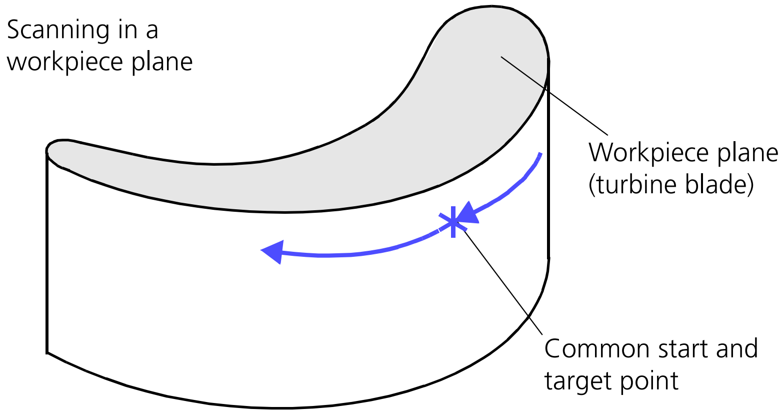
Measuring method: Scanning or measuring according to nominals.

Unknown curve

After measuring the unknown curve, it is possible to store the actual values as nominal values with **NOM CAL**. The normal direction is calculated for each measuring point.

Measuring methods: Scanning line, scanning in workpiece plane, single point measurement etc.





3D measurement

Known curve

For a curve measurement with a spherical probe on a doubly curved surface, the **3D normal direction** of the contact point must be *known*. Only if the center of the probe sphere is positioned exactly in this 3D normal direction, does the probe sphere make contact with the 3D surface at the specified point. If the coordinates of the nominal curve are known, the normals are also defined and the conditions for an exact 3D curve measurement are fulfilled, see sketch ➤*"Measured value - contact point" on page 2-4*.

Unknown curve

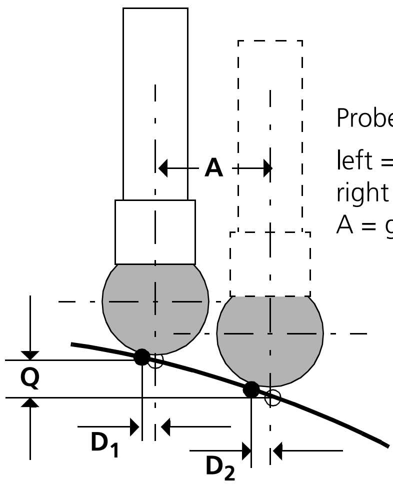
If with a measuring run no nominals exist for the curve to be measured, the program provides the option of calculating the normals required *internally*. The 3D normal direction at the contact point is calculated from *two curves lying parallel* by the cross-connection of the two curves.

The curve path used for determining the measured values is called the **reference curve**. The other curve is used as **auxiliary curve** for calculating the normals, ➤*"Reference curve - Auxiliary curve" on page 2-6*.

Effect of the slant on the measurement

Favorable measuring situation

Due to the slight slant (Q) the required actual values and actual contact points lie close together (D_1/D_2)

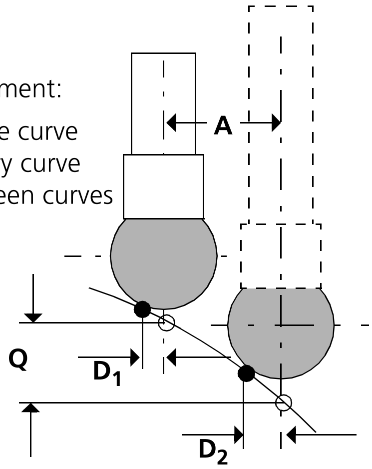


Unfavorable measuring situation

With a large slant (Q) between reference and auxiliary curve, the measured and contact points lie considerably far apart (D_1/D_2)

Probe arrangement:

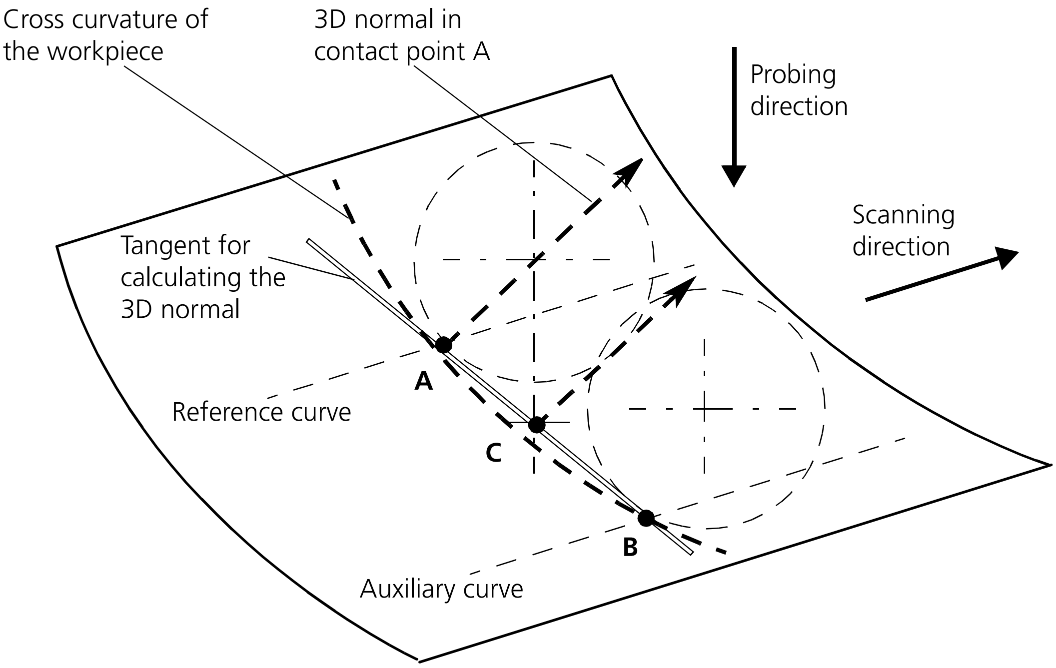
left = reference curve
right = auxiliary curve
A = gap between curves



Positioning the auxiliary curve

Two different workpiece coordinates can be calculated by linking the measured data of the reference curve with that of the auxiliary curve:

- Coordinates of point A with corresponding 3D normal (contact point on the reference curve)
- Coordinates of point C with corresponding 3D normal (tip simulation). For information on defining the auxiliary curve, please see Chapter 2.1.5 “Reference curve-Auxiliary curve”.



A = Contact point on the reference curve

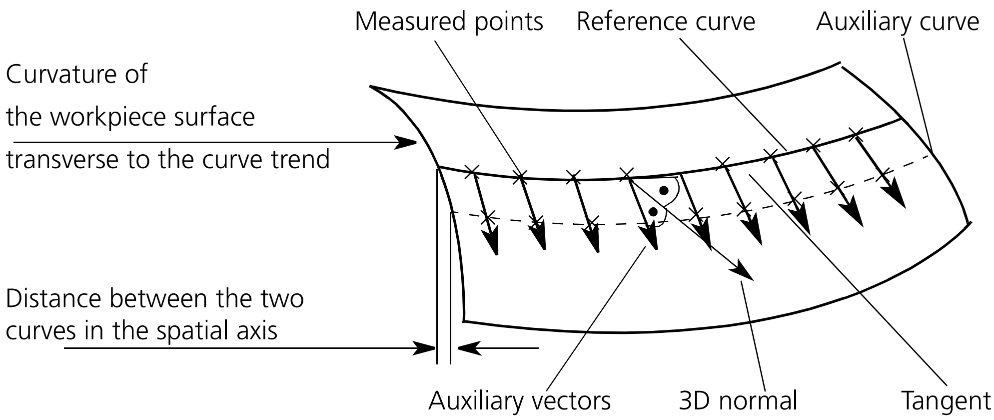
B = Contact point on the reference curve

C = Calculated actual with 3D normal during tip simulation

To calculate the 3D normal of the reference curve in points A or C, the points of the reference curve and the auxiliary curve are individually linked together. This results in the auxiliary line AB. The reference and auxiliary curve should be roughly the same length and have the same number of points.

Calculating the 3D normal from two nominal curves

Prerequisite for calculating the normal direction are two 2D curves *running parallel* to each other. The distance between the curves should be adapted to the curvature which runs transverse to the curve trend. Usually the distance between the curves lies between *a tenth* and *several millimeters*.

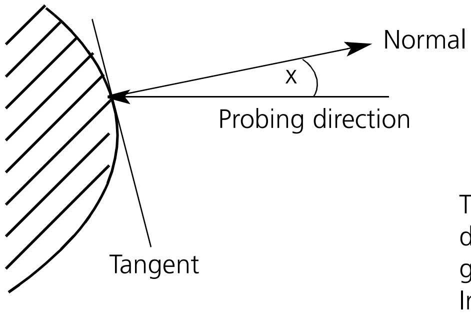


Application note

With face, normal or axial sections on screw compressors (rotors), conveyor spindles, ball roller spindles or similar parts, a profile is propagated corresponding to the pitch around the rotational axis. This means that a given **2D profile** is identical at every height of the part.

To define the measuring run, only 2D coordinates are therefore required for such a profile. Due to the possibilities of **nominal value transformation** a second curve can be generated, which is rotated for example 1° around the rotation axis and is displaced in the axis direction corresponding to the axial pitch.

With the **auxiliary curve** generated in this way, the 3D normal directions can be calculated for the points of the reference curve. However, this only applies under the condition that the **probe sphere radius** is the same for the reference and auxiliary curve (with generated curves the probe sphere radius = 0).



The angle x between probing direction and normal cannot be greater than 90°.
In this way, the direction of the normal is clearly defined.

When probing directions exist (always with measured values), the normal direction is defined by the probing direction.
With generated data the probing vector is missing. In this case, the normal vector is rotated about 90° in math. positive direction, in contrast to the tangent vector whose direction of travel is given by the sequence of the curve points. The normal direction must therefore be checked by the user and if necessary reversed with the **NOM TRA** or **MVA TRA** function.

Measured value input - main menu

Data input

The measured value input is controlled with this dialog window, if the curve exists (otherwise ➤*"Editing new curves (measured values)" on page 6-19*). There are several ways of entering or changing data. However, please note that only one of the options offered can be selected; *combinations* are *not allowed*.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

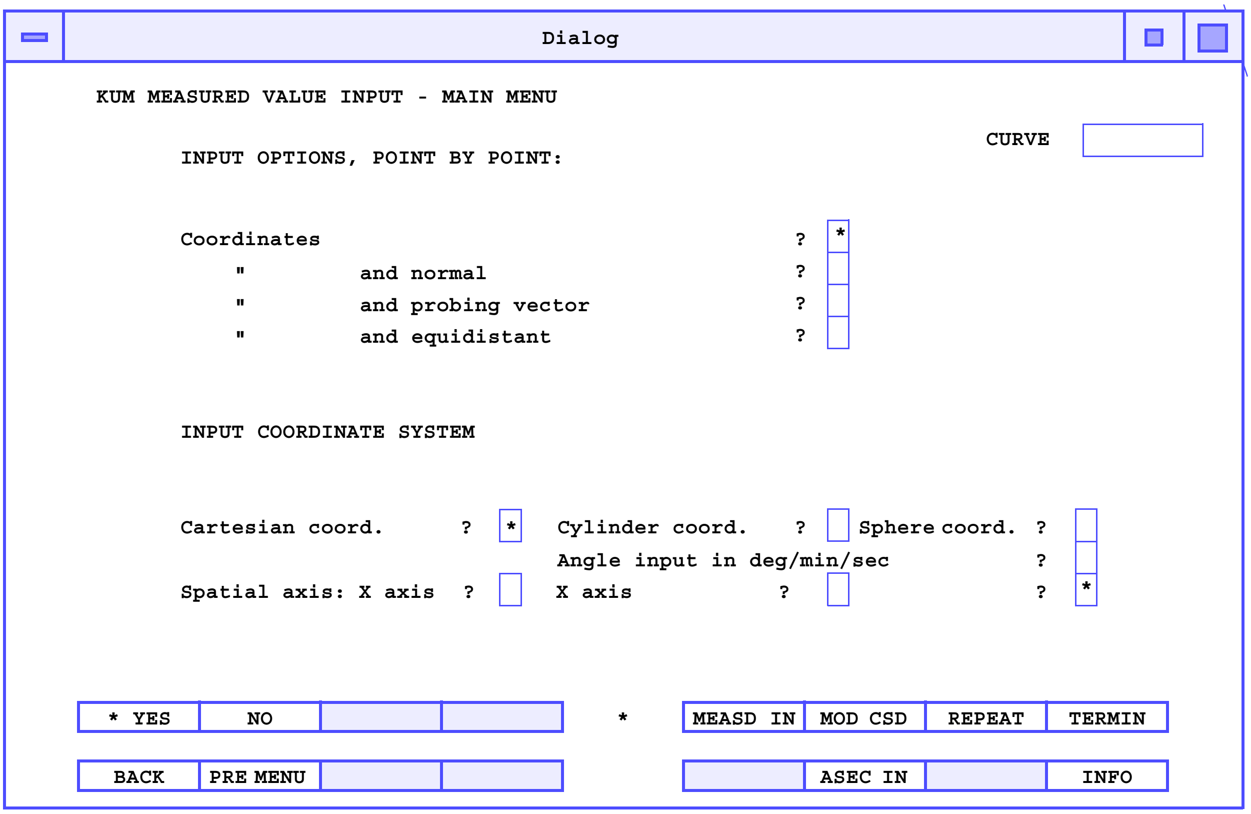
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **MVA**, Action: **EDI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM MEASURED VALUE INPUT - MAIN MENU** is displayed.



Softkey functions

TERMIN **INFO** **YES** **NO** **PRE MENU** **REPEAT** **BACK**	See general softkey functions, ➤ *"General softkey functions" on page 1-10*.
MEASD IN	Measured value input for the type of data selected, ➤ *"Entering measured values point by point" on page 6-21*.
MOD CSD	Modification of the curve specific data, ➤ *"Changing curve-specific data of measured curves" on page 6-26*.
ASEC IN	Sector by sector input of equidistants, ➤ *"Entering equidistants sector by sector" on page 6-24*.

Notes on the input and display boxes

If data is to be entered point by point, then the type of data desired (coordinates, normals, probing vectors and equidistants) must be selected with **<YES> <NO>** and concluded with **<MEASD IN>**.

If the normals, probing vectors or equidistants are to be entered for the first time for an existing curve (i.e. if the data for the curve does *not* exist), then in the control of the nominal value input in the menu **KUM curve-specific input CHANGE MODE** the corresponding box must be answered with **<YES>**.

If the relevant boxes are not selected, then the message **Input code not set** appears when you try to enter data.

Coordinates

If this data box is confirmed with **<YES>**, the coordinates of a curve can later be entered point by point or corrected. If **<NO>** is entered, one of the next boxes can be confirmed.

and normal

Alternative selection to the above if coordinates and normals are to be entered later.

and probing vector

Alternative selection to the above if coordinates and probing vectors are to be entered later.

and equidistant

Alternative selection to the above if coordinates and equidistants are to be entered later.

Cartesian coord./ Cylinder coord./Sphere coord.
Alternative confirmation of one of the three data boxes with **<YES>**, depending on the form in which the coordinates to be entered exist.

Angle input in deg/min/sec
By confirming with **<YES>**, the coordinate angles can be entered in degrees/minutes/seconds. A decimal input is possible if **<NO>** is entered.

Spatial axis: X axis, Y axis, Z axis
The desired spatial axis must be confirmed with **<YES>**.

Editing new curves (measured values)

This program is only activated with the input for a *new curve*. In this case it is determined which curve-specific data is to be entered.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

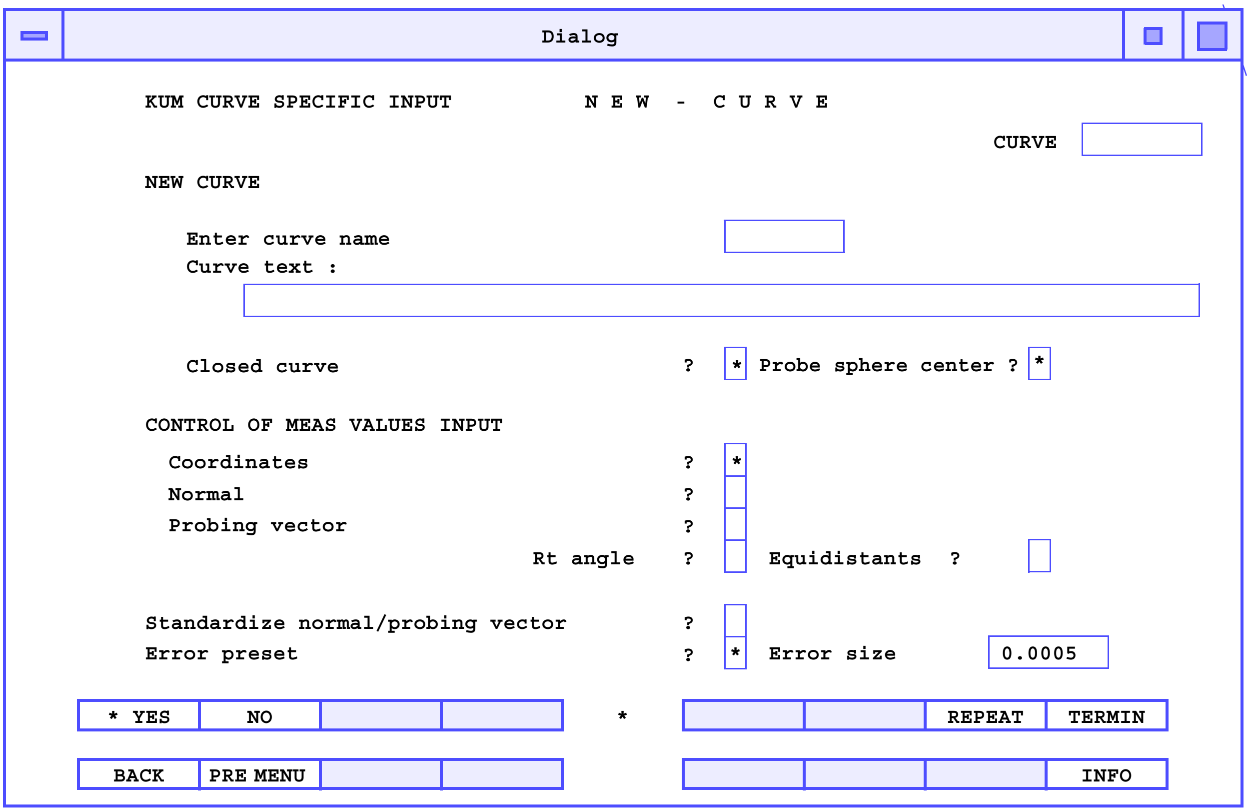
– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
Object: **MVA**
Action: **EDI**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM CURVE SPECIFIC INPUT NEW CURVE** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Enter curve name

Option of entering any name to identify the curve to be measured. The name is output with the curve administration.

Curve text

Option of entering a comment. This text is output after the record header.

Closed curve

<YES>
The coordinates give a closed curve.

<NO>
The coordinates refer to an open curve.

Probe sphere center

<YES>
The coordinates refer to the probe sphere center.

<NO>
The coordinates refer to the contact points.

CONTROL OF MEAS VALUES INPUT

Coordinates/Normal/Probing vector

The type of data to be entered later manually must be selected here. Individual selection and combinations are possible. Information not selected cannot be entered. In the Measured value input - Main menu the message **Input code not set** appears.

Rt angle

The rotary table angle cannot be selected in this software version. A function selection will be provided in future.

Equidistant

A curve which runs parallel to an existing curve has the same distance from each curve point in the normal direction over the entire curve path. This distance is called an equidistant. In KUM the equidistant can be entered by points or sectors.

NOTE

With the **Transform nominal data** command; coordinate transformation, equidistants, a curve can be displaced in the normal direction.

<YES>
The control takes place with equidistants.

<NO>
The control does not take place with equidistants.

Standardize normal/probing vector

If confirmed with **<YES>** the normals are standardized, i.e. the sum of the direction cosines squared results in the value "**1**".

Error preset

If confirmed with **<YES>** the error size can be defined.

Error size

Input of the value by which the sum of the direction cosine squared may deviate from the theoretical value **1**.

Entering measured values point by point

This program is used for editing measured values. The following data, corresponding to the input in ➤*"Measured value input - main menu" on page 6-16*, can be entered point by point and/or changed:

– coordinates, possibly in combination with normals,

– probing vectors and

– equidistants.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

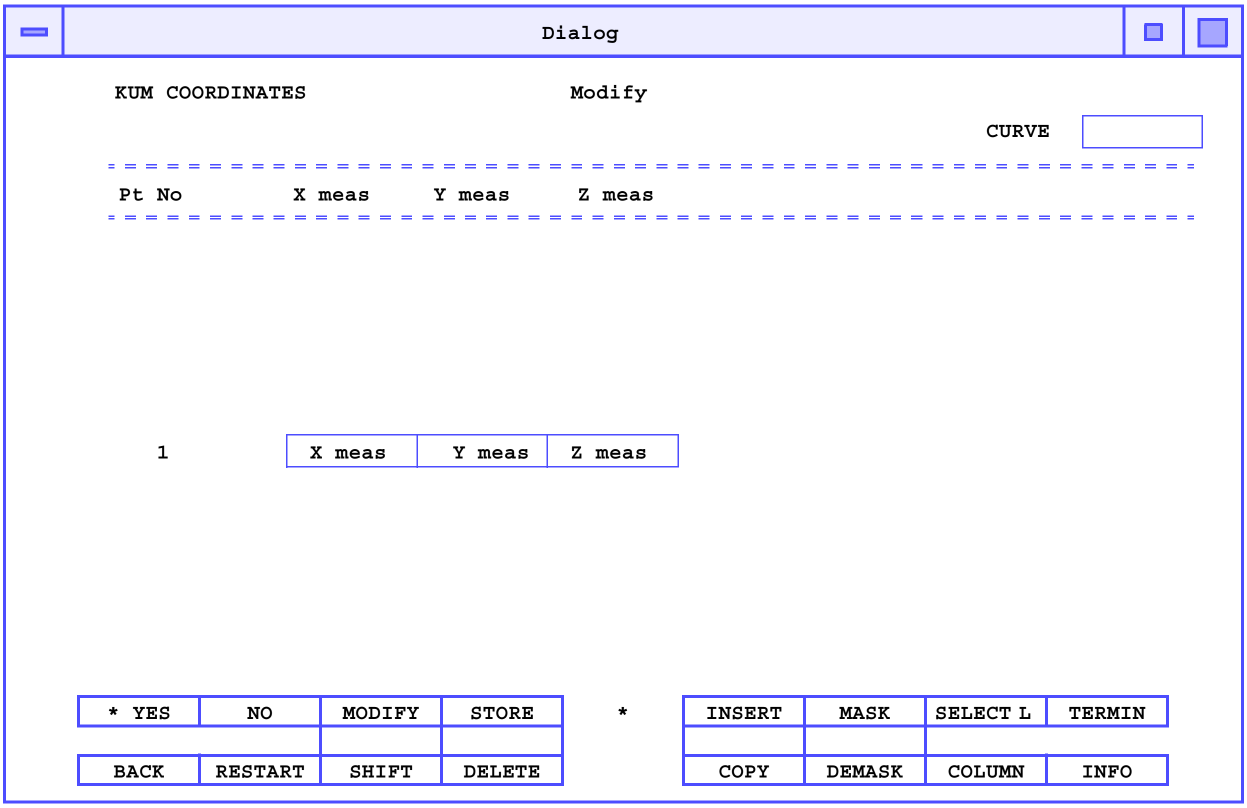
– Enter the KUM command in the data boxes.
Object: **MVA**, Action: **EDI**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM MEASURED VALUE INPUT - MAIN MENU** is displayed.

MEASD IN

– Press **<MEASD IN>**.
The dialog window with the menu title **KUM COORDINATES** is displayed.



Comments

Depending on what has previously been selected in ➤*"Measured value input - main menu" on page 6-16*, the existing data is listed here. It can be deleted, supplemented or corrected with the corresponding softkeys, see softkey functions on the next page.

Softkey functions

TERMIN

INFO

BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

YES

NO

These softkeys have no function in this dialog window.

MODIFY

After selecting this softkey the required data can be entered. The following rules must be observed:

- To conclude a line and jump to the next: Press **<Shift>** + **<↑>**
- To exit the modification mode press **<MODIFY>** again
- To modify a particular column: First press **<COLUMN>**, then input column, then **<TERMIN>**, then press **<MODIFY>**.

STORE

The current (modified) measured values are stored.

INSERT

Insert an additional line.

MASK

To mask the marked line. The masking causes a reduced fit; it has no influence on the measuring or evaluation process. When plotting, you can select whether the masked points are to be displayed. When the List deviations function is performed, the text Point number xxx is masked is displayed in the deviation protocol.

SELECT L

Selection of a measured value line.

RESTART

New start of a measured value input.

SHIFT

Move the marked line.

DELETE Delete the marked line.

COPY Copy the marked line.

DEMASK Demask the marked line.

COLUMN 1st activation: To switch to column by column input

2nd activation: To switch back to line by line input.

Entering equidistants sector by sector

This program is used for sector by sector input or modification of equidistants. An equidistant curve can be calculated with **MVA TRA**, ➤*"Changing equidistants" on page 7-72*, **Coordinate transformation: Equidistants**.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **MVA**, Action: **EDI**

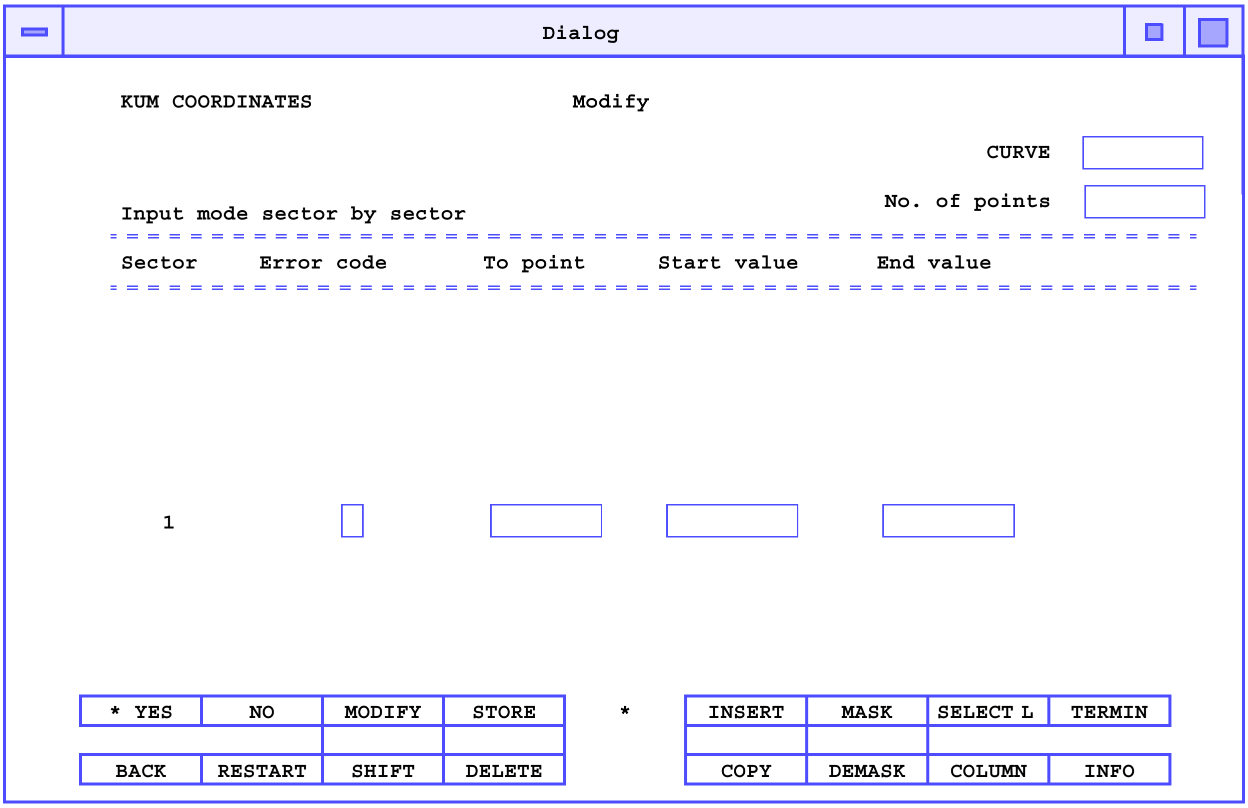
DEFINE
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM MEASURED VALUE INPUT - MAIN MENU** is displayed.

MOD CSD
– Press **<MOD CSD>**.
  The dialog window with the menu title **KUM CURVE SPECIFIC INPUT NEW CURVE** is displayed.

YES
– Acknowledge the Equidistants data box with **<YES>**.

TERMIN
– Press **<TERMIN>.**
  The dialog window with the menu title **KUM MEASURED VALUE INPUT - MAIN MENU** is displayed.

ASEC IN
– Press **<ASEC IN>**.
  The dialog window with the menu title **KUM INPUT OF EQUIDISTANTS** is displayed.



Softkey functions

TERMIN
INFO
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

YES
NO

These softkeys have no function in this dialog window.

MODIFY

Re-enter equidistants; this mode is automatically selected when the page is called up.

STORE

The current (modified) measured values are stored.

INSERT

Insert an additional line.

MASK

Mask the marked line.

SELECT L Selection of a measured value line.

RESTART New start of equidistants input.

SHIFT Move the specified or selected line.

DELETE Delete the specified or selected line.

COPY Copy the specified or selected line.

DEMASK Demask the specified or selected line.

COLUMN 1st activation: To switch to column by column input

2nd activation: To switch back to line by line input.

Notes on the input and display boxes

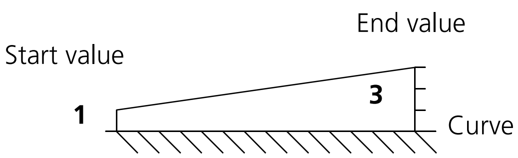
Sector Sector number: is automatically incremented when entering equidistants.

Error code Check for logical errors (e.g. typing errors, connections, permissible data) in the input. An error is displayed when the page is concluded with **<TERMIN>**.

To point If only one sector is required for the entire curve, then the number of curve points is specified here.

Start value, end value Input of the start and end value of the equidistants (data in mm).

Example:
Start value = 1
End value = 3



Changing curve-specific data of measured curves

This program is only activated for an existing curve. It enables you to make a decision on which data is to be entered. It is also used for correcting the curve name, curve comment and the curve-specific data.

The presetting of the curve-specific data depends on which data is available for the curve. The input of further data is only possible if the corresponding code is set. Otherwise, the following message appears in the **KUM measured value input - main menu** ➤*"Measured value input - main menu" on page 6-16*: **Input code not set**.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

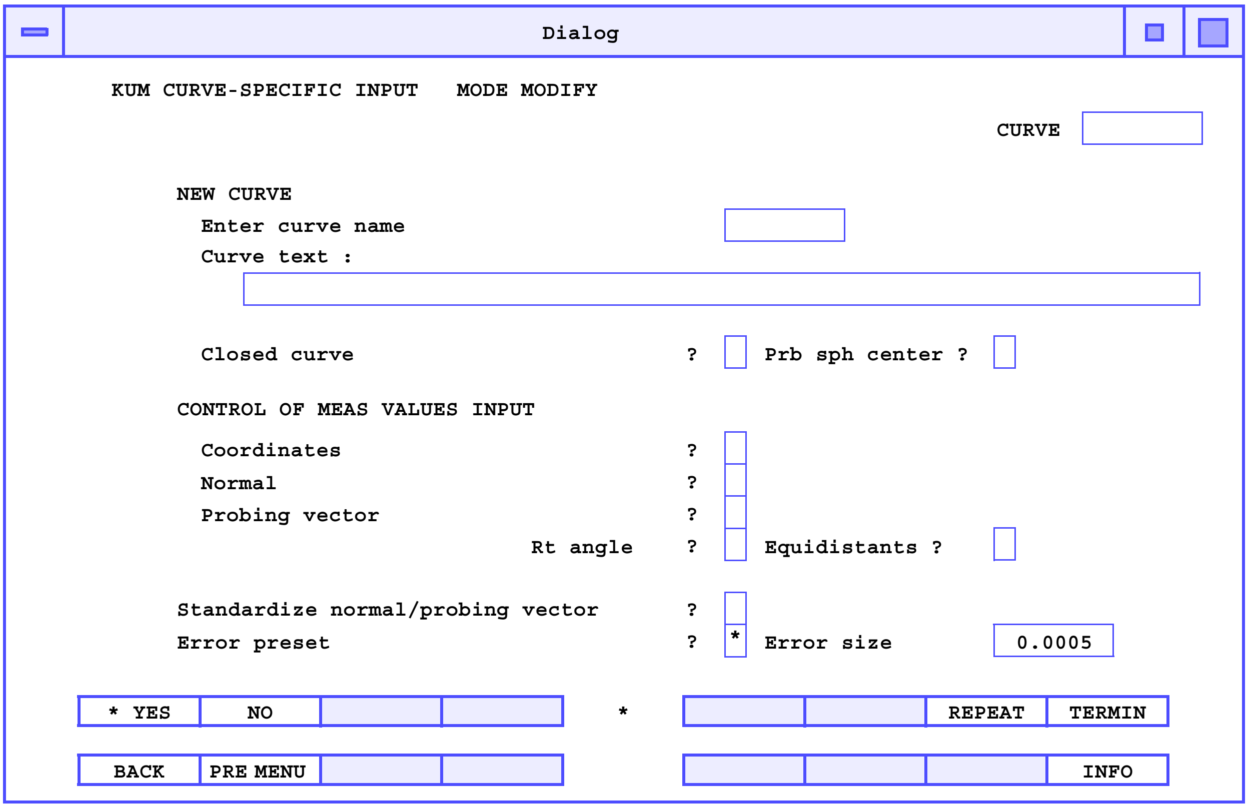
ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **MVA**, Action: **EDI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM CURVE SPECIFIC INPUT NEW CURVE** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Enter curve name

You can enter any name for identifying the curve to be measured. The name is output with the curve administration.

Curve text

You can enter a comment. This text is output after the record header.

Closed curve

<YES>
The coordinates result in a closed curve.

<NO>
The coordinates relate to an open curve.

Prb sph center

<YES>
The coordinates refer to the probe sphere center.

<NO>
The coordinates refer to the contact points.

CONTROL OF MEAS VALUES INPUT

Coordinates/Normal/ Probing vector

The type of data to be entered later manually must be selected here. Individual selection and combinations are possible. Information not selected cannot be entered. In the Measured value input - main menu the message **Input code not set** appears.

Rt angle

The rotary table angle cannot be selected in this software version.

Equidistant

<YES>
Set input curve for equidistant.

<NO>
Delete input code for equidistant.

Standardize normal/ probing vector

If confirmed with **<YES>** the normals are standardized, i.e. the sum of the direction cosines squared results in the value "**1**".

Error preset

If confirmed with **<YES>**, the error size can be defined.

Error size

Input of the value by which the sum of the squares of the direction cosine is allowed to deviate from the theoretical value **1**.

CNC mode

Preparing the measurement

We recommend that you plan the measuring run before starting the learn programming:

– **Record header** (UMESS)

– **W-position** (UMESS)

– **UMESS→KUM** Preparation (e.g. plot form). Measurement, evaluation and results display can run simultaneously.

– **Measurement** (KUM)–Note curve number and part number if appropriate!

– **Evaluation** (KUM)–Note curve number and part number if appropriate!

– **KUM→UMESS <TERMIN>**

NOTE

In KUM, a probing vector is stored and administered for every probing point.

Programming the CNC measuring run

Before starting the learn programming, make sure that the necessary **peripherals** (printer, plotter) are **ready for operation**.

Preparation in UMESS

Define W-position

<DI 1625> Activation of plot peripheral

<DI 1639> or **<PROG>** Start of the learn programming

Enter W-name

<DI 1610> Define record header

<DI 1713 Define workpiece system (= W-position)

Set I-position

If necessary enter safety position for the CNC start

<DI 1511> Position before first probing point

Scanning in KUM

<DI KUM> Transition to KUM

Select part

Perform part selection via parts administration

<MEASURE> Select the measurement menu

<SCAN MOD> Define scanning mode

<SCAN RUN> Enter scanning parameters and start scanning run (description in UMESS operating manual)

Further run after scanning

Probe point or select function

Set INT POS; Specify safety position (between several measurements)

<TERMIN> Return to KUM Main Menu

<DEFINE> Define command block; if a command block has already been defined, you only have to enter the block number

<EXECUTE B> Execute the command block with input in control data

or

<CMD PROG> Only input in control data

<UMESS> Return to UMESS

Set INT POS; Specify safety position for CNC end

<P END> End of learn programming

Starting the CNC run

Before starting a CNC run, make sure that all the **peripherals** required (printer, plotter) are **ready for operation** and are **activated**.

– **<DI 1625>** (select the plot peripheral)

– **<DI 1614>** or **<1615>** (output to printer or terminal)

The start of the CNC run takes place with the dialog window shown below (UMESS operating instructions, **<DI 1640>**). There are two options:

Start menu: UMESS Main Menu

F12

– Press the **<F12>** key.
  The direct input window (DI) is then displayed.

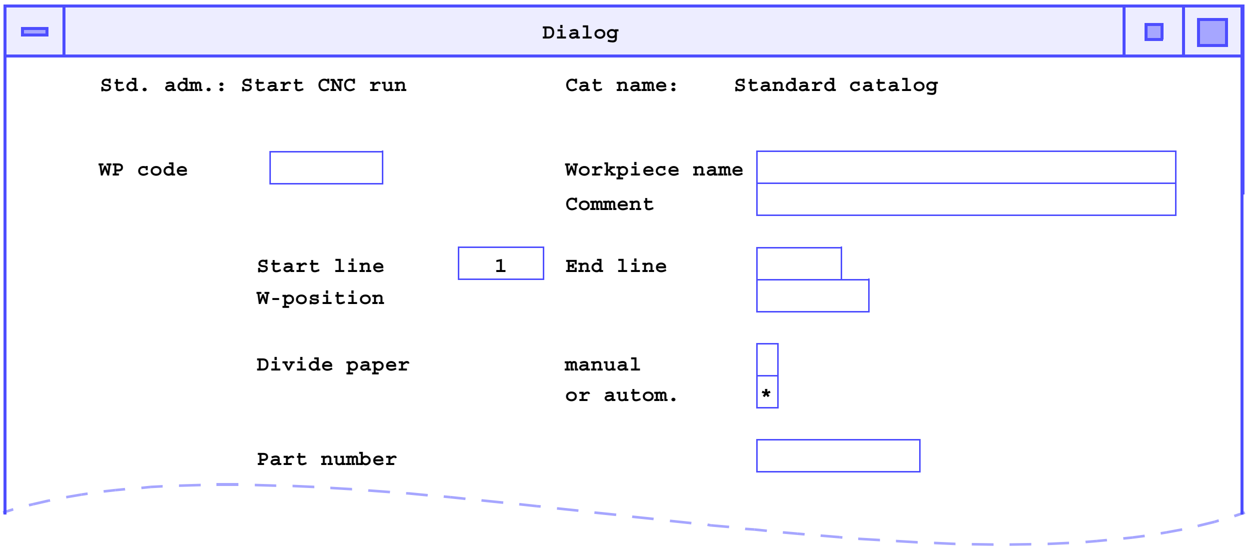
– Enter **<DI 1640>** in the data box.

ENTER

– Press **<ENTER>**.
  The dialog window with the menu title **Std. adm: Start CNC run** appears. *or*

Start menu: UMESS Main Menu

– From the pull down menu **select <CNC/CNC start/CNC-run>**. The dialog window with the menu title **Std. adm: Start CNC- run** appears.



Point collection file

Transfer to UMESS

KUM nominal or measured data can be converted using the Convert nominals **NOM CON** or Convert measured values **MVA CON** functions and saved in a point collection file. A **point collection file** can be read from **UMESS** – from the data, geometrical elements can be calculated and form plots created.

Nominal values

Nominals are always **surface coordinates** in KUM.

Measured values

The following must be noted for measured values:

After a measurement, measured values are available as **probe sphere center point coordinates**. The probe sphere correction may be made in UMESS and KUM according to different methods.

NOTE

If necessary, you can convert the probe sphere correction with the Convert measured values **MVA CON** function before saving the data in a point collection file. In the curve administration, using the curve-specific data, you can check whether the KUM data is available as probe sphere center points or as surface data.

You can save the data either in **workpiece** or **machine coordinates** as defined by your screen input.

NOTE

If you save the data in machine coordinates and then read it on another column or computer, the data is transformed into the current workpiece system!
To avoid unwanted transformations, the data can be saved as **workpiece coordinates**.

Reading in files

NOTE

Point collection files can be read into KUM as measured data using the **MEASURE, FILE EVALUATION** function.

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

DEFINE

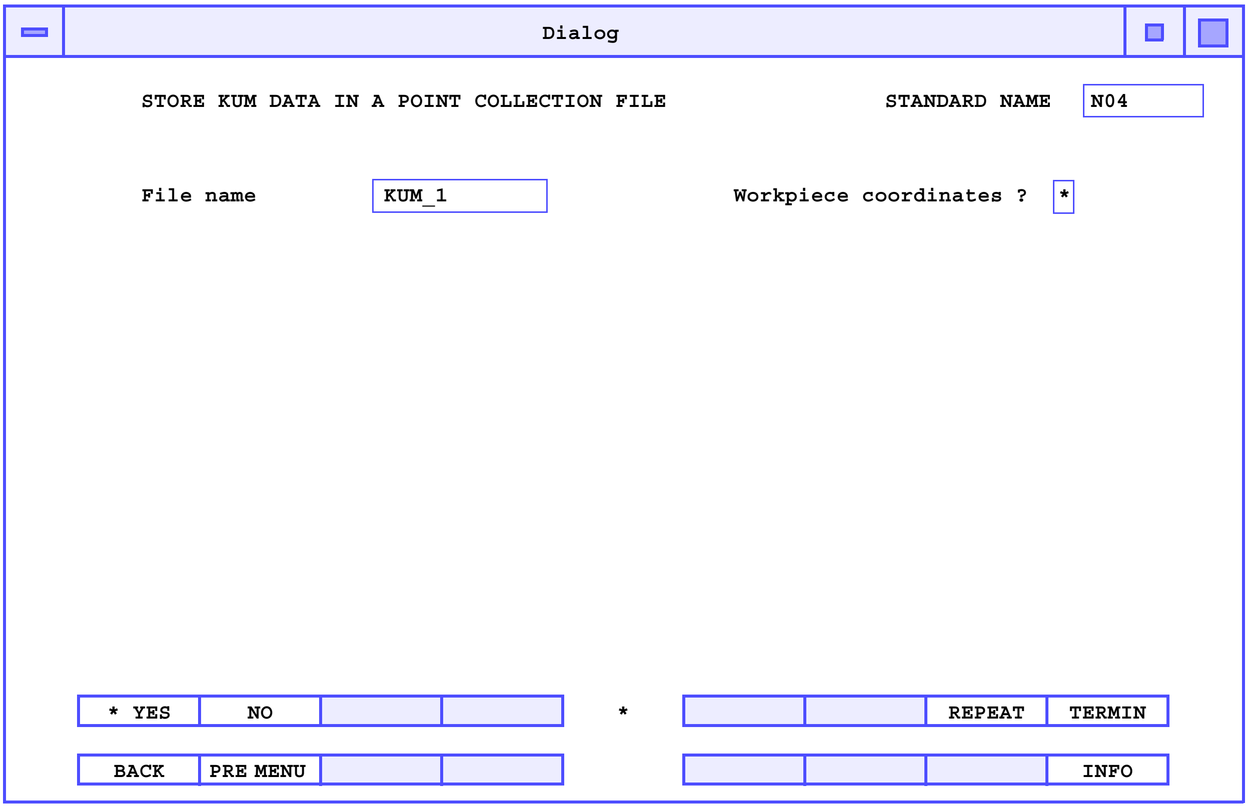
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **MVA** or **NOM**, Action: **UFO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **SAVE KUM DATA IN A POINT COLLECTION FILE** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

File name

Enter file name.

Workpiece coordinates

<YES>
The data is saved as workpiece coordinates.

<NO>
The data is saved as machine coordinates.

Chapter 7

Calculations

This chapter contains:

Conversion main menu

Functions

You can use the calculation functions to calculate the normals, tangents, arc lengths and line center of gravity of a curve, with reference to every point of an existing curve.

Prerequisite

ATTENTION!
The prerequisite for a deviation calculation is that the nominals have already been converted, as for the best fit and deviation calculation, tangents, normals etc. are used, as well as the nominals.

If certain data already exists (calculated or entered), then the relevant queries must be answered with **<NO>**. In this case the data is retained, otherwise it is deleted and recalculated. With contour lines the normals are undefined, the relevant queries are answered with **<NO>**.

Measured value conversion

When converting measured values, the existing probe center point data is corrected by the probe sphere radius. The original measured values are overwritten.

Identical points

Identical points are automatically deleted–therefore, the **Correct measured values** function (**MVA COR**) is not necessary prior to calculation. With the **Calculate nominals** function (**NOM CAL**), a check is automatically made for identical points after the probe sphere radius correction. These are then deleted if necessary and the conversion is repeated with the corrected data.

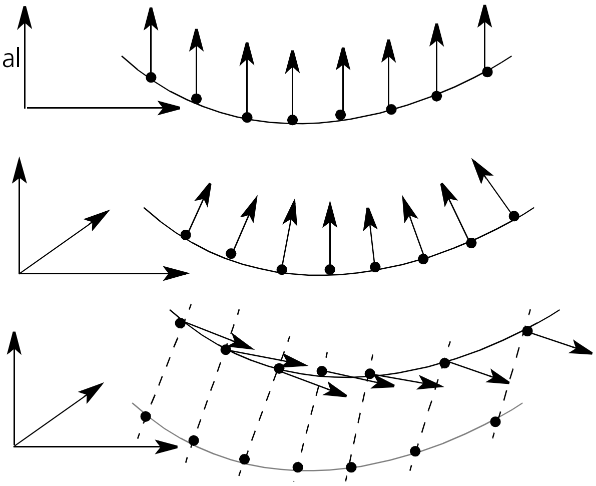
Types of normals

You can calculate three different types of normal with these functions: 2D normal or 3D normal without auxiliary curve or 3D normal with auxiliary curve.

Calculation of 2D normal

Calculation of 3D normal *without* auxiliary curve

Calculation of 3D normal *with* auxiliary curve



There are two different ways of calling up the dialog window.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

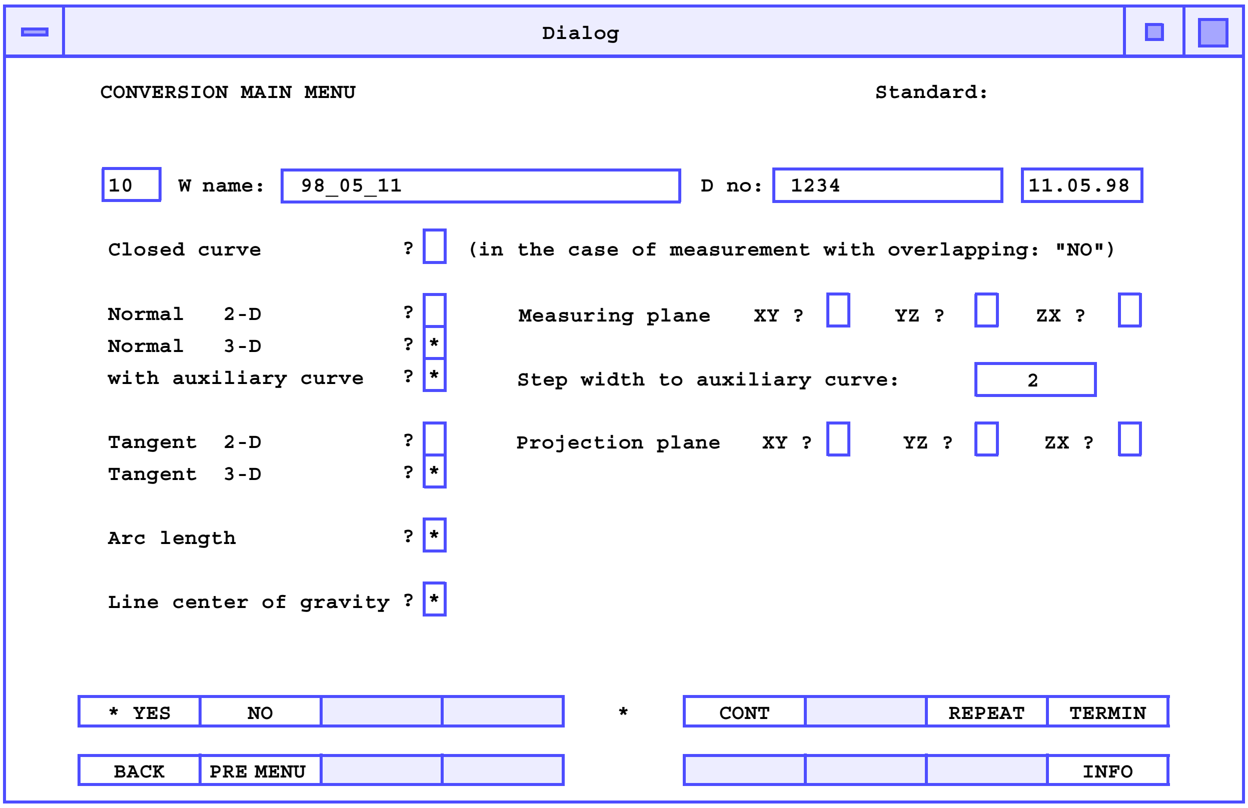
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM**
  Action: **CON** or **CAL**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **CONVERSION MAIN MENU** is displayed.
– Enter the desired data.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

W name: D no

Display boxes with header data

Closed curve

Depending on whether the curve is open or closed, this input box must be answered with **<YES>** or **<NO>**.

Normal 2-D
Measuring plane
XY/YZ/ZX

If confirmed with **<YES>**:

The normal is calculated for every curve point and projected onto the measuring plane to be specified.

Normal 3-D

If confirmed with **<YES>**:

The 3D normal is calculated for each curve point with or without an auxiliary curve.

with auxiliary curve
(normal 3-D)
Step width to
auxiliary curve

If confirmed with **<NO>**:

The 3D normal is calculated for each curve point (without using an auxiliary curve).

If confirmed with **<YES>**:

The 3D normal is calculated for each curve point using an auxiliary curve (however, no normals are calculated for the auxiliary curves). The number for the auxiliary curve is given as step width with reference to the nominal curve.

Continue:
with auxiliary curve
(normal 3-D)
Step width to
auxiliary curve

Example of a *single* curve:

If the number of the nominal curve is 1 and the number of the desired auxiliary curve 5, then the step size is 4.

Example of *several* curves:

Curves 1 to 5 are to be converted and the auxiliary curves are to be numbered 6 to 10. In this case, only the value 5 needs to be entered as the step width. The conversion can now be performed for all curves, without the performance specification having to be changed.

Tangent 2-D
Projection plane
XY/YZ/ZX

If confirmed with **<YES>** the tangent is calculated for every curve point and projected into the projection plane to be specified (face cam).

Normal 2-D

NOTE

ATTENTION!
The measuring plane must also be marked, otherwise no conversion will take place.

Tangent 3-D

If confirmed with **<YES>** the tangent is calculated for each curve point. The normals remain unchanged.

Arc length

Depending on whether the arc length is to be calculated, this data box must be answered with **<YES>** or **<NO>**. **<YES>** is required for a best fit.

Line center of gravity

Depending on whether the line center of gravity is to be calculated, this data box must be answered with **<YES>** or **<NO>**. **<YES>** is required for a best fit.

Contact point correction with 3D normals

This dialog window is a follow-on window from ➤*"Conversion main menu" on page 7-2* and serves for alternative definition of the correction type with 3D normals.

There are two different ways of calling up the dialog window.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM** ; Action: **CAL**
  or Object: **MVA**; Action: **CON**

DEFINE

– Press **<DEFINE>**.
  The dialog window appears.

YES

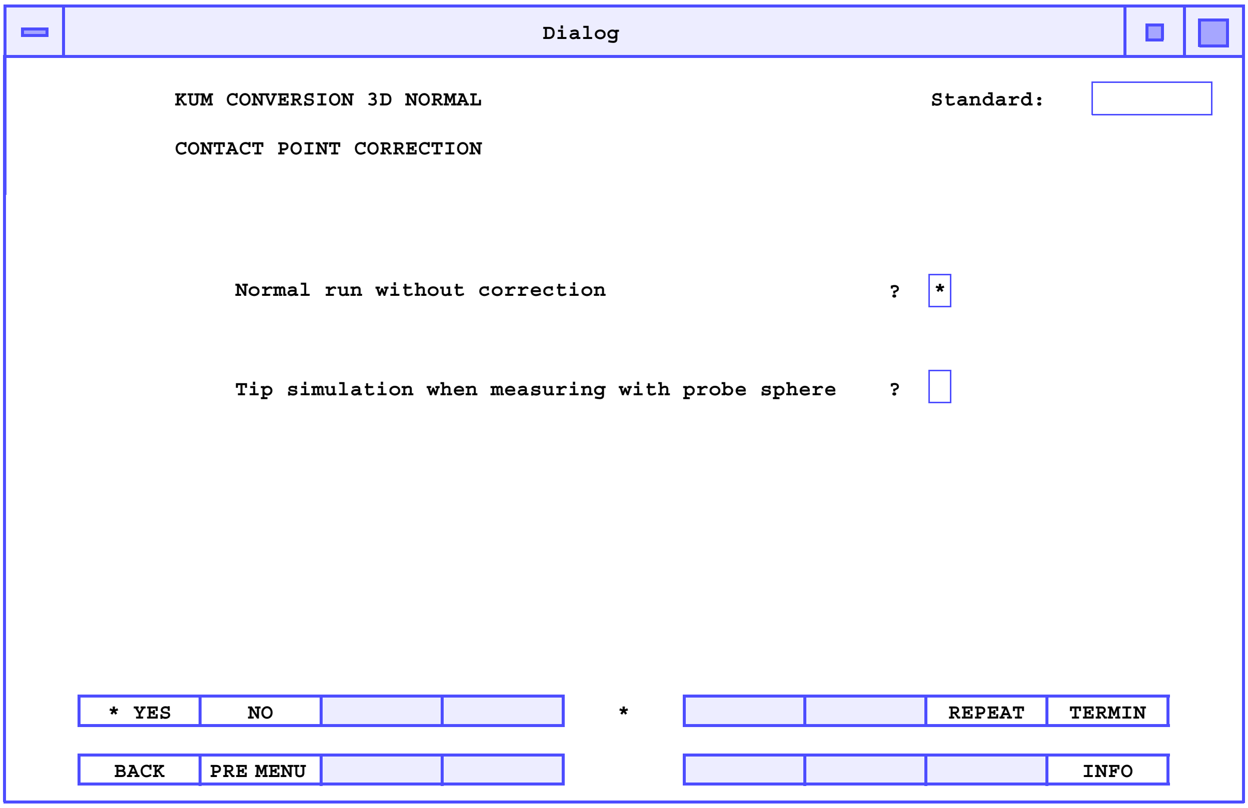
– Acknowledge the **Normal 3-D** data box with **<YES>**.

YES

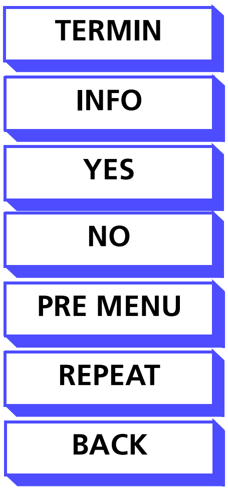
– Acknowledge the **with auxiliary curve** data box with **<YES>**.
– Enter a number in the **Step width to auxiliary curve** data box.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **KUM CONVERSION 3-D-NORMAL CONTACT POINT CORRECTION** is displayed.



Softkey functions



See general softkey functions, ➤*“General softkey functions” on page 1-10*.

Notes on the input and display boxes

Normal run without correction

If confirmed with **<YES>** a normal contact point calculation takes place. (see diagram ➤*“Positioning the auxiliary curve” on page 6-12*)

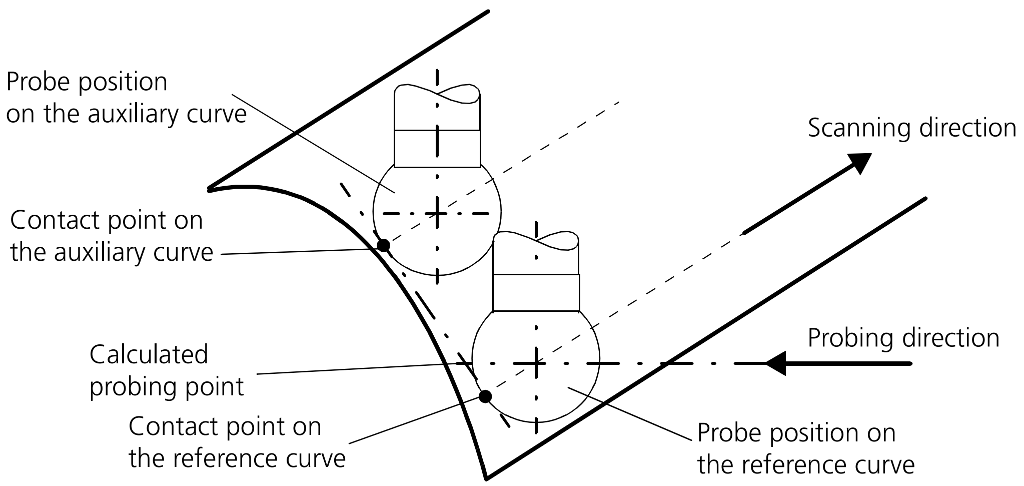
If **<NO>** is entered, the next data box must be answered.

Tip simulation when measuring with probe sphere

Alternative data box to the above. If confirmed with **<YES>**, the calculation for a tip simulation is carried out, i.e. the point which would have been determined during measurement with a pointed probe is calculated.

The theoretical tip probing point is calculated from the two contact points, the probing direction and the probe sphere radius. See representation in following diagram. Further explanatory notes on the reference and auxiliary curve ➤*"Reference curve - Auxiliary curve" on page 2-6*.

Display of the tip simulation



Calculation of a 3D normal

3D component

During the measured value conversion, the contact point of the probe sphere on the workpiece is one of the elements calculated. Here the probe sphere radius is corrected in the direction of the normal–starting from the probe sphere center point. The accuracy of the probe sphere radius correction depends on how accurately the normal can be calculated.

Calculation

There is now a new way of calculating the normal:

If a 3D curve lies on a multi-curved surface, the 3D normals of the measured points cannot be calculated without additional information. This additional information is contained as 3D- components in the normals of the nominal data (NOM components) and is transferred to the measured value conversion.

Transformation

Transformation of the contact points to section height:

In metrology, you may want the measured points of a curve to lie at a *specific section height*. This may be the case, for example, for the measuring method “Scanning in workpiece plane”. The probe sphere center point is regulated to a selectable section height.

However, after the probe sphere radius correction with 3D normals (with NOM components), the contact points are no longer located at the section height of the probe sphere center points.

It is now possible to transform the contact points *retroactively* to the *section height of the contact points* or to a preset section height.

The contact point is moved along a vector which is vertical to the 3D normal and the tangent of the measured point. The transformation plane lies on the new section height. The displacement vector intersects the transformation plane in the new contact point.

Start menu: KUM Main Menu, ➤*“Calling the KUM Main Menu” on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **MVA**
  Action: **CON**

DEFINE

– Press **<DEFINE>**.
  The dialog window appears.

YES

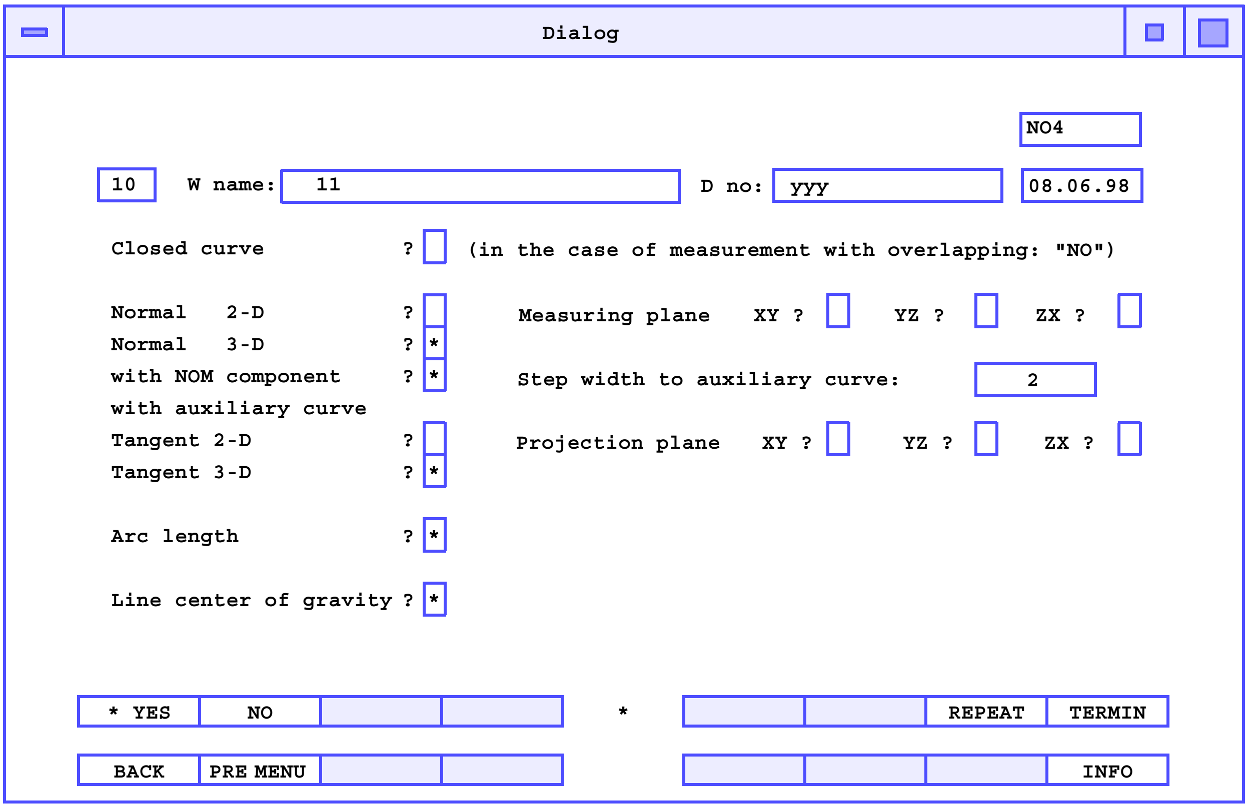
– Acknowledge the **Normal 3D** data box with **<YES>**.

YES

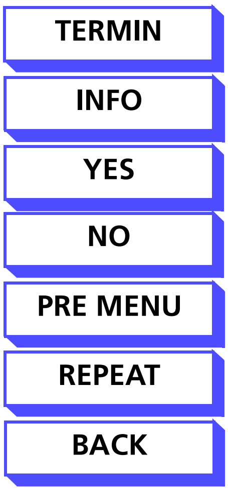
– Acknowledge the **NOM component** data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **KUM CONVERSION 3-D NORMAL CONTACT POINT TRANSFORMATION** is displayed.



Softkey functions



See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

W name: D no

Display boxes with header data.

Closed curve

Depending on whether the curve is open or closed, this data box must be answered with **<YES>** or **<NO>**.

Normal 2-D measuring plane XY/YZ/ZX

If acknowledged with **<YES>**:

The normal is calculated for each curve point and projected into the measuring plane to be specified.

Normal 3-D

If acknowledged with **<YES>**:

The 3D normal is calculated for each curve point with or without the use of an auxiliary curve.

with NOM component

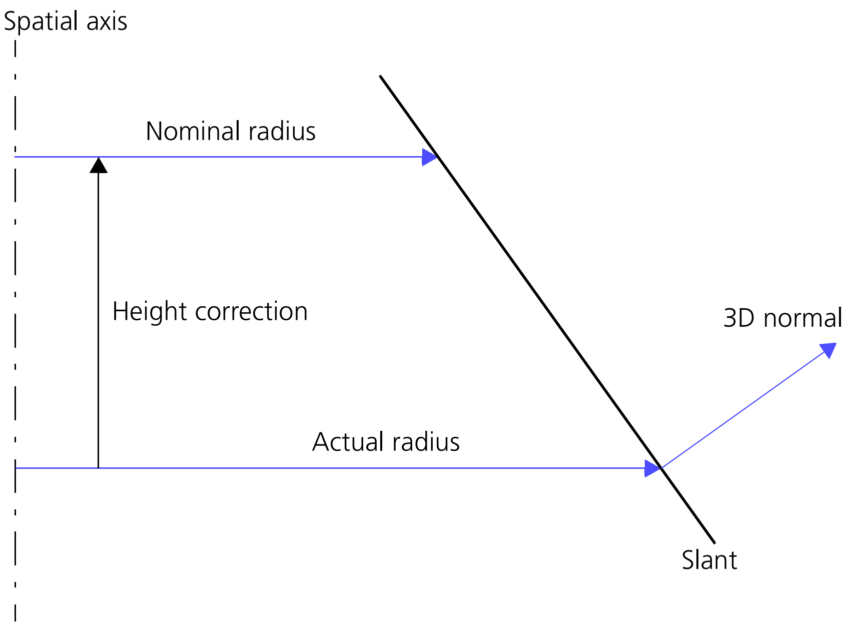
If acknowledged with **<YES>**:

The 3D component from the normals of the nominal data is transferred.

When viewing a circular path along a cylindrical surface (spiral, cylindrical cam) the measured data is best displayed as cylindrical coordinates in the form of radius, angle of rotation and height.

If this circular path is located on a *slanted surface*, then the height changes if the radius changes. With a spiral, this effect is noticeable as a **variation in pitch**.

When measuring such a circular path, the probe may deviate from a given radius. The radius can be *subsequently corrected mathematically*, if the *height is corrected* at the same time. To do this, the **3D normal** of the measured point in question must be known.



The 3D normals of the measured curve can be calculated with the help of the **Convert measured values** function. Either a parallel auxiliary curve can be used or the 3D components are taken from the nominal data, the nominal normals.

The probe sphere radius correction as well as the transformation of the cylinder coordinates to a constant radius, including the corresponding height correction, is made using these 3D normals.

NOTE

The spatial axis (center axis) of the cylindrical workpiece must run *parallel* to *one* of the three main axes of the workpiece coordinate system. The **workpiece zero point** must be located somewhere on this **spatial axis**.
Probings *vertical* to the spatial axis are *not* allowed, as in this case a radius or height correction is not possible. An error message is output.
Exception: If the circular path does not lie on a slanted surface but on a **flat** surface, then it is a **2D curve (face cam)**. The 3D normals run **parallel** to the spatial axis. In this case, the *height remains* **constant** for the radius correction.

with auxiliary curve (normal 3-D)
Step width to auxiliary curve

If acknowledged with **<NO>**:

The 3D normal is calculated for each curve point (without using an auxiliary curve).

If acknowledged with **<YES>**:

The 3D normal is calculated for each curve point using an auxiliary curve (however, no normals are calculated for the auxiliary curves). The number for the auxiliary curve is given as step width with reference to the nominal curve.

Continue with:
with auxiliary curve (normal 3-D)
Step width to auxiliary curve

Example for a *single* curve:

If the number of the nominal curve is 1 and the number of the desired auxiliary curve is 5, then the step width is 4.

Example for *several* curves:

Curves 1 to 5 are to be converted and the numbers of the auxiliary curves are to be 6 to 10. In this case, only the value 5 needs to be entered as the step width. The conversion for all curves can now be performed, without the execution specification having to be changed.

Tangent
2-D projection plane XY/YZ/ZX

If acknowledged with **<YES>**, the tangent is calculated for each curve point and projected into the projection plane to be specified (face cam).

Tangent 3-D

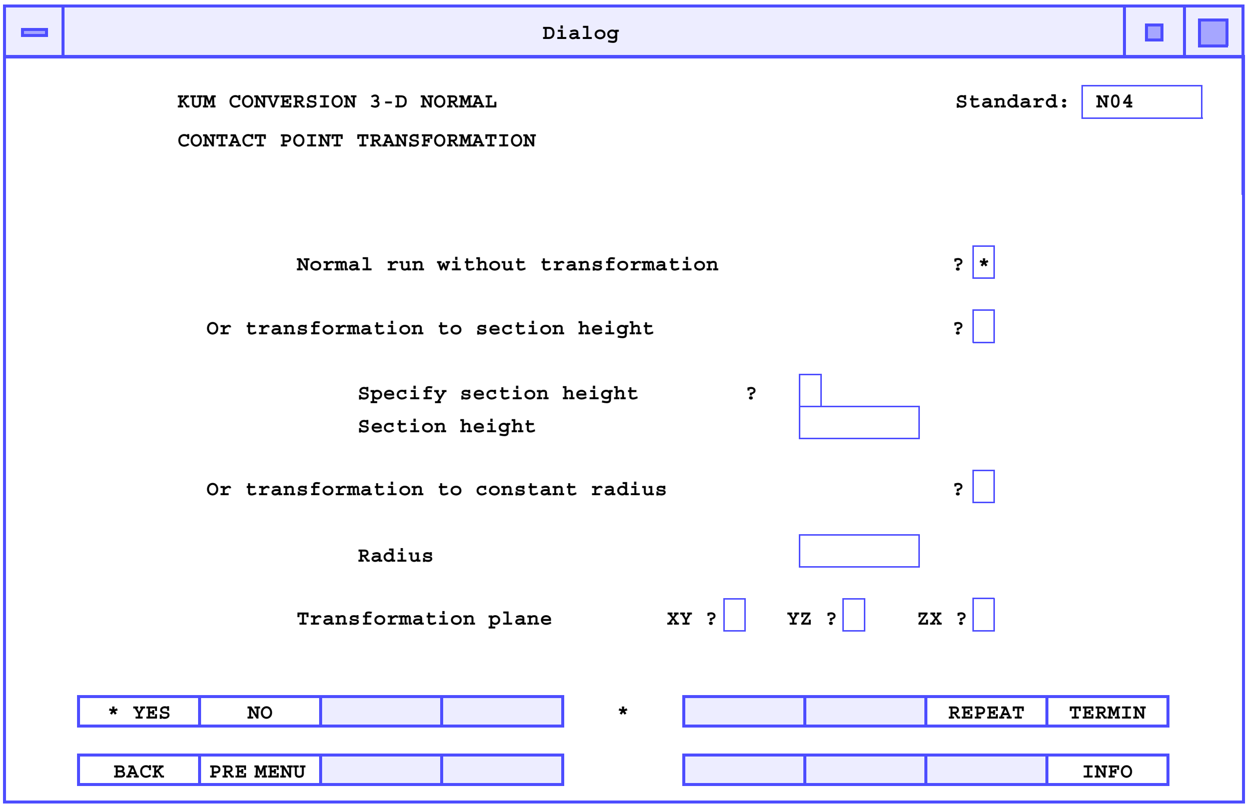
If acknowledged with **<YES>**, the tangent is calculated for each curve point.

Arc length

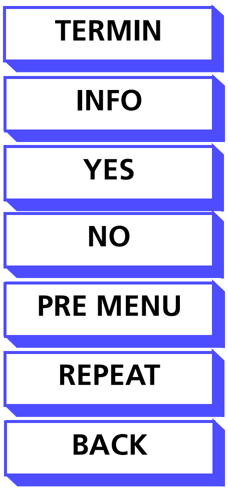
Depending on whether the arc length is to be calculated, this data box must be answered with **<YES>** or **<NO>**.

Line center of gravity

Depending on whether the line center of gravity is to be calculated, this data box must be answered with **<YES>** or **<NO>**.



Softkey functions



See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Normal run without transformation
If acknowledged with **<YES>** a normal run is executed without transformation.

or transformation to section height
If acknowledged with **<YES>**, the contact points are transformed to section height.

Specify section height
<YES>
Enter the section height in the next box.

<NO>
The contact points are transformed to the section height of the probe sphere center points.

Section height
Enter the section height.

or transformation to constant radius
The contact points are transformed to a constant distance from the spatial axis.

Radius
Input of the distance from the spatial axis, to which the contact points are to be transformed.

Transformation plane XY, YZ, ZX
Input of the transformation plane.

Deviations - Main menu

This dialog window is used for controlling the deviation calculation.

NOTE

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

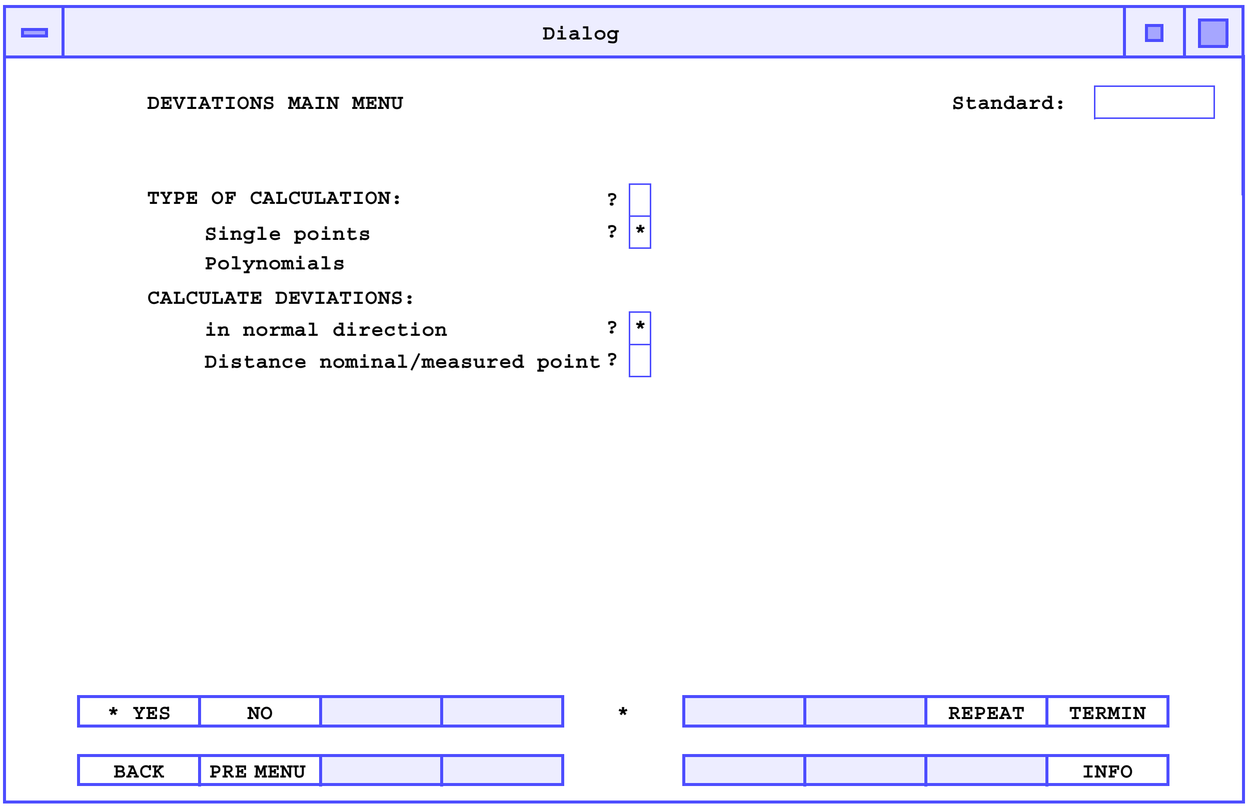
ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **DEV**
  Action: **CAL**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **DEVIATIONS MAIN MENU** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

TYPE OF CALCULATION: Single points

Point by point assignment of nominal and measured points. For this type of calculation it is prerequisite that the *same number* of nominal values and measured values are available.

TYPE OF CALCULATION: Polynomials

For every nominal, the piercing point of the measured curve through the normal plane of the nominal point is calculated. The spatial axis of a normal plane is the tangent. Polynomials of the nth degree are used for this procedure.

For this type of calculation it is prerequisite that the **tangents of the nominal points** are available (see nominal conversion).

CALCULATE DEVIATIONS: in normal direction

The deviations are calculated in the **normal direction** of the nominal points.

CALCULATE DEVIATIONS: Distance nominal/measured point

With this type of calculation, no probe sphere radius correction is carried out. If probe sphere center point coordinates are available: first convert measured values; the necessary correction is then made. Application of this function: e.g. deviation calculation of contour lines.

(Standard) deviation calculation

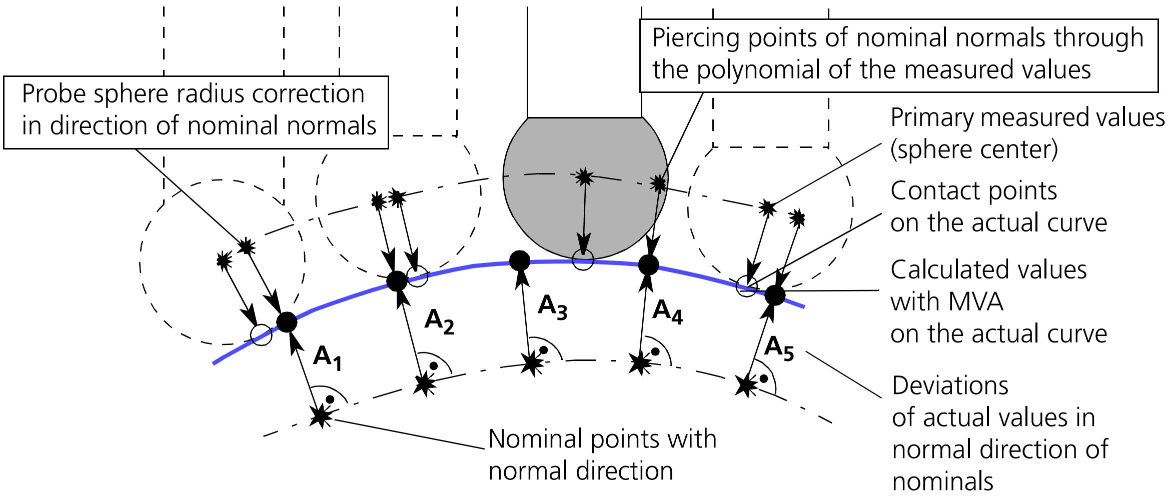
According to the type of calculation specified, either **polynomials** or **single points** form the basis of the deviation calculation. The deviations can be defined either projected in the **normal direction** (and calculated) or defined as the distance between **nominal and actual point.**

1st type of calculation

Selection: Polynomials/ in the normal direction

Generally, the deviation of a curve is output from the difference in the normal direction between the nominal values and the calculated actual values (polynomials). This has the advantage that the number of measured points does *not* have to coincide with the number of nominals specified.

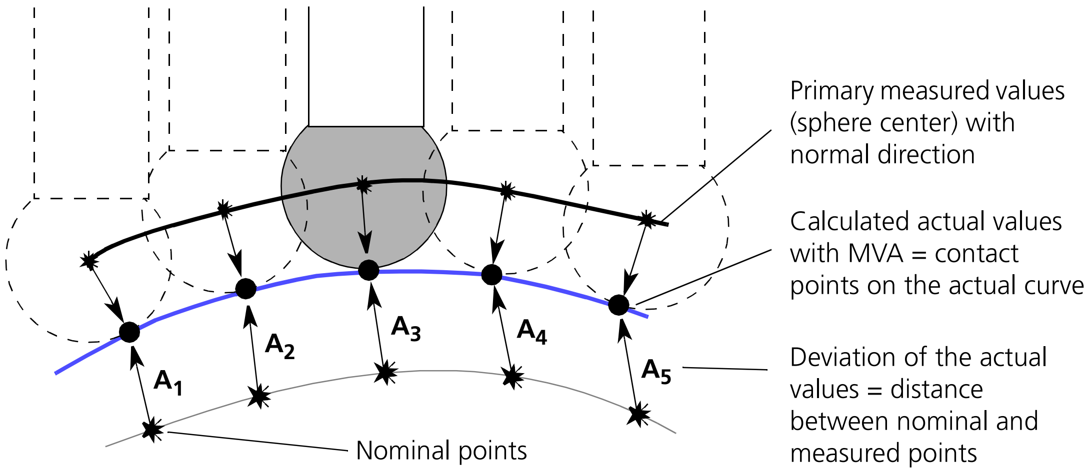
Deviation calculation using polynomials in the normal direction



2nd type of calculation

As the second option for the deviation calculation, the **distance** to the corresponding **nominal** can be determined for each measured point. In this case, the *number of measured points* and the nominals specified must *coincide*.

Distance between single points of the nominal- and actual values



With a cross combination of the two types of calculation explained above, you can also calculate:

3rd type of calculation

Selection: Polynomial/distance

Distance between nominal and polynomial as well as

4th type of calculation

Selection: Single points/ in normal direction

Single point deviation in normal direction.

The 3rd type of calculation is also useful if the nominal and measured curve are so far apart that no deviations can be calculated with calculation types 1 and 3.

Example: No calculation of the piercing points of the nominal normals through the polynomial of the measured curve is possible.

Deviation calculation for large deviations

The problem

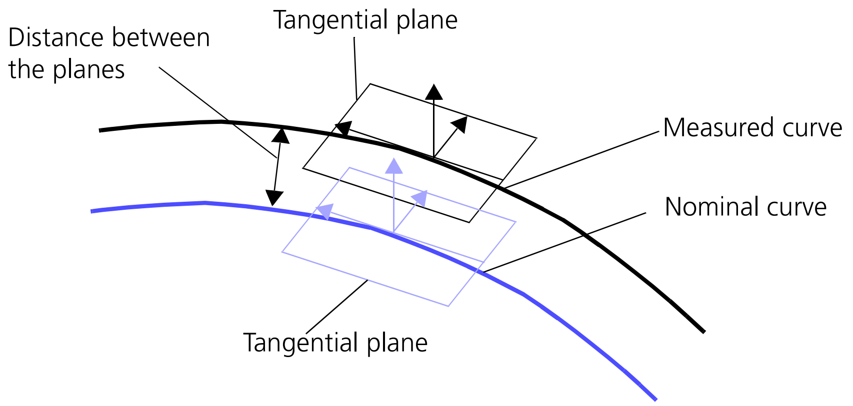
In coordinate metrology, deviations are defined as the difference between the displayed value and the determined value. The direction of the deviations corresponds to the direction of the nominal normal of the corresponding nominal point. However, in the case of large deviations, this calculation method can lead to a dilemma where the deviations can take on an *infinite size*.

New calculation method

A new calculation method is used as the basis for calculating large deviations:

The deviations are no longer defined in the normal direction; here they are determined from the *shortest distance between tangential planes, in the same direction,* of nominal and measured curve. The great advantage of this method is that in the case of small deviations, it provides identical results to the previously used standard deviation calculation (➤ *"(Standard) deviation calculation" on page 7-18*). The deviation calculation for large deviations must therefore be regarded as completion of the deviation definition.

Tangential plane



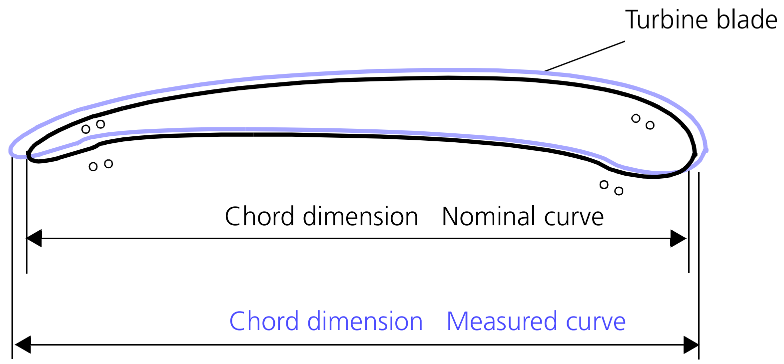
Large deviations

The deviation calculation for large deviations determines the deviations of **quasi-conformal closed curves**. Quasi-conformal representations are geometric curves which are similar in shape.

Turbine blades

The deviation calculation for large deviations has been *specially developed* **for turbine blades** whose chord dimension differs greatly in comparison with the nominal data. These error-containing turbine blades can be regarded as quasi-conformal in relation to their nominal data.

Chord dimension



Contour overlapping

With the standard deviation calculation, the probe sphere radius may also be calculated incorrectly with very accentuated curves and a very small distance between points, when using a large probe sphere. This leads to contour overlapping during evaluation.

The deviation calculation for large deviations is a method which enables the effects of the infinite size of the deviations and the contour overlapping to be removed. (cf. ➤*"Contour overlapping with sharp outer corners" on page 9-60*)

Procedure

The deviation calculation for large deviations is a very *complex function* both mathematically and from a programming point of view. The following (simplified) procedure results:

First of all the nominal points are interpolated by a suitable substitute function. In the case of turbine blades, these are smooth curves which can be described accurately enough by cubic spline functions. The measured points are approximated mathematically by substitute functions. At the same time this causes a filtering, as a result of which an equally smooth formation which is quasi-conformal with the nominal curve is obtained.

The deviation is now determined at points at which the tangents of both curves are the same.

Prerequisites

The following prerequisites are met for the evaluations:

- The functions must be quasi-conformal and must be able to be defined by cubic spline functions.
- The evaluation only takes closed smooth curves into consideration.
- The measured points must lie near to the nominal point plane.
- A rough best fit must be performed first of all in curves which are considerably twisted.

NOTE

First of all you must change to the deviation calculation mode for large deviations with the command **DEM SET**. Then call up the deviation calculation with the command **DEV CAL**. If you did not use the **DEM SET** command first, the **standard deviation calculation** (➤*"(Standard) deviation calculation" on page 7-18*) would be activated.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

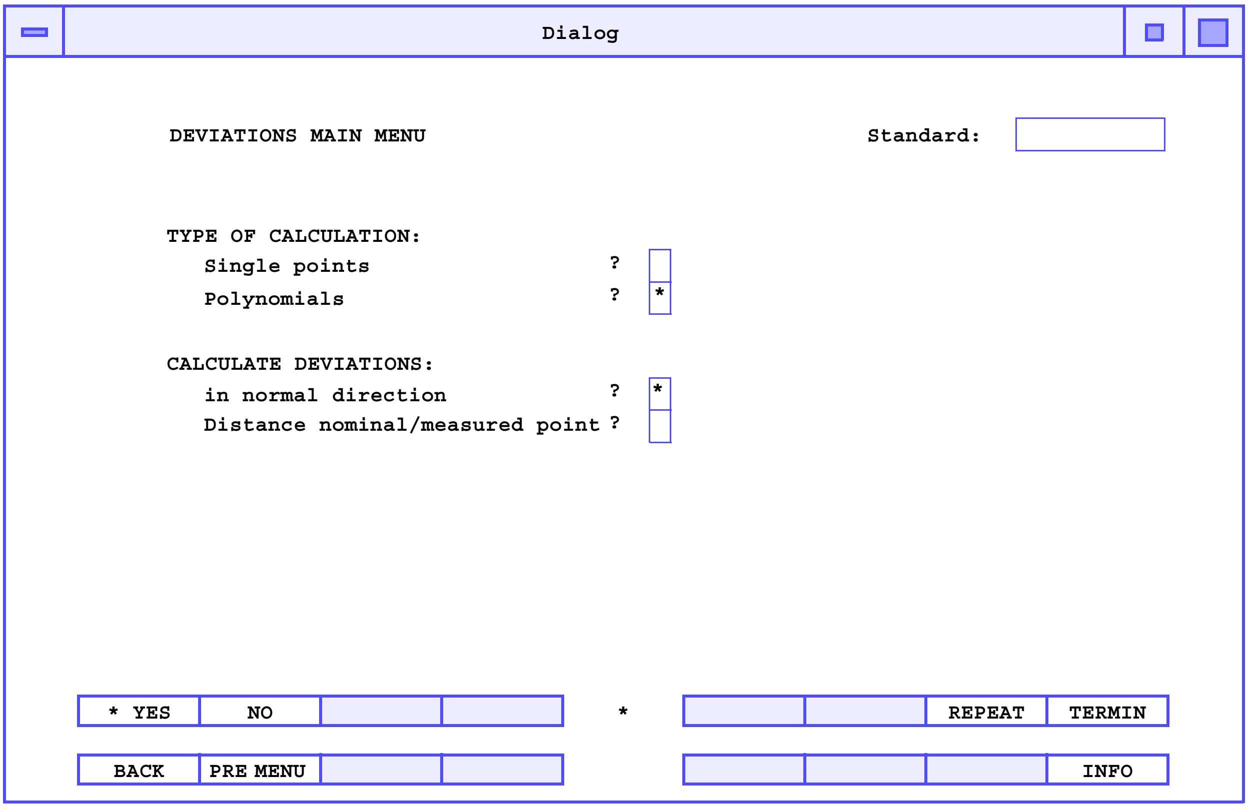
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **DEM**; Action: **SET**

L-TERMIN

– Press **<L-TERMIN>**.
  Jump to the next line.
– Enter the KUM command in the data boxes.
  Object: **DEV**; Action: **CAL**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **DEVIATIONS MAIN MENU** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

TYPE OF CALCULATION: Single points

Point by point assignment of nominal and measured points. For this type of calculation it is prerequisite that the *same number* of nominal values and measured values are available.

TYPE OF CALCULATION: Polynomials

For every nominal, the piercing point of the measured curve through the normal plane of the nominal point is calculated. The spatial axis of a normal plane is the tangent. Polynomials of the nth degree are used for this procedure.

For this type of calculation the **tangents of the nominal points** must be available (see nominal conversion).

CALCULATE DEVIATIONS: in normal direction

The deviations are calculated in the **normal direction** of the nominal points.

CALCULATE DEVIATIONS: Distance nominal/measured point

With this type of calculation, no probe sphere radius correction is carried out. If probe sphere center point coordinates exist: first convert measured values; the necessary correction is then made. Application of this function: e.g. deviation calculation of contour lines.

Calculating actuals

When **ACT CAL** is called up, nominal data and deviations are added.

The deviations can be calculated by a deviation calculation **DEV CAL** or by a best fit **MVA BFT**.

ATTENTION!
With this calculation the measured data memory is overwritten.

Data error

NOTE

When calculating the actual values, so-called data errors may occur if the deviations calculated are incomplete. This is always the case if some deviations could not be calculated during the deviation calculation.
These data errors can be eliminated with **NOM COR** or **MVA COR**, ➤*"Check of nominal and measured data" on page 1-15*.

Smoothing a curve

You can use the **DEV FIL** function to filter curves in accordance with DIN ISO TC 57/SC1 WG 1.

The **DEV FIL** function mathematically smooths short-waved parts of the curve shape which usually superimpose the pure form deviation as a quite distinctive peak and trough line.

NOTE

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

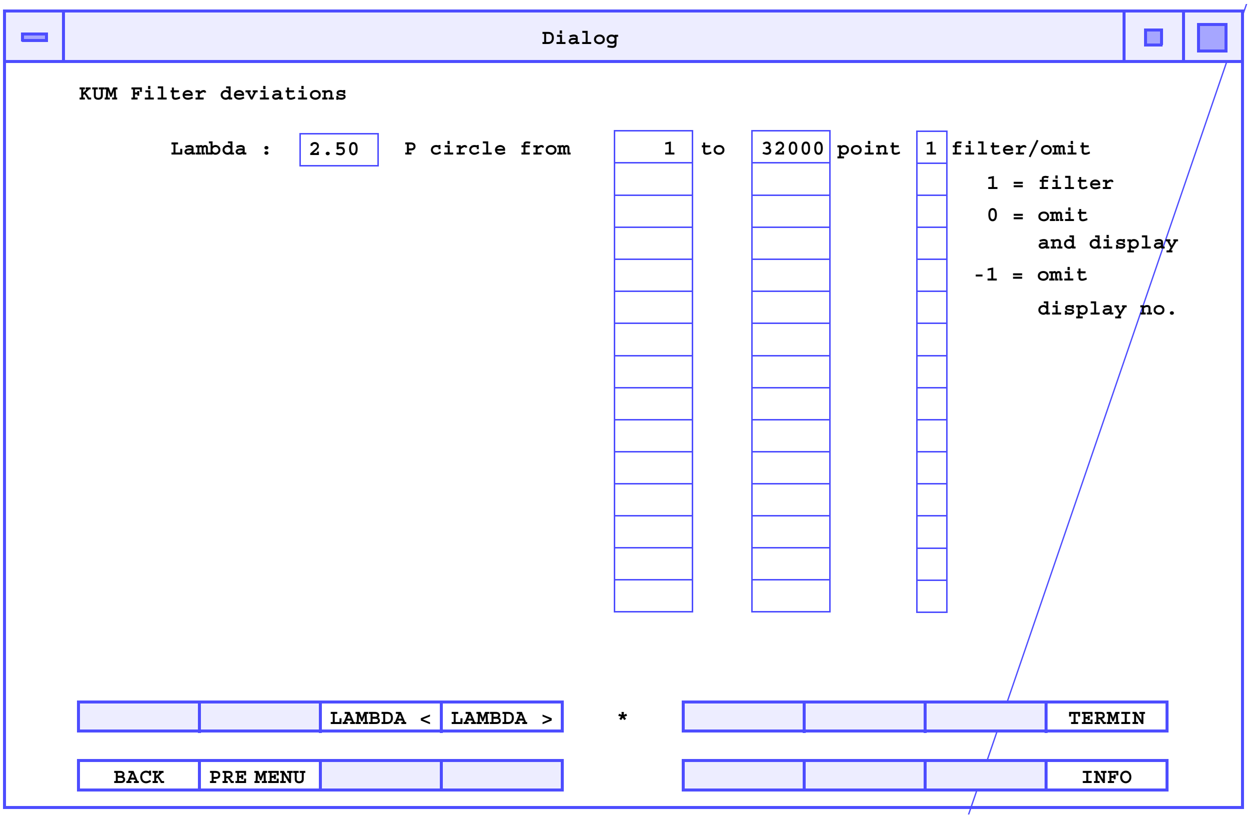
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

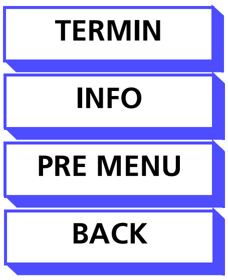
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **DEV**, Action: **FIL**

DEFINE

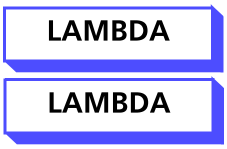
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM Filter deviations** is displayed.



Softkey functions



See general softkey functions, ➤ *"General softkey functions" on page 1-10*.



To increase or decrease the limiting wave length step by step.

Notes on the input and display boxes

Lambda

NOTE

The LAMBDA limiting wave length corresponds to a length on the workpiece surface. Standard steps are: 0.8 | 2.5 | 8
For further explanations refer to UMESS Basic Operating Instructions, **<DI 1185>** “Filter”.

P circle from to point

To form circular segment from desired points.

Code numbers

1 = filter

0 = omit and display

-1 = omit and no display

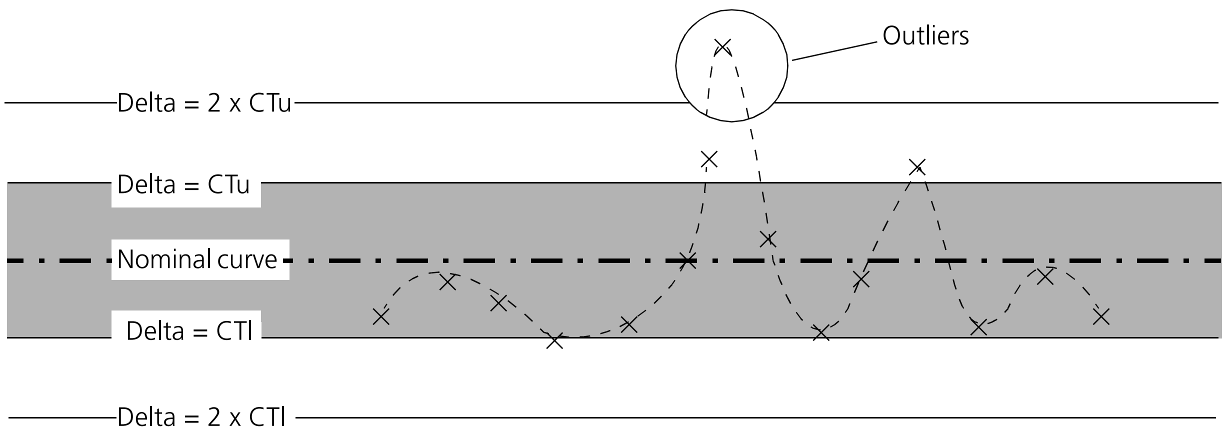
Deviations–eliminating outliers

The **DEV ELO** function allows you to delete deviations whose distance is greater than the delta value entered.

NOTE

If the dimension is constantly high or low, you must carry out an offset calculation beforehand, as otherwise no deviation outlier can be calculated.

Eliminating outliers



Delta value entered = Curve dimension tolerance = 2 x CTu

The outlier consideration functions symmetrically; if, for example, all deviations outside the tolerance band are not to be taken into consideration, you must enter half the value of the curve dimension.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

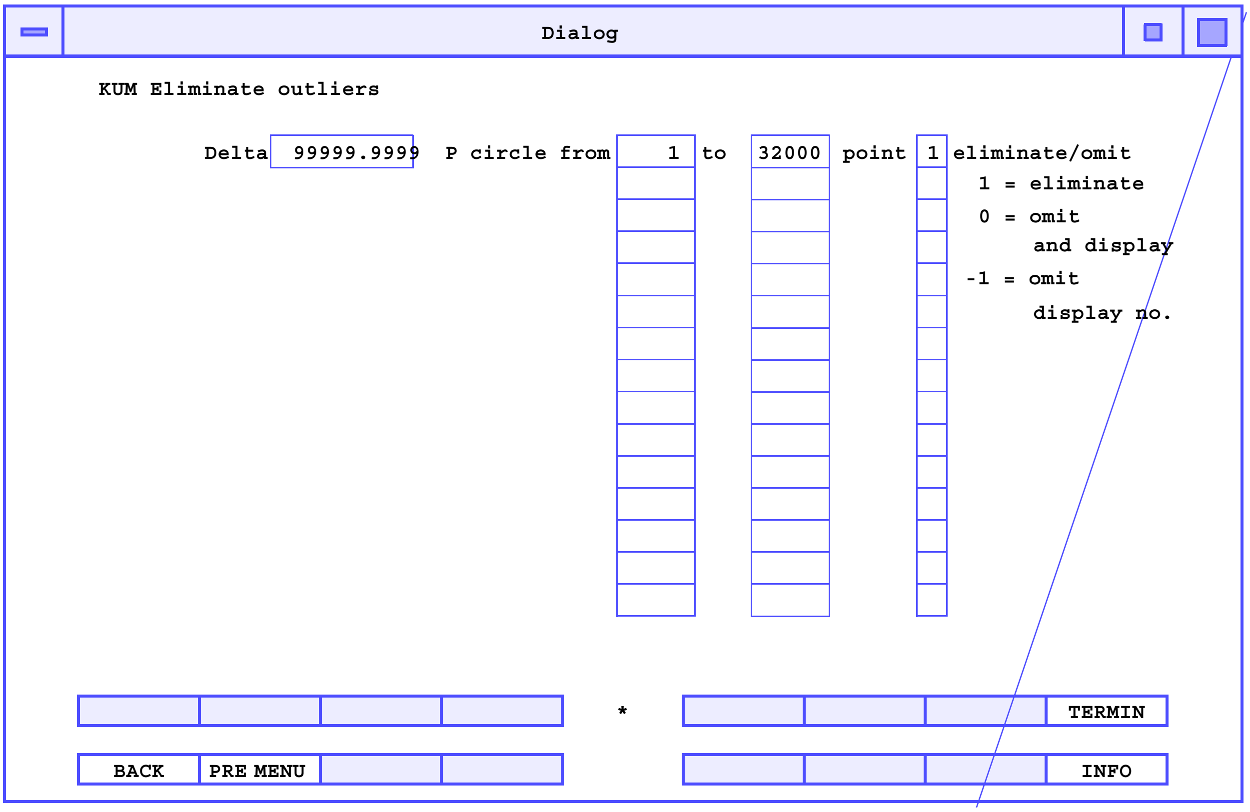
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **DEV**, Action: **ELO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM Eliminate outliers** is displayed.



Softkey functions

TERMIN

INFO

PRE MENU

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Delta
Enter a factor for the outlier consideration.

P circle from ... to ... point
Form a circular segment from the desired points

Code numbers
1 = eliminate

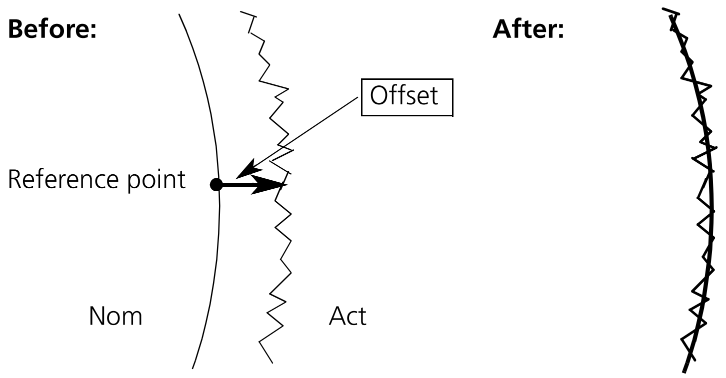
0 = omit and display

-1 = omit and no display

Calculating the offset

By **offset** we mean the dimension by which a form is uniformly too large or too small compared with the nominal form. This involves a shift of the curve points in the normal direction.

The deviations (EN) already determined and stored are changed by the simple addition or subtraction of the offset in the direction of the nominal normals. The corrected deviations can then be output as usual. The offset values are output in the header of the deviation list and the deviation plot.



Prerequisite

The deviations must have already been calculated. Nominal data must be available with normals. The offset can be entered or calculated.

Methods

Possible methods for calculating the offset

- Calculate minimum value (minimum form deviation: E_{MIN}) from the deviations
- Calculate maximum value (maximum form deviation: E_{MAX}) from the deviations
- Calculate the arithmetic mean from E_{MIN} and E_{MAX} "$(E_{MIN} + E_{MAX})/2$"
- Calculate arithmetic mean from the deviations
- Calculate standard deviation from the deviations
- First valid deviation is used as offset
- Masking of the nominals can be taken into consideration
- The offset can be calculated over several curves

ATTENTION!
The offset calculation overwrites the results of the deviation calculation or best fit. The offset calculation may only be used once.
A new offset calculation is only possible if a new deviation calculation or best fit has been performed beforehand–it this is not observed, incorrect results will occur.
A deviation which could not be calculated for a deviation calculation or best fit is not a valid deviation and is not used for the offset calculation.

Using this program

Cam

A cam can be too large or too small within certain limits. However, the form itself and the transition from base circle to cam must be correct.

Piston

As for cams, a piston can also deviate in its diameter from the absolute nominal values. However, the relative form must be retained.

Translational best fit of open curves.

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7.*

DEFINE

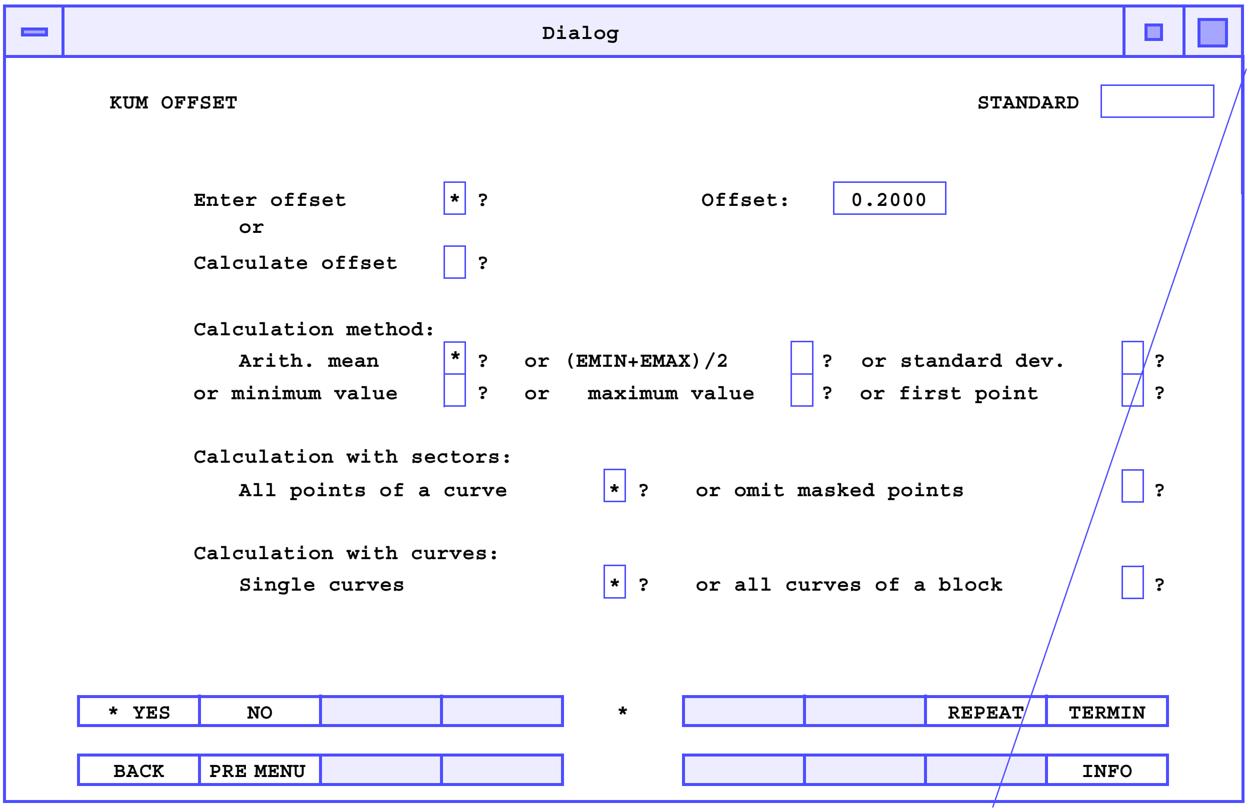
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **OFS**
  Action: **CAL**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM OFFSET** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Enter offset

<YES>
Enter an offset numerical value.

<NO>
Calculate offset.

Calculate offset

<YES>
Select the calculation method:

Calculation method:

Arith. mean
Calculate arithmetic mean from the deviations. Formula: "Sum of all deviations in normal direction of the nominals/number of points".

or (E_{MIN} + E_{MAX})/2
Calculate the arithmetic mean from E_{MIN} and E_{MAX}
"(E_{MIN} + E_{MAX})/2"

or standard dev.
Calculate standard deviation from the deviations. Formula: "Root of the (sum of squares of all deviations in the normal direction of the nominals/number of points-1)".

or minimum value
Minimum value (minimum form deviation: Calculate E_{MIN}) from the deviations.

or maximum value
Maximum value (maximum form deviation: Calculate E_{MAX}) from the deviations.

or first point
The first valid deviation is used as offset.

ATTENTION!
Exception:
If **Masking nominals** is selected, the *first unmasked* valid deviation is used as offset. In this way, a *specific point number* can be selected as offset by masking.

Calculation with sectors

All points of a curve or omit masked points

The masking of nominals can be taken into consideration: The **Edit nominals** command (**NOM EDI**) allows you to mask or unmask nominals sector by sector. This masking is always taken into consideration for a best fit and optionally for an offset calculation.

If the **Omit masked points** data box is selected, then only deviations which are valid and not masked are included in the offset calculation. However, the calculated offset is subtracted from *all* the deviations, even the masked ones.

Calculation with curves

individual curves or all curves of a block

The offset can be calculated over several curves: The offset can be calculated either from deviations of one or of several curves. If a total offset is calculated from several curves, then the determined value is subtracted from *all* deviations of all curves.

Deviations

NOTE

After calculating the offset, the corrected deviations are stored. However, the measured points remain unaffected by this operation, so that a repeat calculation of the deviation can take place at any time (without taking the offset into consideration).

Calculating the pitch

After a pitch measurement, the deviations between nominal and measured data are calculated with the **PIT CAL** function.

Pitch

The term **pitch** is understood to mean a helical line (e.g. worm compressor), whereby the actual **pitch** is the lead per rotation about an angle of 360 degrees.

Difference between absolute and relative pitch measurement

absolute

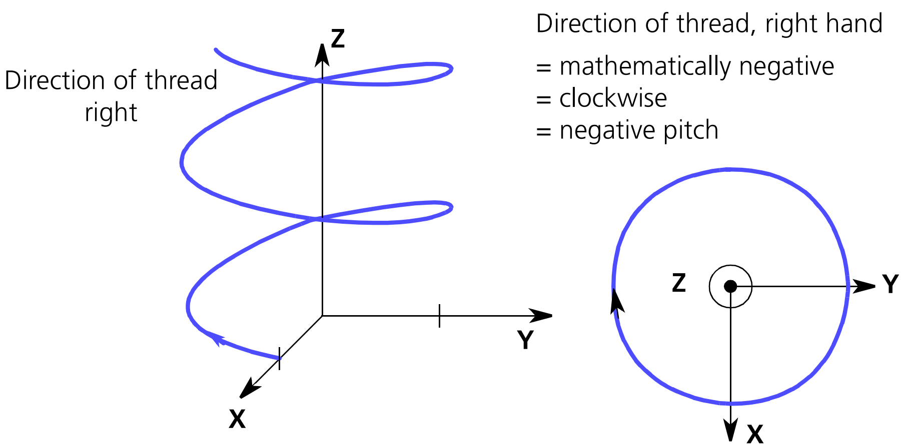
Nominals are used for the absolute pitch measurement.

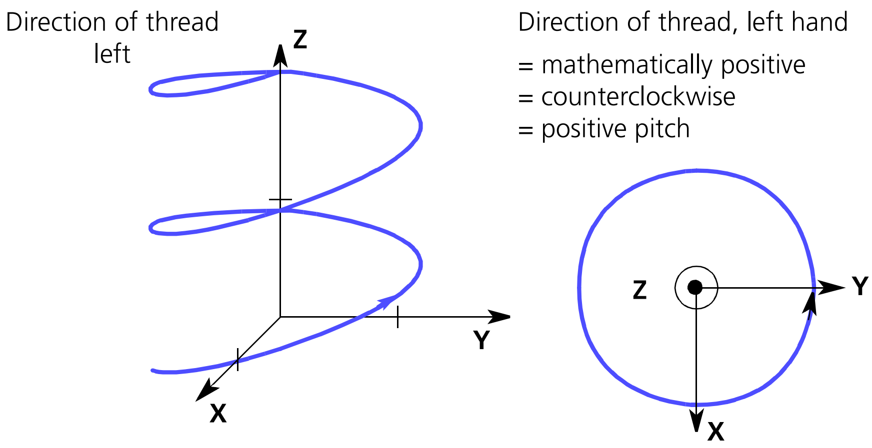
relative

For the relative pitch measurement, the nominals are calculated from the **measured data** and the **preset pitch** at the end of measurement.

ATTENTION!
Any existing nominal data will be *overwritten*. All subsequent data refers to the *first probing point*. In this case, the deviation at the first point always has the value zero.

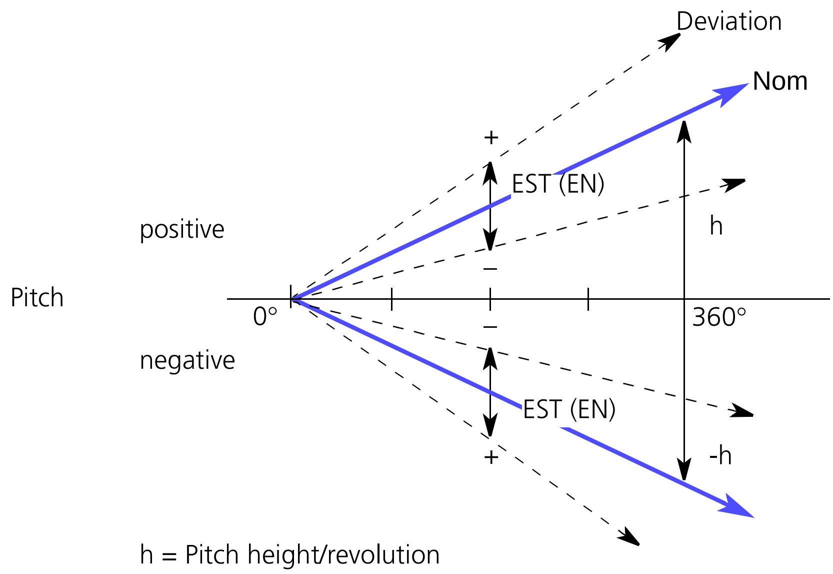
Direction of thread





Deviation

The deviation from the nominal pitch is measured axially, i.e. in the direction of the thread (spatial axis, axis of rotation). Errors in the measuring plane are not taken into account.



Printing

Special feature when printing deviations:

In the deviation list, the **nominal pitch** and the **pitch error** are automatically printed out in the header information if the **PIT CAL** command has previously been used for calculating the deviations. The deviations **EST** (EN) can be listed and/or output as a linear plot.

Plotting

Data output during plotting:

Nominal pitch, pitch error, E_{MIN}, E_{MAX}, as well as the **total deviation** are plotted as curve information if the relevant boxes have been filled in for the **PLT INI**, **FOR PLO** and **ASG PLO** commands.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

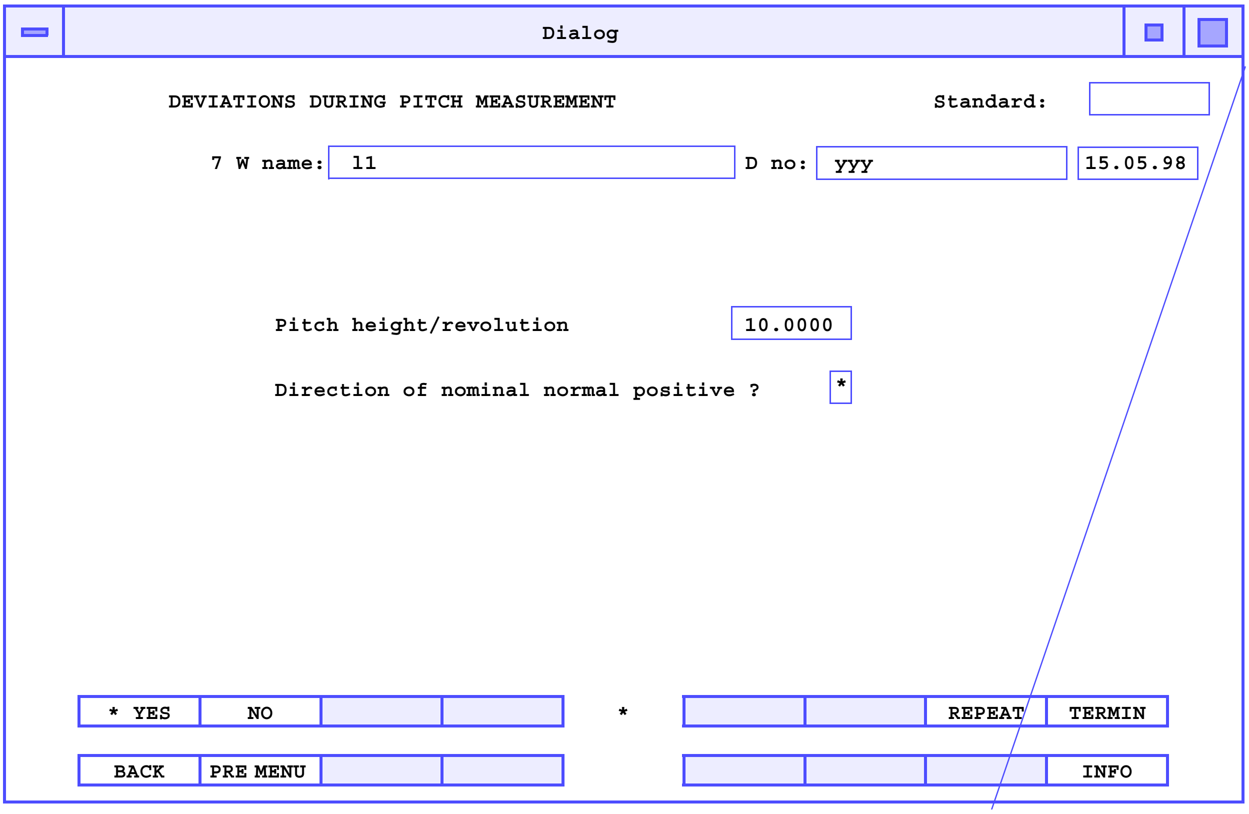
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **PIT**
  Action: **CAL**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **DEVIATIONS DURING PITCH MEASUREMENT** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Pitch height/ Revolution

Specify the nominal pitch.

The preceding sign of the nominal pitch is dependent on the direction of rotation of the curve:

If the nominal pitch has a positive value, then the pitch is left-handed (left-hand thread). In the case of a negative nominal pitch, the pitch is right-handed (right-hand thread).

Direction of nominal pitch positive

<Yes>
The normal vector of the nominals points in the direction of the spatial axis of the pitch

<No>
The normal vector of the nominals points in the opposite direction to that of the spatial axis

NOTE

The preceding sign of the deviations is dependent on the direction of the nominal normals (error in normal direction).

Calculating the distance

The result of the **Calculate distance** function (**DIS CAL**) is the distance between *two parallel nominal curves* and the corresponding deviations. Linking is performed via the point number. The points must be in *different* curves.

You can calculate the distance for outer contours, inner contours or steps.

Prerequisite

Deviations must already have been calculated. The *number of nominal points* must be the *same* for both curves.

ATTENTION!
The distance calculation *overwrites* the results of the deviation calculation or best fit. The distance calculation may only be used *once*.
A new distance calculation can only be performed if a deviation calculation or best fit has been carried out beforehand. If this is not observed, then incorrect results will occur.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

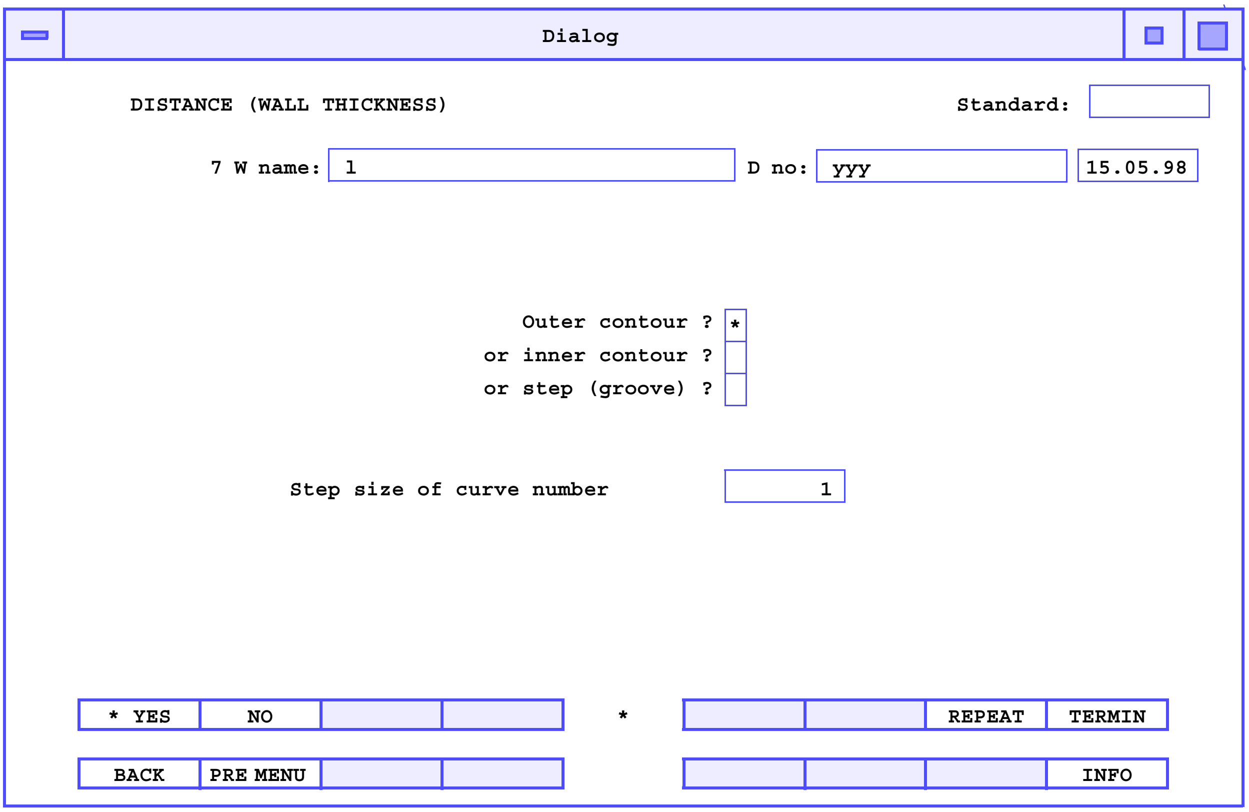
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **DIS**
  Action: **CAL**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **DISTANCE (WALL THICKNESS)** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

The following **abbreviations** are used in the subsequent figures:

D_{act} Distance between two parallel actual curves.

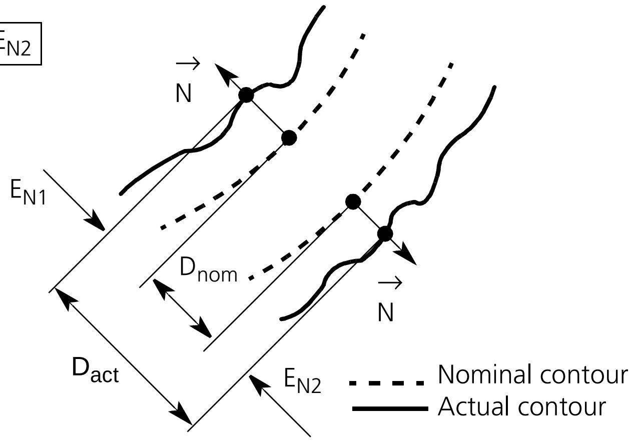
D_{nom} Distance between two parallel nominal curves.

E_{N1} Deviations of curve 1 in the normal direction of the nominal data.

E_{N2} Deviations of curve 2 in the normal direction of the nominal data.

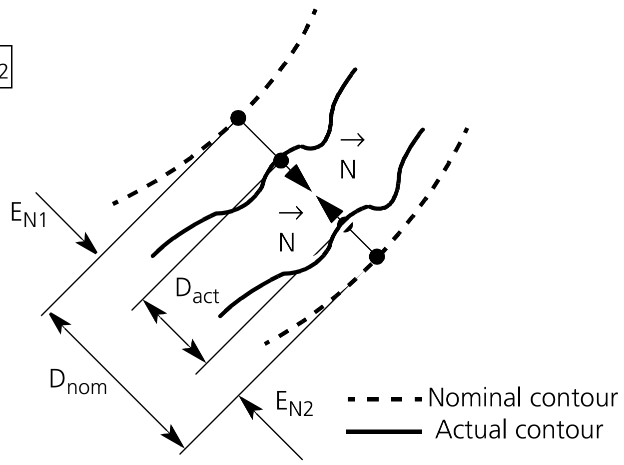
Outer contour

$$\boxed{D_{act} = D_{nom} + E_{N1} + E_{N2}}$$

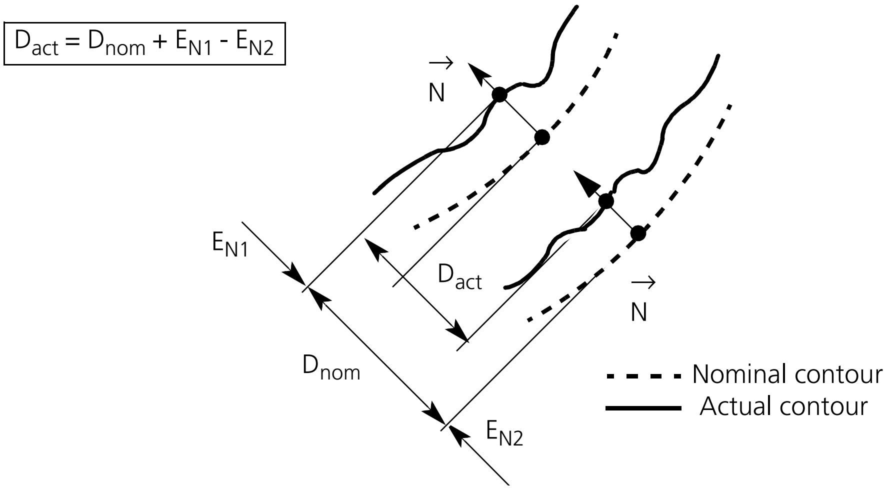


Inner contour

$$\boxed{D_{act} = D_{nom} - E_{N1} - E_{N2}}$$



Step (groove)



$D_{act} = D_{nom} + E_{N1} - E_{N2}$
$\vec{N}$
E_{N1}
D_{act}
$\vec{N}$
D_{nom}
E_{N2}
Nominal contour
Actual contour

Best fit of measured values

This dialog window is almost identical to that described in ➤*"Deviations - Main menu" on page 7-16* for the main menu of the deviation calculation. The two additional data boxes are required for controlling the best fit over several curves.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

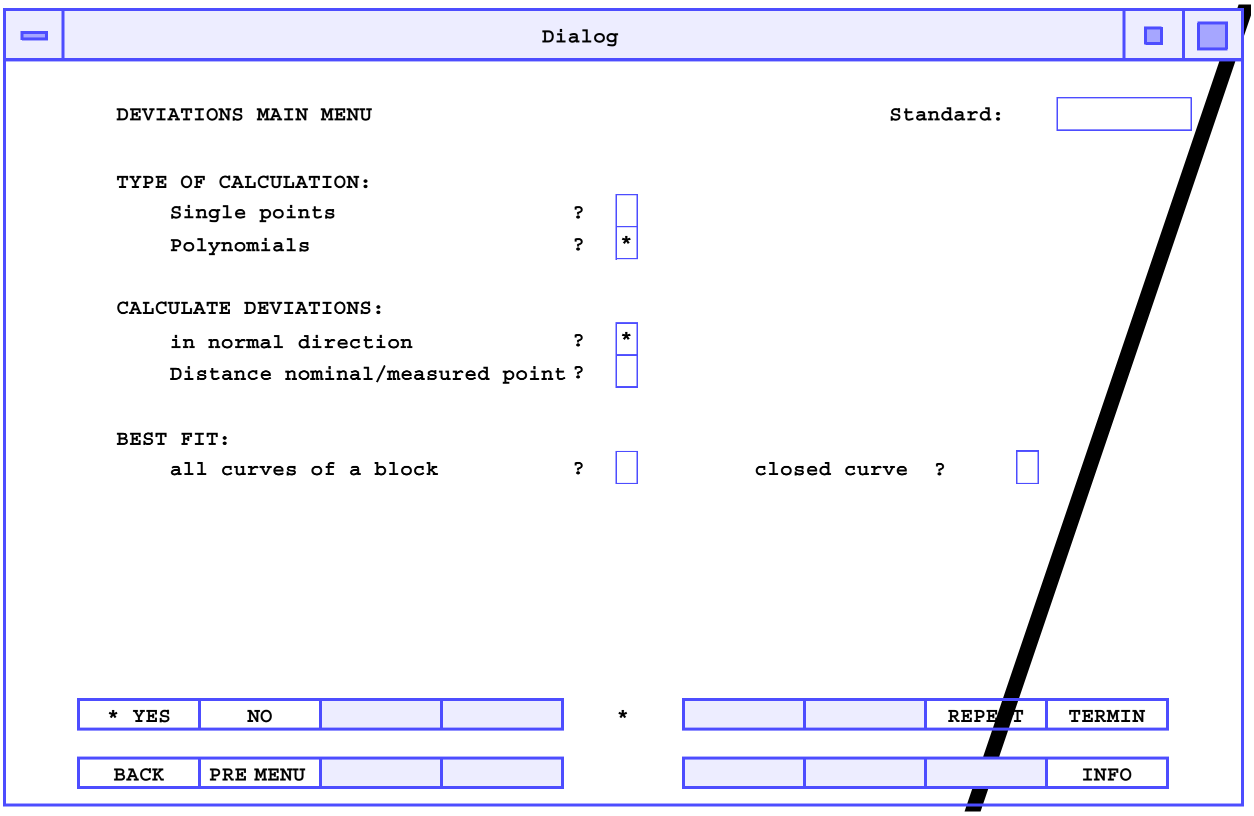
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **MVA**
  Action: **BFT**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **DEVIATIONS MAIN MENU** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

TYPE OF CALCULATION: Single points

Point by point assignment of nominal and measured points. For this type of calculation the *same number* of nominal values and measured values (homogeneous number of points) must be available. The Filter measured values function **MVA FIL** calculates a homogeneous number of points from nominal and measured data, i.e. both curves (nominal and measured curve) subsequently have the same number of points ➤*"Filtering measured values" on page 7-59*.

TYPE OF CALCULATION: Polynomials

For every nominal, the piercing point of the measured curve through the normal plane of the nominal point is calculated. The spatial axis of a normal plane is the tangent. Polynomials of the nth degree are used for this procedure.

For this type of calculation the **tangents of the nominal points** must be available (see nominal conversion).

If a considerable number of points on a curve are masked–as is the case when fitting the inlet and outlet edge of turbine blades–best fit according to polynomials may not give the best result.

For this reason, the point to point fit must be used. However, a homogeneous set of points is required for this, i.e. the same number of nominal and measured points.

A homogeneous set of points can be created as follows:

– Scanning according to nominals with point recording on the nominal point – or
– after the measurement, calculate the deviation, calculate the actual values and correct the measured values. If points are deleted when correcting the measured values, then a homogeneous set of points is no longer available – *or*
– after the measurement, convert and filter measured values. The measured data filter changes the measured curve by deleting or extrapolating measured points.

Option "**A**" is the most accurate from a metrological point of view.

CALCULATE DEVIATIONS in normal direction

The deviations are calculated in the **normal direction** of the nominal points

CALCULATE DEVIATIONS Distance nominal/ measured point

With this type of calculation, no probe sphere radius correction is carried out. *If probe sphere center point coordinates exist: first convert measured values; the necessary correction is then made. Application of this function: e.g. deviation calculation of contour lines.* **Deviation calculation** ➤*"(Standard) deviation calculation" on page 7-18*.

BEST FIT

Use the data boxes to define the criteria for the 2D best fit.

BEST FIT: all curves of a block

<YES>
For the 2D best fit, all curves are combined, which are specified in the main menu in the boxes **from curve** and **to curve**. The curves are made temporarily into one curve, fitted, and the common fit result stored in the curve-specific data for each individual curve. Once this window is concluded with **<TERMIN>**, the follow-on window **2D BEST FIT** is displayed, ➤*"Best fit of measured values" on page 7-47*.

BEST FIT: Closed curve

You can select open or closed curves. This information is decisive for the calculation of the line center of gravity of the linked nominal and measured curves.

Best fit of measured values

During the 2D best fit, **form deviations** and **position deviations** are separated from one another. As best fit result, the position deviation is stored as displacement (translation) and/or as rotation of the measured curve (rotation).

All types of best fit are possible, including best fit according to the center of gravity of the nominal data, i.e. the position deviation can be related to a selectable point, this being

– the nominal curve center of gravity determined during the nominal value conversion

– the workpiece zero point

– or any coordinate point.

NOTE

The curves to be fitted must all lie in the same measuring plane.
The catalog data of the curves remains unchanged.
The curves can have any direction of travel.
A nominal value conversion must be performed for the individual curves.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
Object: **MVA**
Action: **BFT**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **DEVIATIONS MAIN MENU** is displayed.

– Enter the desired data.

YES

– Acknowledge one or both data boxes **BEST FIT all curves of a block or Closed curve** with the **<YES>** softkey.

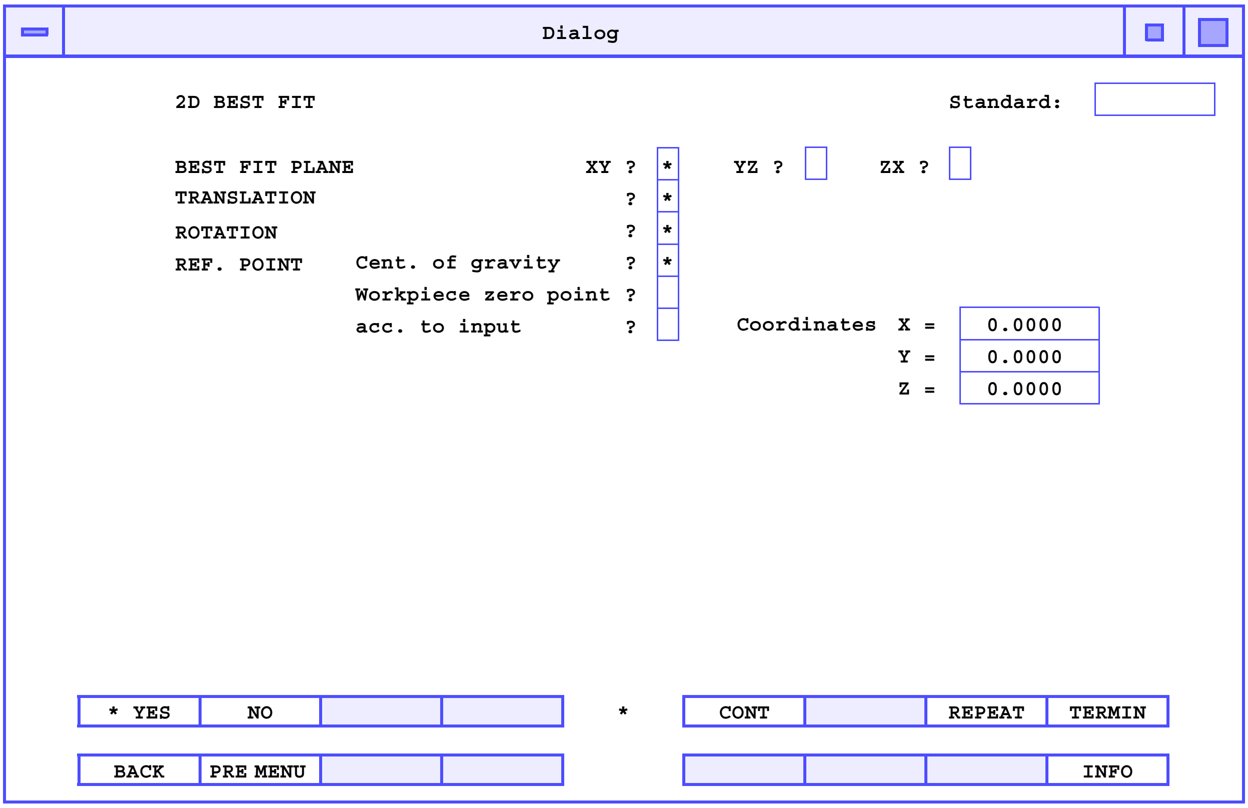
TERMIN

– Press **<TERMIN>**.
The dialog window with the menu title **2D BEST FIT** is displayed.

– Enter the desired data.

CONT

– Press **<CONT>**.
The dialog window with the menu title **MODE: 2D Best Fit** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
CONT
REPEAT
BACK

See general softkey functions, ➤*“General softkey functions” on page 1-10*.

Notes on the input and display boxes

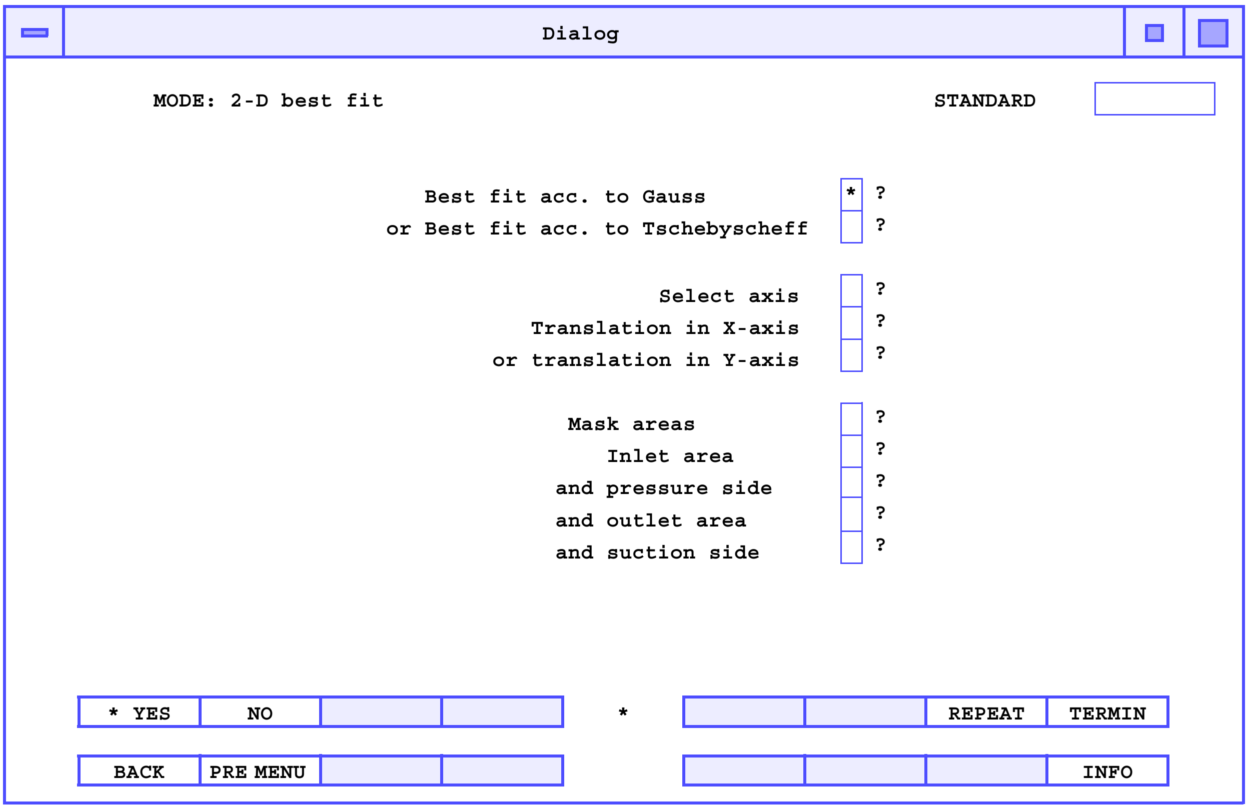
BEST FIT PLANE XY/YZ/ZX
Definition of the best fit plane by acknowledging the desired data box.

TRANSLATION
If confirmed with **<YES>** a transl. 2D best fit is made, description ➤ *“Translational best fit” on page 7-52*.

ROTATION
If confirmed with **<YES>** a rotational 2D best fit is made. The rotational best fit can also be combined with translation, description ➤ *“Translational and rotational best fit” on page 7-54*.

REF. POINT Cent. of gravity/ Workpiece zero point/ acc. to input
By confirming one of the three boxes with **<YES>** the reference point is specified for the 2D best fit.

Coordinates X/Y/Z
If as reference point for the 2D best fit the box **acc. to input** is confirmed with **<YES>**, the desired coordinates for the reference point of the rotational best fit must be entered in these three boxes.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Best fit acc. to Gauss

If confirmed with **<YES>** a fit is made using the method **Best Fit acc. to Gauss**.

Best fit acc. to Tschebyscheff

If confirmed with **<YES>** a fit is made using the **Tschebyscheff** method. The Tschebyscheff best fit requires a homogenous set of points. If this is not available, it can be created with Filter measured values **<MVA FIL>** ➤*"Filtering measured values" on page 7-59*.

Select axis

If acknowledged with **<YES>**, the translation axis can be defined with one of the two data boxes.

Translation in the X axis

If acknowledged with **<YES>**, a translation is made about the X axis.

Translation in the Y axis

If acknowledged with **<YES>**, a translation is made about the Y axis.

Mask areas

If acknowledged with **<YES>**, the areas can be selected with the following four data boxes.

Inlet area/ Pressure side/ Outlet area/ Suction side

The area is selected by acknowledging with **<YES>**.

Checking the best fit results

Two methods

For the 2D best fit in KUM, you can select between two calculation methods.

– Best fit acc. to Gauss

– Tschebyscheff

Best fit acc. to Gauss

With the 2D best fit in KUM the method **Best fit acc. to Gauss** is used; this minimizes the sum of the errors squared. This method is very reliable. It also works with large translations as well as with large angles of rotation, and provides practice-oriented results. The option of the reduced best fit (masking nominals) means that the best fit can be directly influenced.

Preparation

– Nominals are available and are converted with **NOM CON**

– Measured data and best fit data are available

– Deviations are listed and plotted (**DEV LIS** or **DEV PLO**)

Procedure

In order to check the best fit, the measured data is transformed using the best fit data and a deviation calculation is executed. These deviations must coincide with the deviations calculated in the best fit (see preparation). If this is the case, then the best fit results were correct.

– Transform measured values with **MVA TRA** (only translation with changed preceding sign!).

– Transform measured values with **MVA TRA** (only rotation with changed preceding sign!).

– Calculate deviations with **DEV CAL**.

– List deviations with **DEV LIS** or with **DEV PLO**.

– Comparison of the deviations with the values which were calculated during the best fit.

In this case, the measured values must be transformed in two steps, because this is a mixed transformation which must be executed in the reverse order. Mixed transformations are normally executed in the sequence **Rotation-Scaling-Translation**.

However, in our example the sequence **Translation-Rotation** must be kept to. This sequence must also be kept to if a workpiece is to be aligned manually.

Error

The best fit is ended automatically if the fit values change by less than the amount **1. E-9 mm or angular units (rad).**

If no deviation can be calculated (deviation too small or too large), the following error message is output:
H Sum EN2 = *****

Tschebyscheff

The degrees of freedom of the translation can be restricted by locking *one axis*.

Individual areas of nominal data can also be *automatically masked* for a reduced best fit. However, the nominal data originally stored is retained.

For the Tschebyscheff best fit, *homogeneous sets of points*–i.e. the same number of nominals and measured points–are fitted. The **Single points** calculation method is recommended.

Homogeneous sets of points can be created using the Filter measured values function **MVA FIL**, ➤*"Filtering measured values" on page 7-59*.

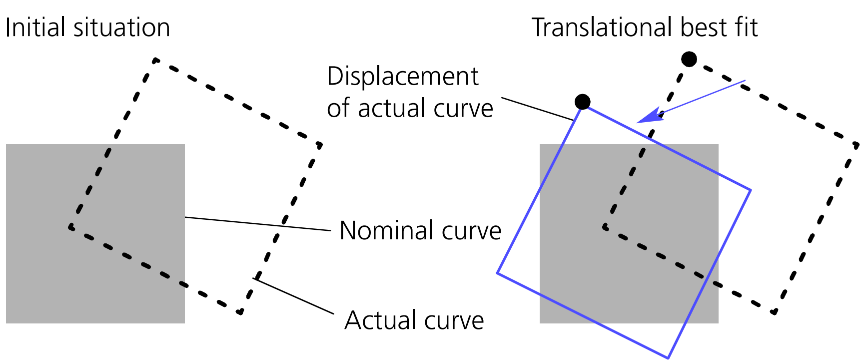
Translational best fit

Definition

If in the dialog window of the 2D best fit (➤*"Best fit of measured values" on page 7-47*) the Translation box has been confirmed with **<YES>**, a translational best fit is made. In the corresponding diagrams, the nominal curves are underlaid as a surface, and the measured actual curves (initial data) are shown as a dotted line. The square outlined with a solid line shows the positioning of the actual curve according to the relevant best fit method.

Translational best fit

The translational best fit causes the transformation of the measured values in the axes of the measuring plane. The actual curve is moved until the sum of the deviations squared has reached a minimum (method: Best fit according to Gauss). The **displacement** of the reference points relating to the actual and nominal curve is given as the result of this best fit.



Rotational best fit

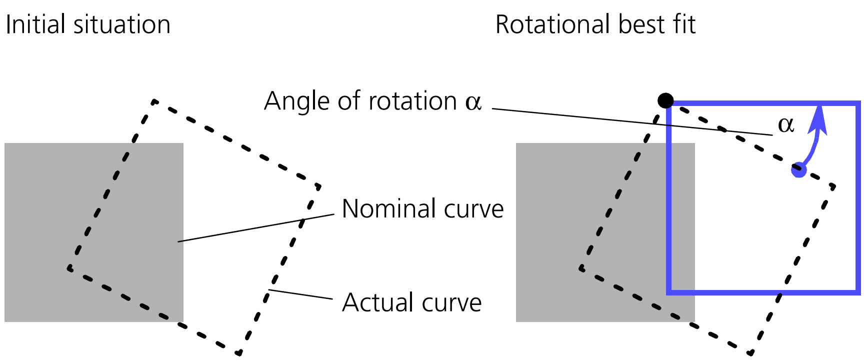
Definition

If in the dialog window of the 2D best fit (➤*"Best fit of measured values" on page 7-47*) the Rotationn box has been confirmed with **<YES>**, a rotational best fit is made. In the corresponding diagrams, the nominal curves are underlaid as a surface, and the measured actual curves (initial data) are shown as a dotted line. The square outlined with a solid line shows the positioning of the actual curve according to the relevant best fit method.

Rotational best fit

The rotational best fit causes a rotation of the actual curve about the reference point.

The actual curve is rotated until the sum of the square of the deviations has reached a minimum. The **rotation angle** about which the actual curve has been rotated is output as the result (a rotation in the clockwise direction results in a negative angle value).
In the example shown below, a positive rotation angle results.



Translational and rotational best fit

Definition

If in the dialog window of the 2D best fit (➤*"Best fit of measured values" on page 7-47*) the two boxes for translational and rotational best fit have been confirmed with **<YES>**, the best fit of the actual curve is executed step by step as follows:

In the corresponding diagrams, the nominal curves are underlaid as a surface, and the measured actual curves (initial data) are shown as a dotted line. The square outlined with a solid line shows the positioning of the actual curve according to the relevant best fit method.

1st step

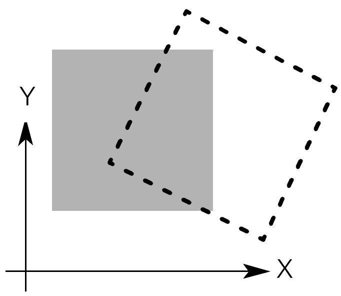
Translational alignment

In contrast to a purely translational best fit, with the combined best fit only the reference point of the actual curve is moved first of all, so that it lies exactly above the reference point of the nominal curve.

2nd step

Rotational best fit

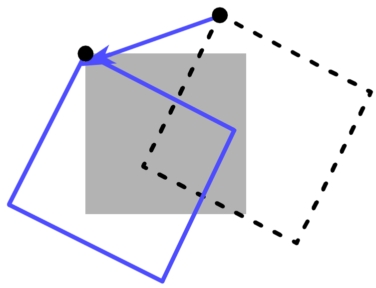
After the translational alignment, the actual curve is rotated until the sum of the square of the deviations is minimized. The actual curve is then fitted optimally to the nominal curve.



Initial situation

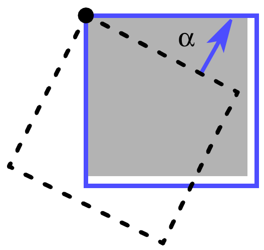
Gray:
Nominal curve

Dotted:
Actual curve



Translational alignment

First only the two reference points of the nominal and actual curve are brought into coincidence.



Rotational best fit

After the translational alignment the actual curve is rotated until it almost covers the nominal curve.

Example

The following explains how best fit results are to be interpreted, depending on the parameters set.

NOM TRA, MVA TRA

The following formula applies for coordinate transformation in the cartesian coordinate system, which includes a rotation and translation.

TRANS	Transformed coordinates
CCO	Start coordinates
R	Rotation matrix
T	Translation matrix
	TRANS = CCO * R + T

MVA BFT

During the best fit, the calculation steps are applied in reverse order to the measurement coordinates, as a previous coordinate transformation or workpiece position displacement is to be canceled. Simplified, this means: first translation with changed preceding sign, then inverse rotation.

ACT	Actual coordinates
NOM	Nominal coordinates
IR	Inverse rotation matrix
T	Translation matrix
	NOM = (ACT - T) * IR

Reference points

Of particular interest is the interpretation of the best fit results depending on the reference points which the user can enter:

– acc. to center of gravity,

– workpiece zero point,

– as input.

Rotation only

The rotation angle between nominal and actual center of gravity is dependent on the reference point selected.

Translation only

The translation is the distance between the nominal and actual center of gravity. This distance is independent of the reference point selected.

The reference point *according to center of gravity* is recommended.

Rotation and translation

The translation is the distance between the nominal and actual center of gravity before rotation of the actual data. The rotation is the angle between the two centers of gravity – after the translation of the actual data – referring to the workpiece zero point.

The reference point *according to center of gravity* is recommended.

The start conditions of the best fit are mainly influenced by the selection of a reference point, as the nominal and actual data are temporarily moved from the fit about the reference values.

Copying KUM best fit data to UMESS

Transfer

With the command **RES COP**, best fit results, which have been calculated with **Best fit measured results**, can be transferred to UMESS. If they exist, the relevant tolerances can also be copied.

2D FIT result

In UMESS a **2D FIT** result is produced, which enables the following coordinate transformations:

– **Rotate plane**: The coordinate system can be rotated about the best fit angle

– **Offset zero point**: The coordinate system can be shifted in 2 axes.

Statistical evaluation

A **statistical evaluation** is also possible.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
Object: **RES**
Action: **COP**

DEFINE

– Press **<DEFINE>**.
No further dialog window is necessary for this command, as no other parameters are required.

NOTE

In the **Learn programming** operating mode, control data is only generated for tolerances if the relevant command block (with **RES COP**) is executed.
Simply pressing **<CMD PROG>** is not sufficient in this case!

Best fit transformation of measured values

The position error of the measuring curve is eliminated as a result of the best fit transformation.

The measured data is transformed using the stored best fit results of the best fit last executed (best fit transformation).

Example

Curve number 3 is fitted - the best fit results are stored automatically. With these best fit results, curves number 1 and 2 can then be transformed.

Type of best fit

The best fit results contain the translational and/or rotational position error of the curve based on the type of best fit selected during the best fit. This is taken into consideration during the best fit transformation.

The type of best fit transformation can therefore be selected by the type of best fit.

Error message

If no best fit has been executed in KUM prior to calling up the best fit transformation, the following error message is displayed: **No best fit data available**.

Reproducibility

If best fit data is available, then the best fit transformation can be executed as often as desired with any number of curves.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **MVA**
  Action: **ETR**

DEFINE

– Press **<DEFINE>**.
  No further dialog window is necessary for this command, as no other parameters are required.

Filtering measured values

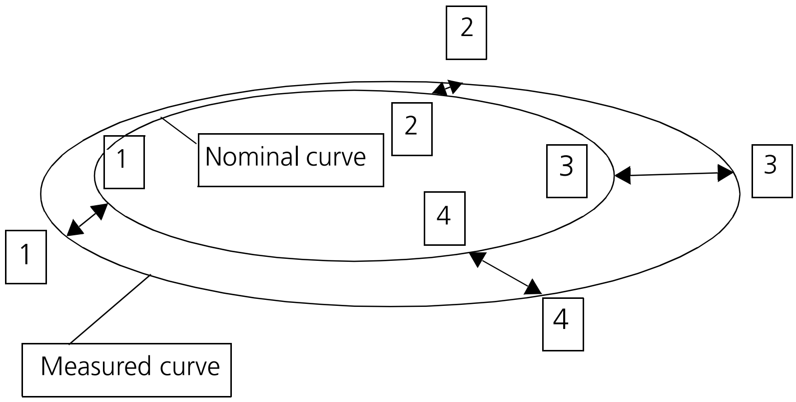
The Filter measured values function **MVA FIL** calculates a homogeneous set of points from nominal and measured data, i.e. both curves (nominal and measured curve) subsequently have the same number of points.

Application area

The **Tschebyscheff best fit** requires a homogeneous set of points.

With a homogeneous set of points, the Gauss or Tschebyscheff best fit can be executed with the **single point method**. This method also gives a result if the method with polynomials can *no longer* be used, because the nominal and measured curves *lie too far apart* or because the *dimensions* of the measuring curve are *too small*.

Filter measured values



The above diagram shows two ellipses of different sizes, the smaller of which represents a nominal curve and the larger a measured curve. A probe sphere radius correction has already been performed for the measured curve and the **Filter measured values** function subsequently called up.

The measuring filter gives a homogeneous set of points, i.e. the number of nominal and measured points are the same. The length of the measured curve remains unchanged.

Four exemplary points are marked on each of the two ellipses. The connecting line between a point on the nominal and measured curve respectively shows the point assignment according to the consecutive point number.

Example

In a point to point assignment, the second point of the nominal curve is assigned to the second point of the measuring curve.

Reducing measured points

An undesirably large number of measured points can be reduced if required.

Filter accuracy

The method uses a **polynomial of the 3rd degree**. The measured curve is smoothed as a result. The more measured points are available, the less the degree of smoothing. If there is a *small number of measured points*, the filtered measured curve becomes relatively *inaccurate*–e.g. in the case of a very accentuated curve with 5 nominal points and 6 measured points.

There should therefore be a *sufficient number of measured points* available if the filter is to be used. This is guaranteed if one of the scanning methods available is used during measurement.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **MVA**
  Action: **FIL**

DEFINE

– Press **<DEFINE>**.
  A new window follows, with the selection option **FILTER CURVE POINTS**.

Transforming nominal and measured values

With this function you can specify which coordinates or normals are to be transformed.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

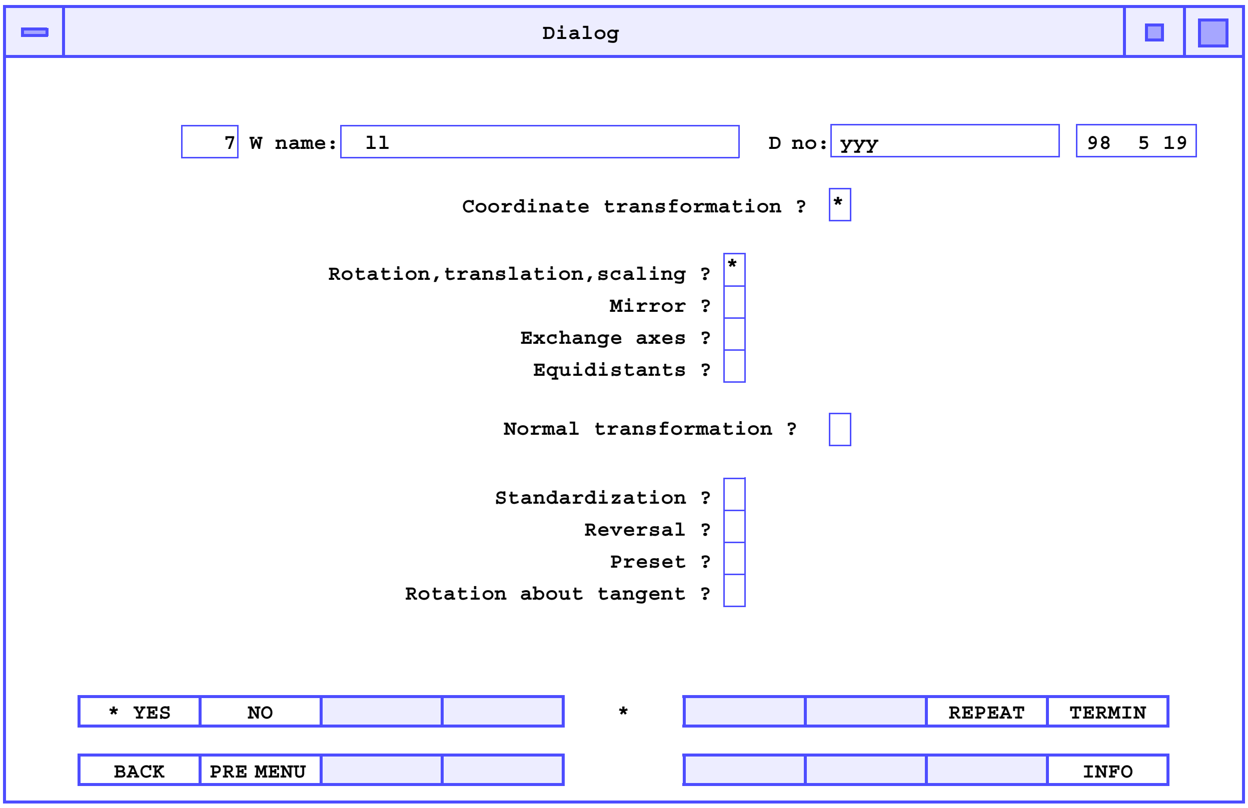
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM**, Action: **TRA**
  or
  Object: **MVA**, Action: **TRA**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **TRANSFORMATION - manual** is displayed.



Softkey functions

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*“General softkey functions” on page 1-10*.

TERMIN

The relevant page is jumped to, depending on the previously confirmed data box. Only for **Standardization** and **Reversal** is the **Command input** page subsequently called up.

Notes on the input and display boxes

Coordinate transformation

If this box is answered with **<YES>**, one of the following four coordinate transformations can be specified. If the box is answered with **<NO>**, the Normal transformation box is jumped to, see below.

Rotation, translation, scaling

Rotation, shifting and scaling data, ➤*“Coordinate rotation, translation and scaling” on page 7-63*.

Mirroring

Mirroring data in different planes, ➤*“Mirroring the planes” on page 7-66*.

Exchange axes

When the axes are exchanged, the workpiece is rotated into the new coordinate system, ➤*“Exchanging axes” on page 7-69*.

Equidistants

Addition and subtraction of equidistants entered, ➤*“Changing equidistants” on page 7-72*.

Normal transformation

If this box is answered with **<YES>**, one of the following four normal transformations can be preselected. if answered with **<NO>**, the Coordinate transformation box is jumped to, see above.

Standardization

Calculation of the unit vector, ➤*“Calculation of the unit vector (normal standardization)” on page 7-80*.

Reversal

Reversal of the normals, ➤*“Reversing the normals” on page 7-81*.

Preset

All nominal or measured points of a curve are given the specified normal, ➤*“Specifying the normal direction” on page 7-76*.

Rotation about tangent

All normal vectors are rotated about the rotation angle entered, ➤*“Rotation of the normal about the tangent” on page 7-78*.

Coordinate rotation, translation and scaling

This program is used for rotating, shifting and scaling data.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
Object: **NOM**
Action: **TRA**
or
Object: **MVA**
Action: **TRA**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **TRANSFORMATION** is displayed.

YES

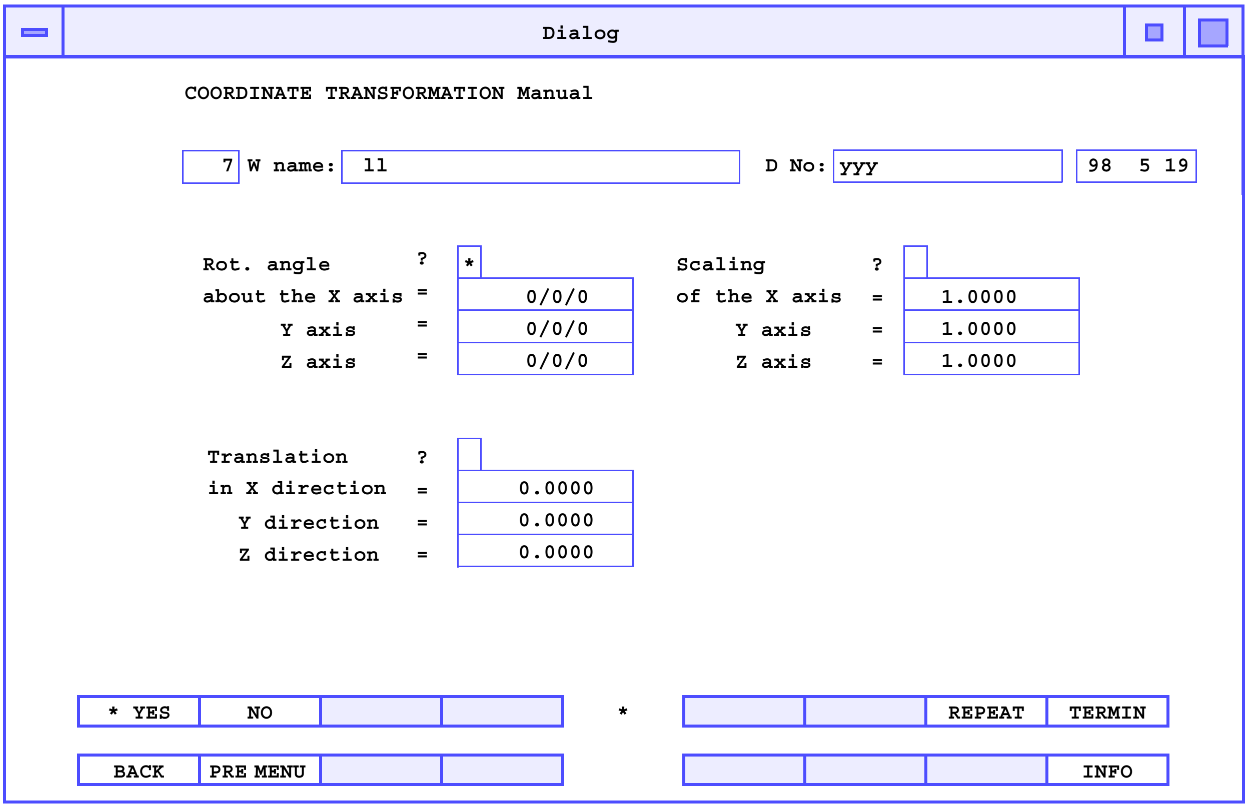
– Acknowledge the **Coordinate transformation** data box with **<YES>**.

YES

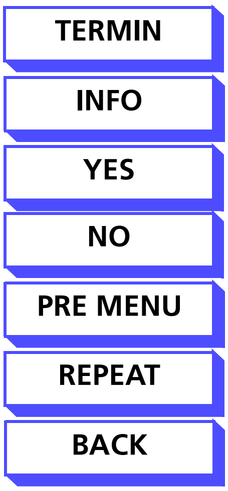
– Acknowledge the **Rotation, translation, scaling** data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
The dialog window with the menu title **COORDINATE TRANSFORMATION - Manual** is displayed.



Softkey functions



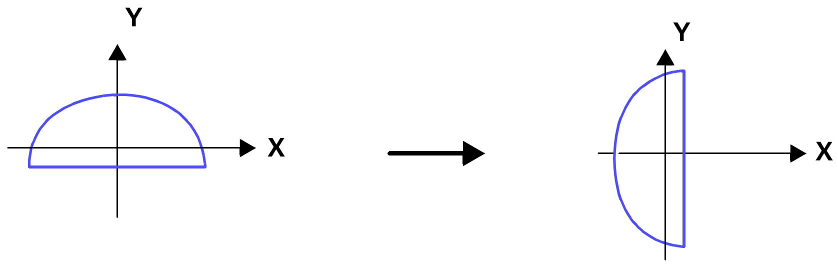
See general softkey functions, ➤ *"General softkey functions" on page 1-10.*

Notes on the input and display boxes

Rot. angle

If this box is confirmed with **<YES>**, the applicable rotation angle for the three axes can then be entered.

If a positive value is entered, the curve is rotated mathematically positively (counterclockwise) about the selected axes. The angle data can be entered in degrees, minutes, seconds or in decimals. If it is entered in decimals, the angle is automatically converted into degrees, minutes, seconds. The rotation takes place in the sequence: X axis, Y axis, Z axis.



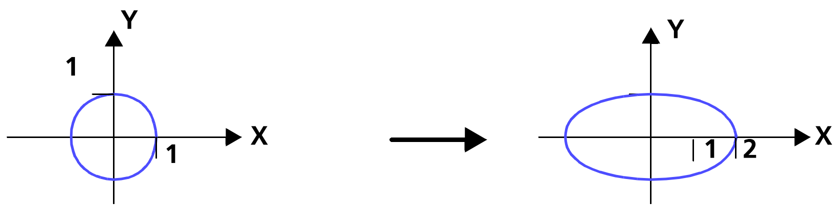
Original curve

Curve after rotation
about the Z-axis by 90°

Scaling

If this box is confirmed with **<YES>**, the applicable scaling factor for the three axes can then be entered.

The scaling allows the curves to be stretched or compressed in all three axes. The factor, which is specified without unit of measurement, can be greater or smaller than 1. With values more than 1, the curve is stretched, and with values less than 1 it is compressed.



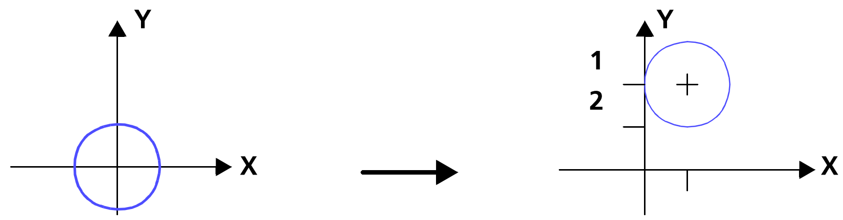
Original curve

Curve after scaling
in X axis by factor 2.0

Translation

If this box is confirmed with **<YES>**, the applicable translation values for the three axes can then be entered.

The selected curve can be displaced in any direction by the translation. The desired translation value must be entered in mm; with a combined data transformation, this takes place in the sequence: Rotation–scaling–translation.



Original curve

Curve after the translation
in X = 1, Y = 2, Z = 0

Mirroring the planes

This program enables the mirroring of coordinates, normals and tangents in different planes. The coordinates of the spatial axis are multiplied by minus 1. A nominal value conversion is then required.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM**
  Action: **TRA**
  or
  Object: **MVA**
  Action: **TRA**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **TRANSFORMATION** is displayed.

YES

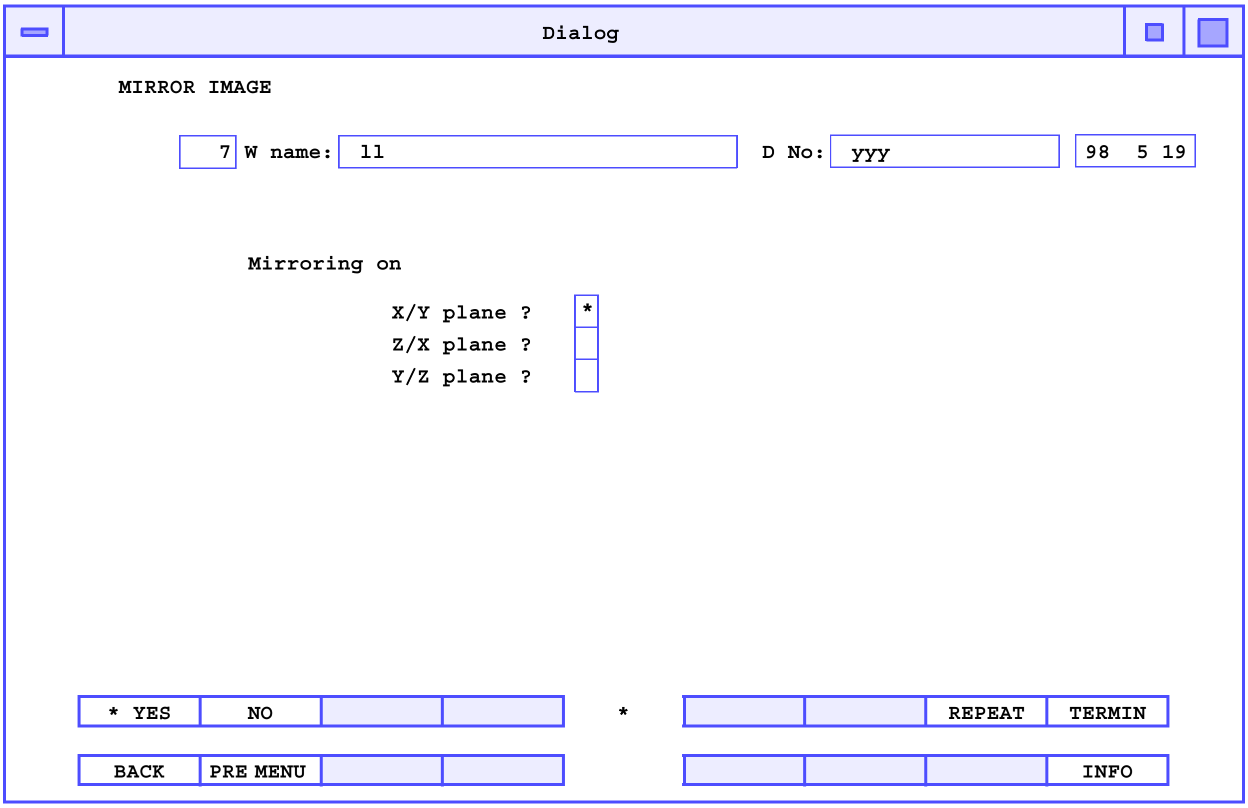
– Acknowledge the Coordinate transformation data box with **<YES>**.

YES

– Acknowledge the Mirror data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **MIRROR IMAGE** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

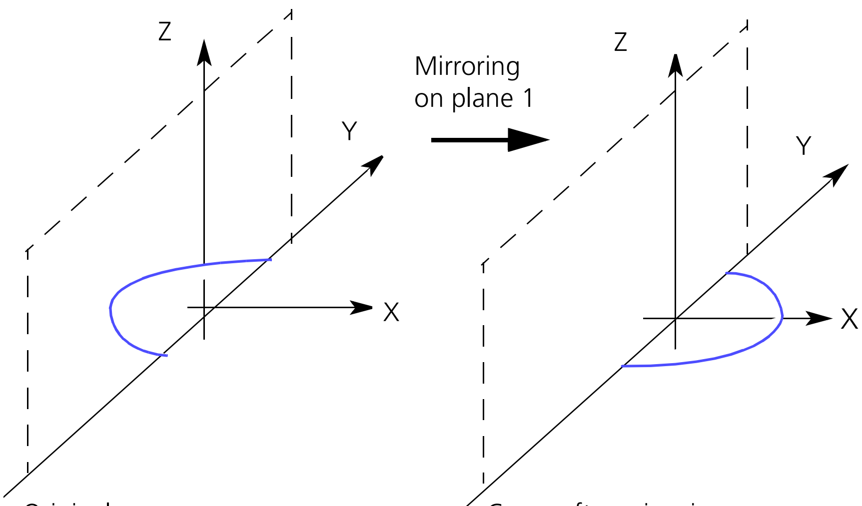
See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Mirroring on X/Y plane, Z/X plane, Y/Z plane

The required plane for the mirroring must be specified here. The following assignment applies:

- YZ plane = plane 1 or spatial axis X
- ZX plane = plane 2 or spatial axis Y
- XY plane = plane 3 or spatial axis Z



Original curve

Curve after mirroring
on the YZ plane (= plane 1)
or spatial axis X

Reverse direction

NOTE

The direction of travel in the curve is changed by the mirroring! If necessary, the direction of travel must be reversed with **NOM REV** or **MVA REV**. To clarify this, the following example shows how a complete circle can be produced from a semi-circle:

– Copy original curve (semi-circle).
– Mirror copied curve about the required axis.
– Change the direction of travel in the mirrored curve.
– Link both curves together.
– Convert nominals if necessary.

Exchanging axes

When the axes are exchanged, the workpiece is rotated into the new coordinate system and the components X, Y, Z refer to the initial system. The table on the next page shows the axis exchange options and the assignment of the code numbers.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
Object: **NOM**
Action: **TRA**
or
Object: **MVA**
Action: **TRA**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **TRANSFORMATION Manual** is displayed.

YES

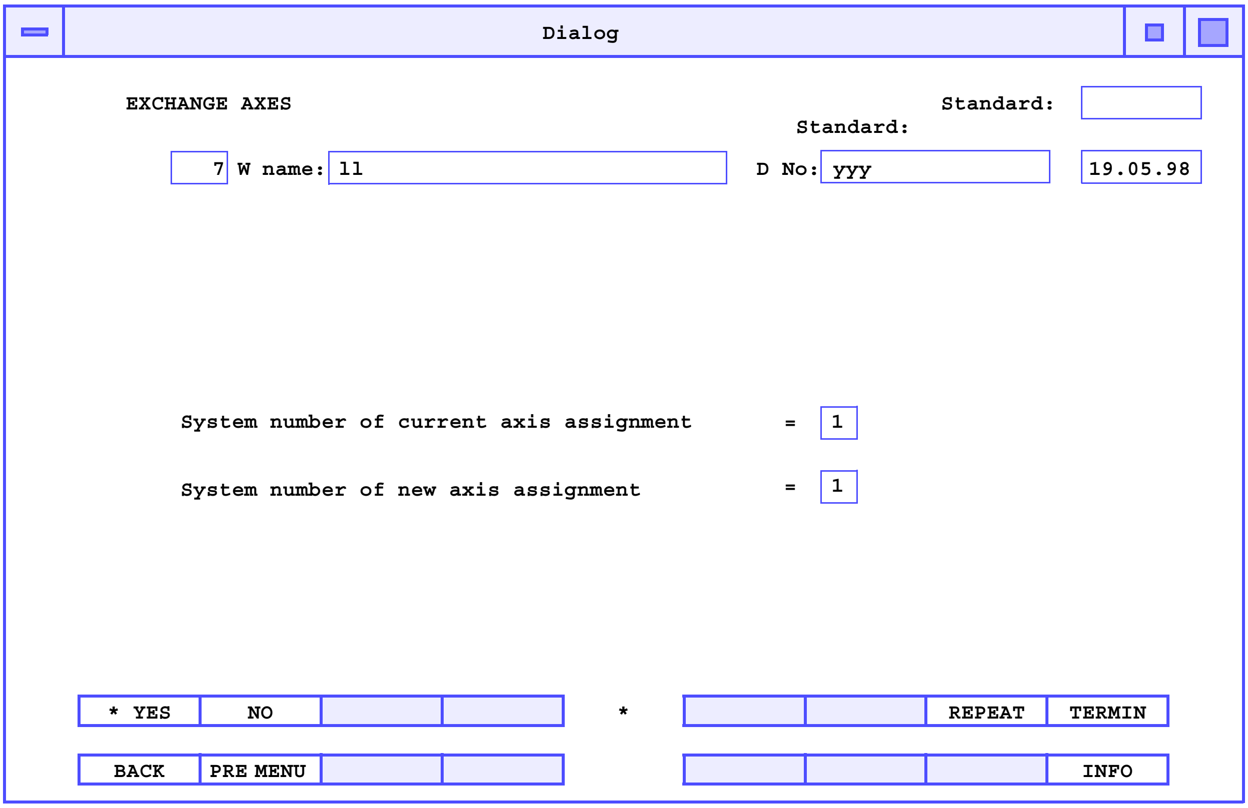
– Acknowledge the **Coordinate transformation** data box with <YES>.

YES

– Acknowledge the Exchange axes data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
The dialog window with the menu title **EXCHANGE AXES** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

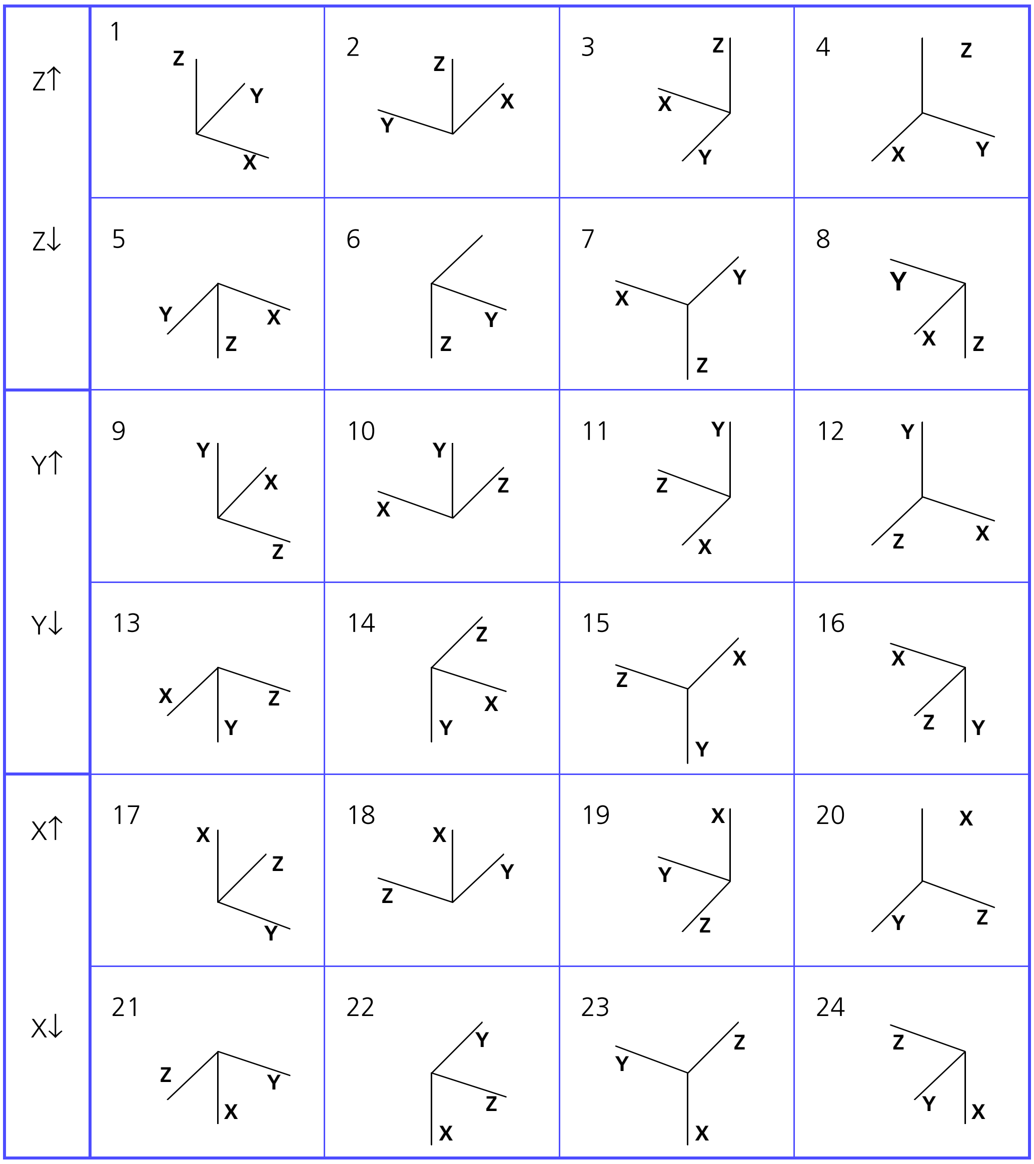
System number of current axis assignment

Code number of current axis assignment.

System number of new axis assignment

Code number of new axis assignment (see overview on next page).

Options for axial assignment



Example of an axial exchange

Initial coordinate system (no. 1)		New coordinate system (no. 13)	
Coordinates	**Axes**	**Coordinates**	**Axes**
X	1	+Z	- 2
Y	2	- X	- 3
Z	3	- Y	1

Changing equidistants

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM**, Action: **TRA**
  or
  Object: **MVA**, Action: **TRA**

DEFINE

– Press **<DEFINE>**.
  TRANSFORMATION Manual is displayed.

YES

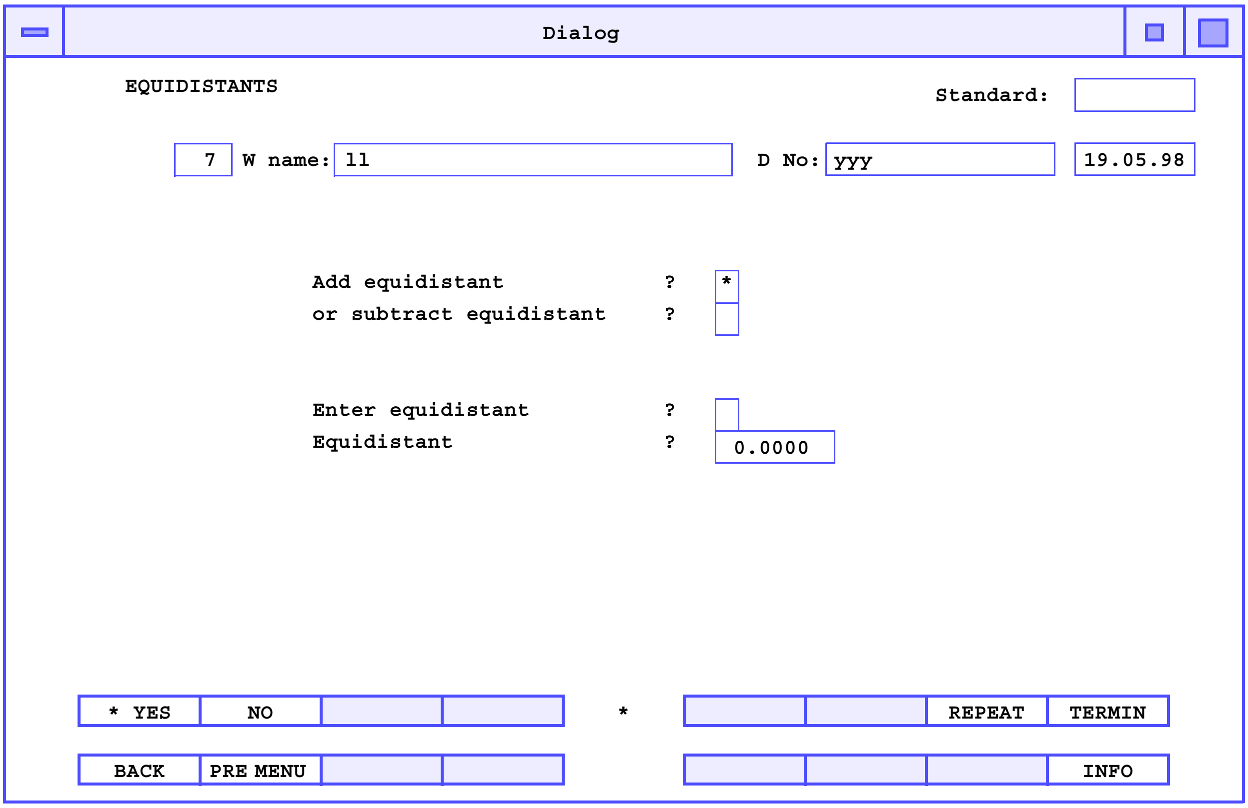
– Acknowledge the **Coordinate transformation** data box with **<YES>**.

YES

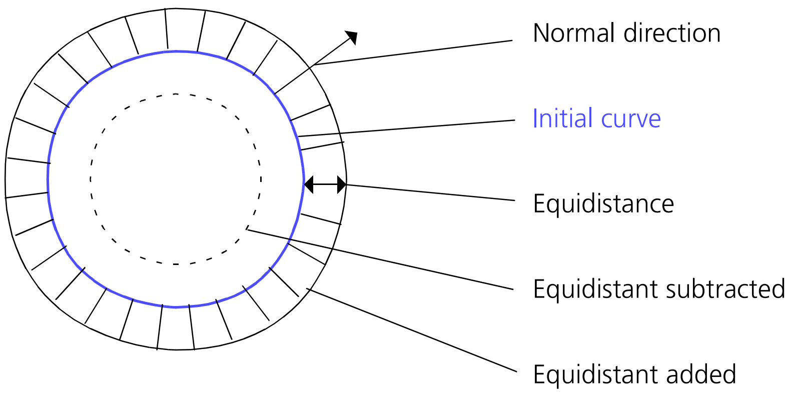
– Acknowledge the **Equidistants** data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **EQUIDISTANTS** is displayed.



This function allows an existing curve to be transformed so that the new curve points lie an equal distance away from the old curve. Both addition and subtraction of the equidistants in the normal direction is possible.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Add equidistant or subtract equidistant

Confirmation of the required direction with **<YES>**.

Enter equidistant

Confirmation with **<YES>**, if a value is to be entered in the next box.

<NO> must be entered if the probe sphere radius is to be used as equidistant or if the equidistants are to be entered later point by point or sector by sector with the **NOM EDI** or **MVA EDI** function.

Equidistant

Input of the required equidistance in mm.

Procedure for entering equidistants

When entering an equidistant, the normal direction must be observed. If e.g. an equidistant is to be produced in the direction of the normals, this means an addition, whereas in the opposite direction a subtraction must be made.

ATTENTION!
With this function, the original data is overwritten after the coordinate transformation.

1 Activate input of equidistants (e.g. Edit nominals and change curve-specific data with **NOM EDI** or **MVA EDI**).

2 Enter equidistants either point by point or sector by sector (e.g. Edit nominals or measured values with **NOM EDI** or **MVA EDI**).

3 Define coordinate transformation (with **NOM TRA** or **MVA TRA**).

4 Execute coordinate transformation with **<EXECUTE>**.

Specifying the normal direction

With this program all nominal or measured points of the curve are allocated the specified normal.

Start menu: KUM Main Menu, ➤*“Calling the KUM Main Menu” on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM** ; Action: **TRA**
  or
  Object: **MVA**; Action: **TRA**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **TRANSFORMATION Manual** is displayed.

YES

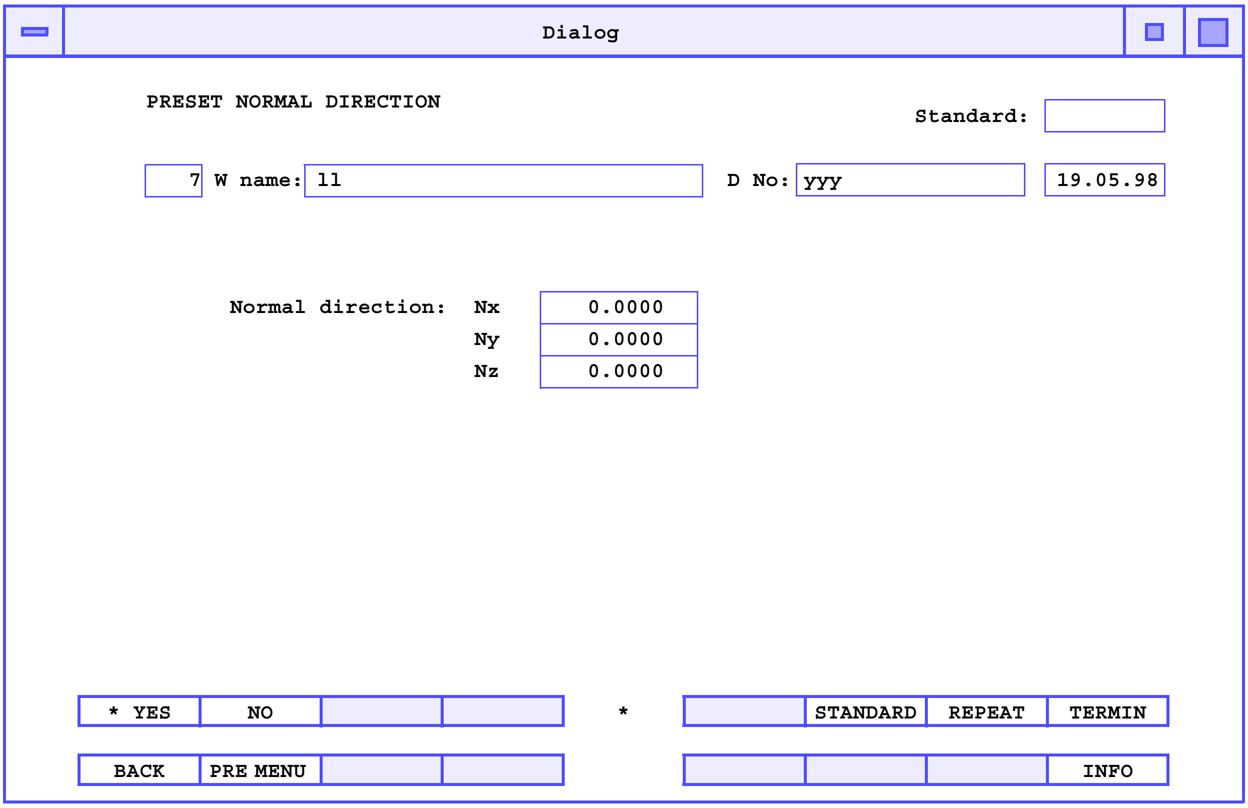
– Acknowledge the **Normal transformation** data box with **<YES>**.

YES

– Acknowledge the Preset data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **PRESET NORMAL DIRECTION** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10.*

STANDARD

The normal vector with the components Nx, Ny, Nz is standardized to the value 1. The result is then displayed.

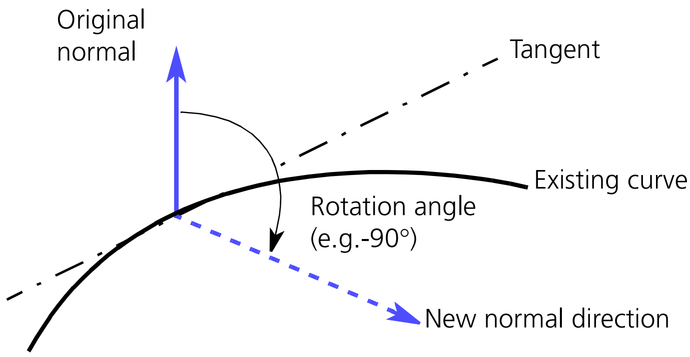
Notes on the input and display boxes

Normal direction Nx, Ny, Nz

The required normal can be entered in these three data boxes.

Rotation of the normal about the tangent

With this program, all normal vectors can be rotated about the entered rotation angle. The rotation axis for each normal vector is the relevant tangent.



Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM**, Action: **TRA**
  or
  Object: **MVA**, Action: **TRA**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **TRANSFORMATION Manual** is displayed.

YES

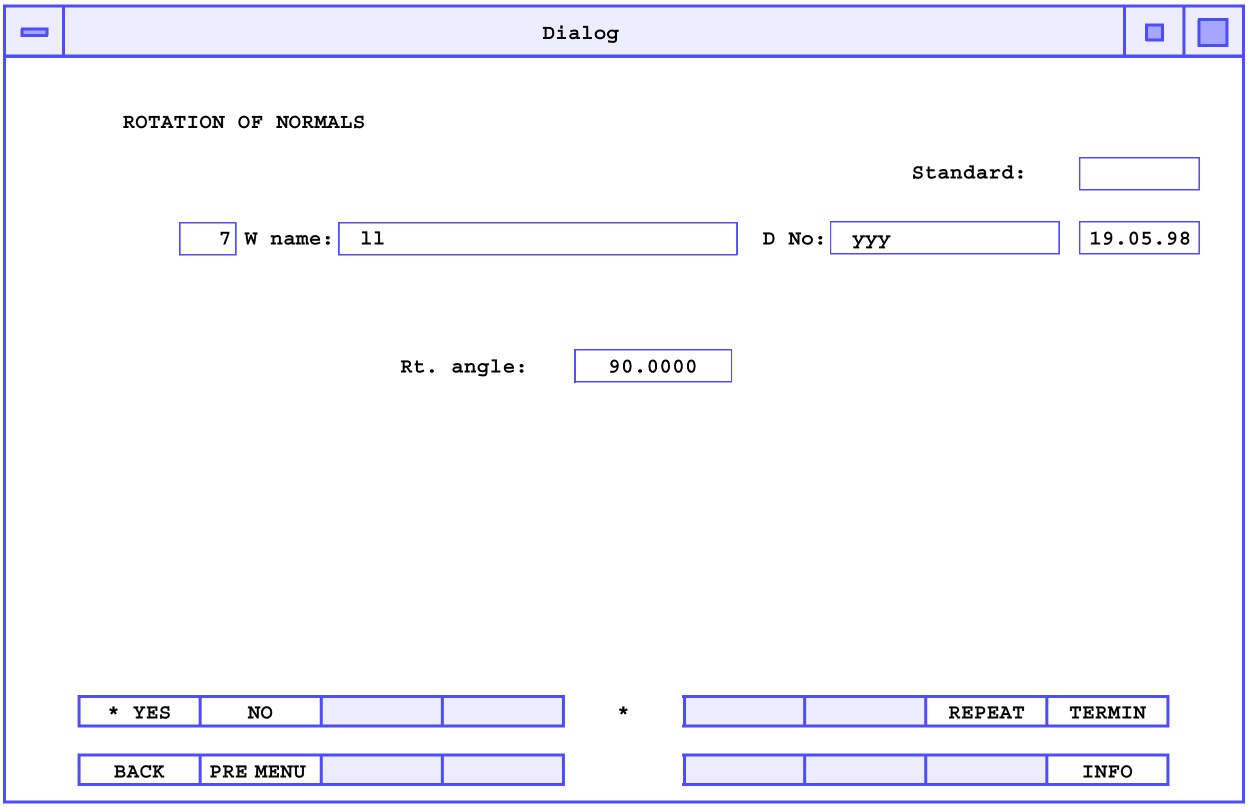
– Acknowledge the **Normal transformation** data box with **<YES>**.

YES

– Acknowledge the **Rotation about tangent** data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **ROTATION OF NORMAL** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Rot. angle

Input of the required rotation angle (the input value is mathematically defined).

Calculation of the unit vector (normal standardization)

With this program, the unit vector (normal) can be calculated from a vector.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM**, Action: **TRA**
  or
  Object: **MVA**, Action: **TRA**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **TRANSFORMATION Manual** is displayed.

YES

– Acknowledge the **Normal transformation** data box with **<YES>**.

YES

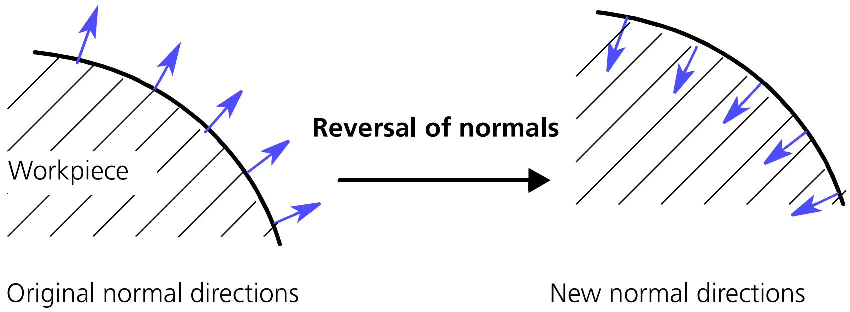
– Acknowledge the **Standardization** data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  No further dialog window is necessary with this function invocation, as no other parameters are required.

Reversing the normals

With this program the normal direction can be reversed.



Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
Object: **NOM**, Action: **TRA**
or
Object: **MVA**, Action: **TRA**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **TRANSFORMATION Manual** is displayed.

YES

– Acknowledge the **Normal transformation** data box with **<YES>**.

YES

– Acknowledge the Reversal data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
No further dialog window is necessary with this function invocation, as no other parameters are required.

Transforming deviations

With this program function you can multiply the components (E_X, E_Y, E_Z) of deviations by a decimal value (multiplier).

If the multiplier for E_X, E_Y, E_Z has the value -1, then the preceding sign of the deviation changes. In die-sinking you can use this for positive/negative contours.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

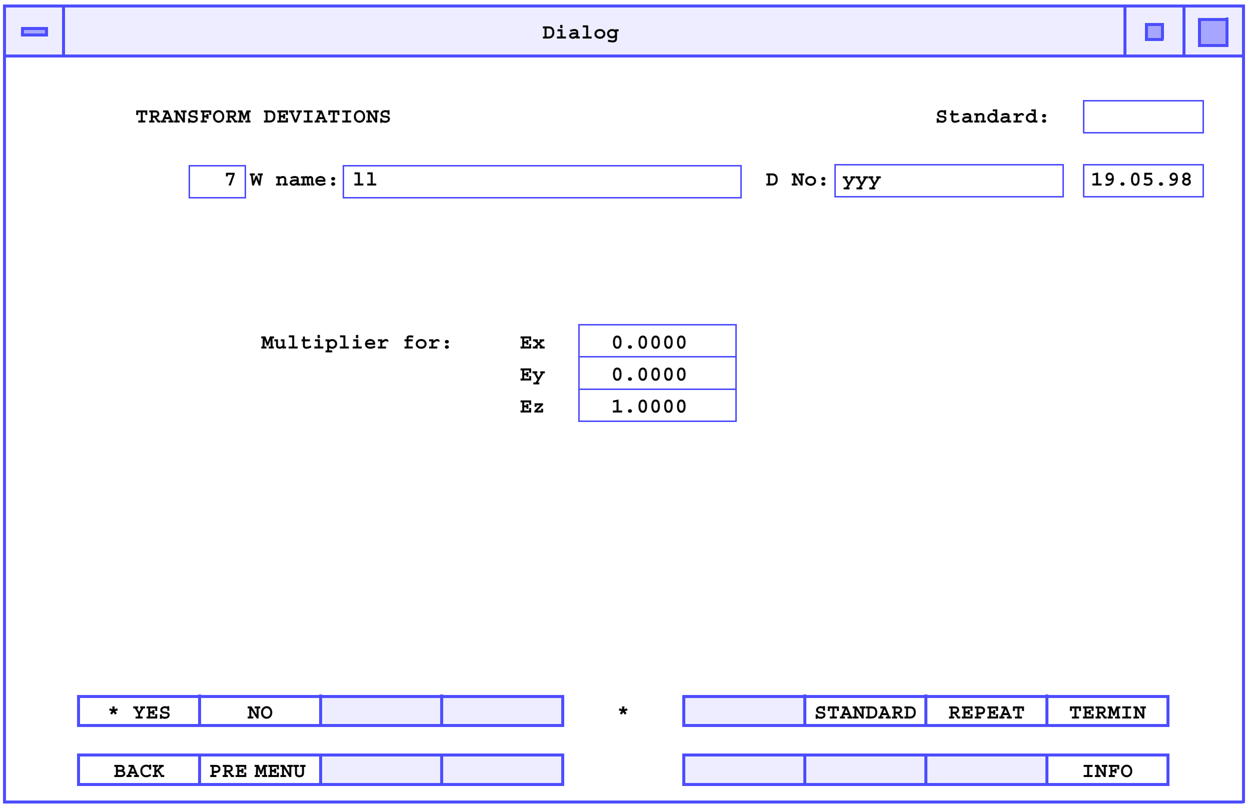
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **DEV**, Action: **TRA**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **TRANSFORM DEVIATION** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

STANDARD

The values entered for E_X, E_Y, E_Z are standardized and displayed again.

Notes on the input and display boxes

Multiplier for Ex, Ey, Ez

Multiplier for the respective components of the deviations.

Calculation of the center curve

The function calculates the center curve between

- two sectors of a curve
- two separate curves

The result is a separate curve, which is called the center curve. From a geometric point of view, the center curve is the sum of the geometric locations (coordinates) of the center points of all minimum inscribed circles which touch the two curves.

Prerequisite

- Curve sectors: the areas of the nominal data and measured data must have been identified, **NOM IDE** or **MVA IDE**. The data from the suction and pressure side (areas 2 and 4) is used to calculate the curve.
- A nominal or measured value conversion is required, **NOM CON** or **MVA CON**.
- The minimum number of nominal or measured data is 6 points.

Direction of travel

Curve sectors

The direction of rotation of the curve sectors (suction and pressure side) must be counterclockwise.

Separate curves

Any direction of rotation is allowed for both curves.

NOTE

- Both curves must lie opposite one another, so that the normal plane of the reference curve is pierced in as many points as possible by a polynomial of the opposite curve, i.e. the curves must not be vertical to one another.
- Constant curves must be available. Curve loops or curves with several piercing points by the normal plane of a point of the opposite curve will give an unpredictable result.
- Otherwise, the curve can be positioned anywhere in 3D space.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

- Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

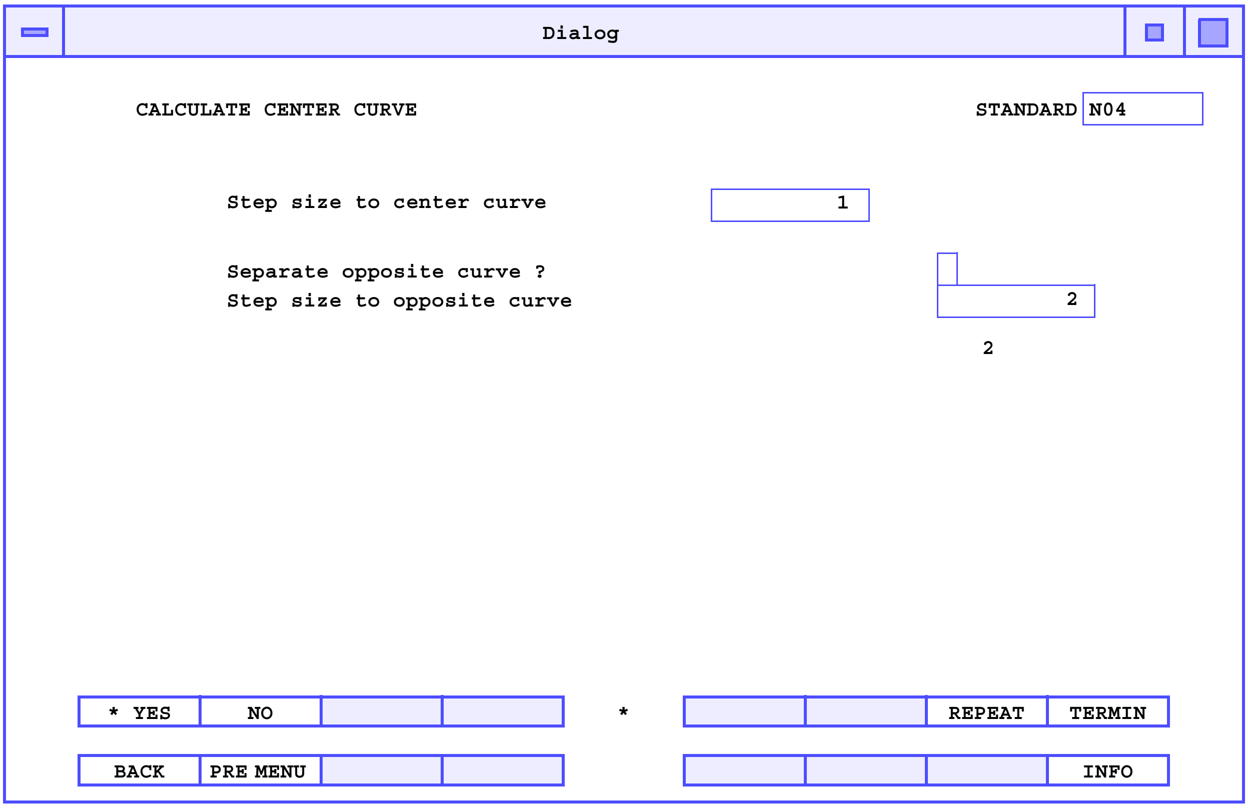
ENTER

- Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
Object: **NOM** *or* **MVA**; Action: **CEN**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **CALCULATE CENTER CURVE** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Step size to center curve

Step size to curve number of center curve.

separate opposite curves

YES

Two independent curves are used to calculate the center curve. The step size to the curve number of the opposite curve can be entered in the next data box.

NO

The pressure and suction side of the reference curve is used to calculate the center curve. The corresponding areas must have first been identified **NOM/MVA IDE**.

Step size to opposite curve

Step size to the curve number of the opposite curve.

Unwinding/winding (cylinder surface)

The unwinding or winding of measured or nominal values takes place with a **constant radius**, which can be entered after calling up the relevant programs.

Rotation axis

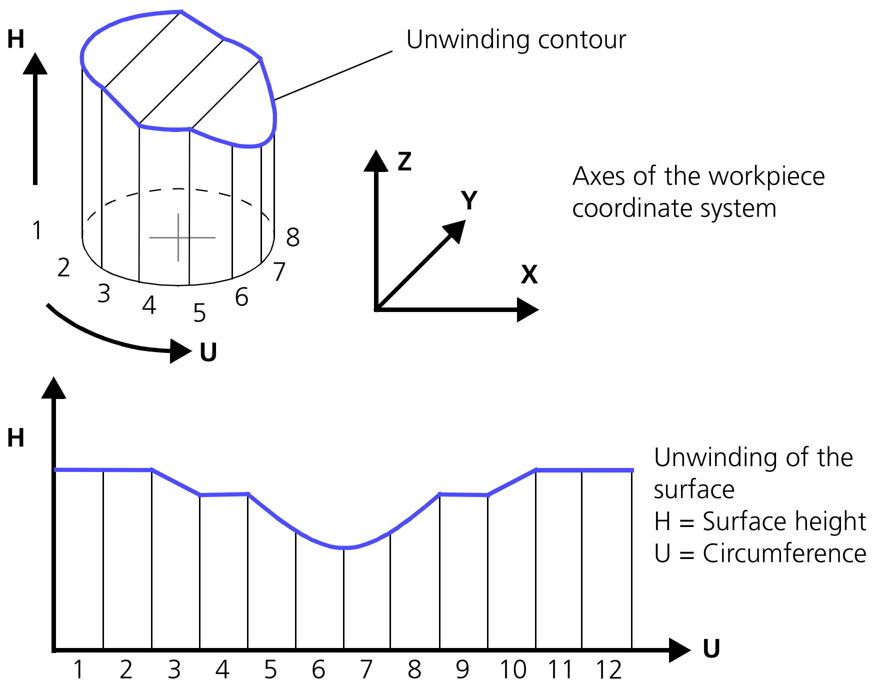
The **rotation axis** of the part corresponds to the spatial axis of the surface curve.

The curve is opened and unwound on the abscissa of the measuring plane.

Winding radius

The third coordinate, here the X axis, corresponds to the **winding radius** and is not included as a constant in the representation of the unwinding.

3D representation of the cylinder surface of interest



Unwinding definition

The unwinding results from the circumference and the measured height of the specified cylinder surface; the surface height is measured parallel to the rotation axis (in mm).

The length of the unwinding is defined by the required angle range of the circumference. A complete circle is shown as closed contour; however, any part areas can also be defined. The following relationship applies:

In the formulas the abbreviations are as follows:

U = Circumference (unwinding in mm)

ΔU = Part circumference with an open contour

R = Radius of the cylinder surface (in mm)

D = Diameter of the cylinder surface

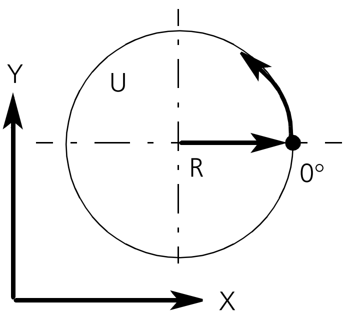
W = Angle range of the unwinding (in °)

Complete circle (closed contour)

$U = D\,\pi$ or $U = 2\,R\,\pi$ [mm]

Part area (open contour)

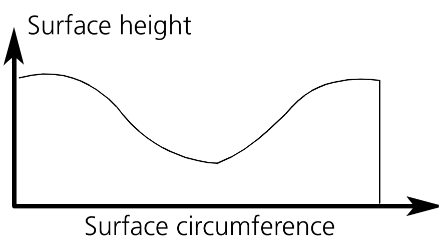
$\Delta U = D\,\pi\;\; W/360$ [mm]



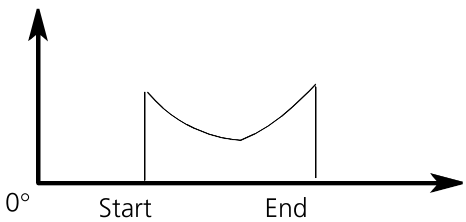
If for example the Z coordinate is selected as rotation axis (see sketch), the generation of the circle arc takes place in the XY plane and the surface height of the unwinding is measured in the Y direction.

In this case, the 0° position of the unwinding lies on the center line in the +X direction.

In general, the following relationship applies:
Rotation axis X → unwinding direction +Z
Rotation axis Y → unwinding direction +X
Rotation axis Z → unwinding direction +Y



In the graphical representation of the unwinding, the surface height is plotted above the circumference. With a specified start position of 0°, the unwinding in the sketch is displayed to the right starting from zero.



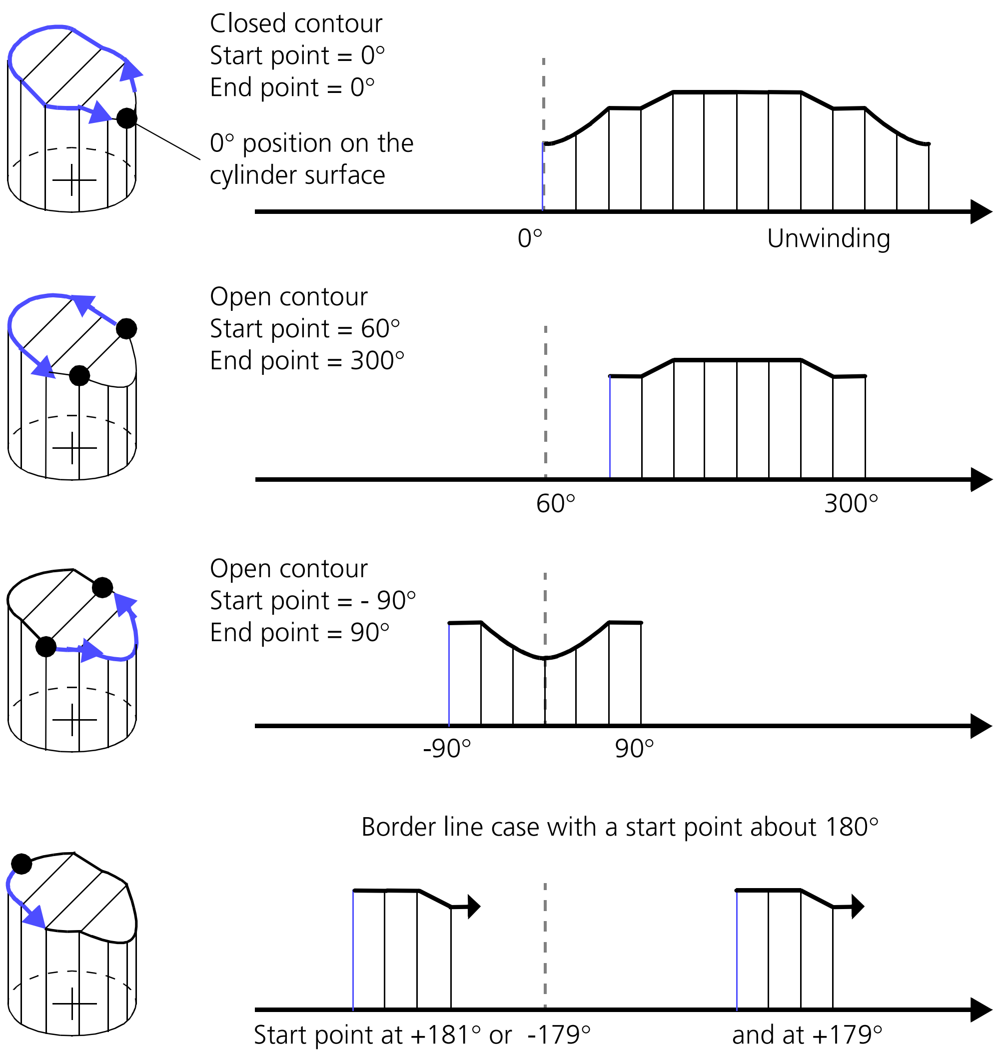
In the representation of partial areas of the surface, the unwinding is shown according to the presets for the start and end angle, see representation examples ➤ *“Representation examples” on page 7-89*.

Representation examples

The start and end point of the unwinding can be calculated with the relationships shown in ➤*"Unwinding definition" on page 7-88*, if a surface curve does *not* start at 0°, i.e. *not* on the abscissa. The representation of the unwinding *is shown* according to the specified conditions for the plotter output.

NOTE

With a preset start point of 180°, it may happen that the first measured point only lies 0.001 mm in *the second quadrant*. For unwinding the measured values, this means that the *first point* lies at *179.999°*. When the unwound measured values are output, the position of the values is quickly checked.



Unwinding nominals or measured values

Vectors

If vectors are available for a curve, then these are also transformed during unwinding.

It is *assumed*, that the curve has a mathematically *positive direction of travel*.

If this is not the case, you can correct the direction of travel with the command **Reverse nominals or measured values** before you unwind the curve.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

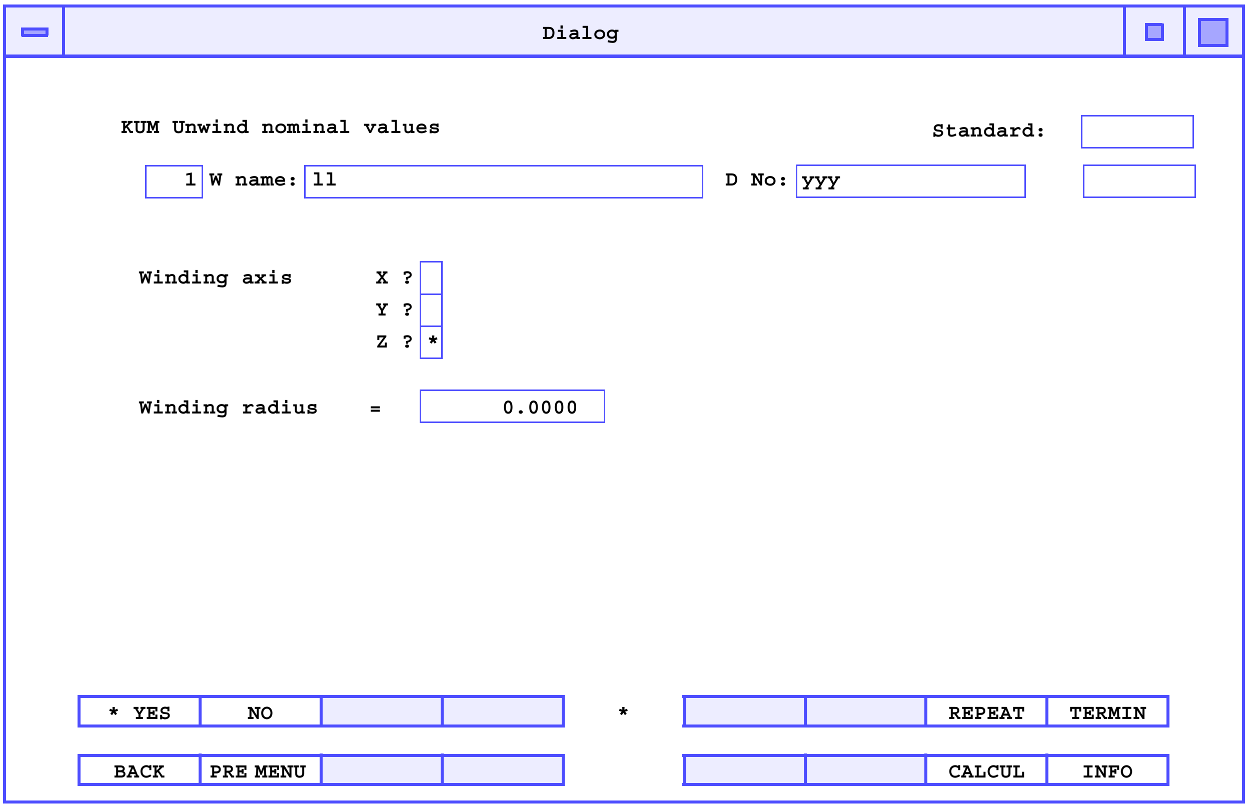
ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **NOM** *or* **MVA;**
  Action: **DVL**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM Unwind nominal/measured values** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

CALCUL

Softkey for additional calculations (function not yet implemented).

Notes on the input and display boxes

Standard/W name/D no Display boxes with header data.

Winding axis X/Y/Z Confirm the required axis with **<YES>**.

Winding radius Data box for the radius (in mm).

Winding nominals or measured values

Direction of rotation

All existing vectors are transformed. It is assumed that the wound curve has a mathematically *positive direction of travel*. If necessary, you can correct the direction of travel with the command **Reverse nominals or measured values**, before you wind the curve.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

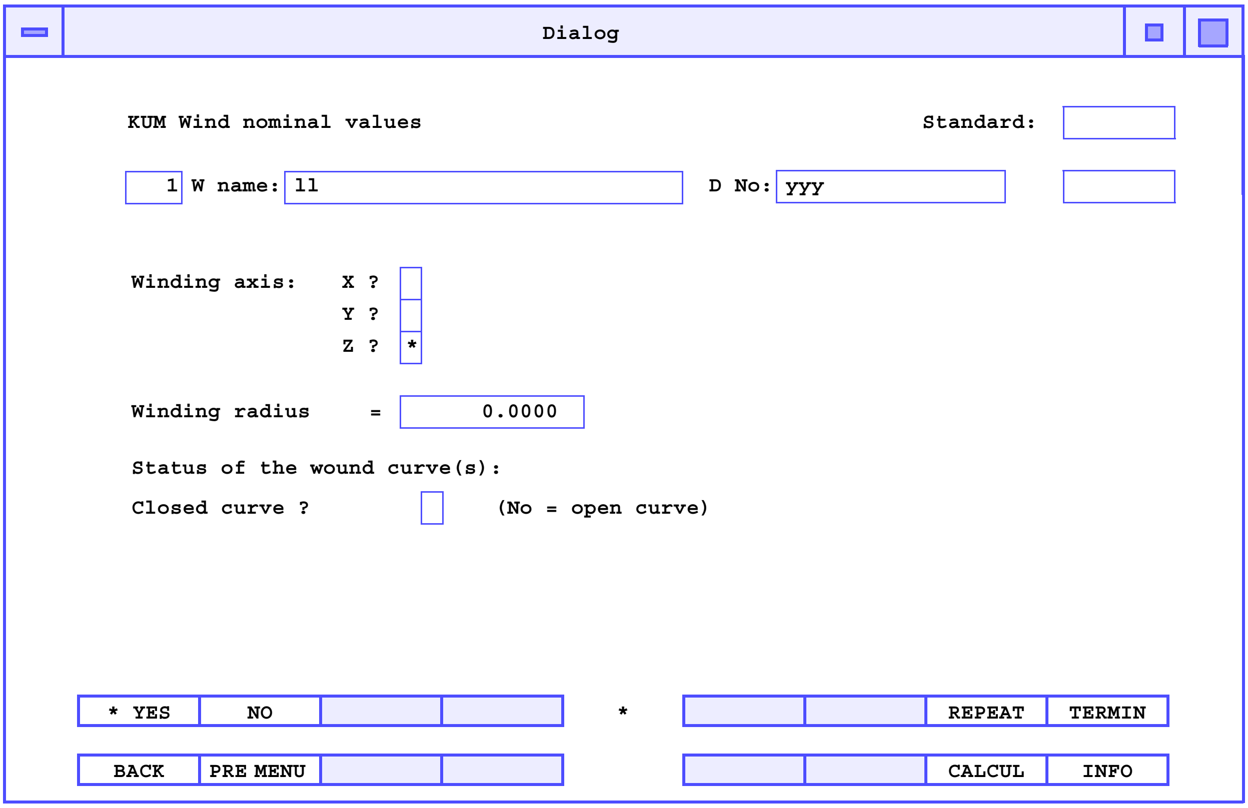
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM** *or* **MVA**, Action: **ENV**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM Wind nominal/measured values** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

CALCUL

Softkey for additional calculations (function not yet implemented).

Notes on the input and display boxes

Standard / W name / D no

Display boxes with header data.

Winding axis X/Y/Z

Confirmation of the required axis with **<YES>**.

Winding radius

Data box for the radius (in mm).

Closed curve

Corresponding to the curve form: Input of **<YES>** or **<NO>**.

Compensation of the probe bend (only with measuring probe heads)

Type of probe head

The probe bend explained in the following chapter is an effect which only occurs with **measuring probe heads**. With machines with a **trigger probe head**, the measured value is already recorded by the trigger impulse of the piezo sensor at a point in time when the probe bend is not yet noticeable.

NOTE

Tensor-calibrated probes do not need to be compensated with **<DI 15228>**, as this is already included in UMESS.

General information

– The compensation of the probe bend is retained in the software due to reasons of compatibility with the earlier software.

– If the probe probes the workpiece with a certain force (which can be set on the control panel), this may lead to a (slight) **bend** in the probe. This **measuring error** is called probe bend; this may lead to noticeable adulteration of the measured values, particularly with long and **thin probes** (a few mm).

– If a *very high measuring accuracy* in the µm range is expected, then this probe bend must be taken into consideration when calculating the measuring result.

– Depending on whether the probe system is in operation or not, a differentiation is made between **static** and **dynamic** probe bend. Further explanations can be found in the UMESS operating instructions.

– The **dynamic** probe bend correction is only intended for the **computer-aided scanning process**. This probe bend correction is not suitable for **control-aided measuring methods**: therefore, it must not be used in KUM in such cases.

– The commands for probe bend correction are only effective *within one command block*, i.e. they are not effective in the following command block. On the other hand, they may be used in succession as often as desired.

– If the **<CANCEL>** softkey has been activated during execution of a command block, then the *basic status* **no probe bend correction** is produced when the command block is exited. The same applies if a command block has been executed for the probe bend correction, but no calculation program with probe sphere radius correction has been carried out subsequently.

Determination of the bend parameters

The determination of the bend parameters is carried out with **<DI 6520>** (see UMESS operating instructions). Please note that no dynamic bend parameters have to be determined for curves which have to be probed in the shaft direction.

In these cases it must be checked whether a static probe bend correction can be used.

If desired, the bend parameters determined can be output with **<DI 6520>**. (see UMESS operating instructions)

Commands for compensation of the probe bend

Two commands

In KUM there are two commands (**object + action**) for activating the probe bend correction:

PBI COR

Correct probe bend.

With this command, the method of the probe bend correction depends on the procedure which was used to acquire the measured data:

If the measured data was recorded using **single probings**, static probe bend correction is automatically applied. If **scanning procedures** were used, on the other hand, **dynamic** probe bend correction takes place automatically.

PBI SCO

Static correction of probe bend

With the command **PBI SCO**, a **static** probe bend correction is always made – *regardless* of which measurement method is used as the basis. This command is therefore also recommended if the measurement procedure **Scanning, measuring according to nominals, computer-aided** is used.

Calculation programs

The two commands specified above activate the probe bend correction in those calculation programs in which the coordinates of the contact points are calculated from the probe sphere center point coordinates (probe sphere radius correction). This involves the following four commands:

DEV CAL Calculate deviations

MVA BFT Best fit measured values

MVA CON Convert measured values

NOM CAL Calculate nominals

Activate probe bend correction

Similarly to UMESS, where the probe bend correction is activated with **<DI 1186>** for the following geometric element, it can also be activated in KUM once or several times within a command block. For this purpose, the following sequence must be observed when entering the commands:

1. Command for probe bend correction (e.g. **PBI COR**).
2. Depending on the task, several commands can be specified here (without probe sphere radius correction).
3. Activate calculation program with probe sphere radius correction (e.g. **DEV CAL**).

Note

The commands **PBI COR** (correct probe bend) and **PBI SCO** (static correction of probe bend) can be used for all computer-aided measuring procedures in the case of measurements with a measuring probe head.

Application example

Task

To scan an ellipse and calculate the nominal data

Procedure

1 Select probe. Make sure that the curve is not probed in the direction of the shaft.

2 Set the measuring force on the control panel (e.g. 0.2 N).

3 Execute the probe calibration.

4 Determine the dynamic bend parameters with the measuring procedure

Scanning, plane in WP system, computer-aided.

5 Select the workpiece in KUM and enter the curve number.

6 Measure an ellipse with the same measuring procedure that was used for recording the bend parameters.

7 Create command block with the commands **PBI COR** and **NOM CAL**.

8 Execute command block.

9 Plot results with standard command block **PLO_3D**.

Notes

– Probe change within a curve measurement is also allowed in conjunction with the probe bend correction.

– If no bend parameters exist, then an error message is output in the record and no probe bend correction is calculated.

– Take care when backing up the data! The bend parameters have not yet been saved.

– If measured data with probe bend correction is to be copied onto another computer, not only must the probe configuration, probe combination and probe number be stored in the KUM measured data, but the relevant bend parameters must also be present. If necessary, the bend parameters for a probe can also be determined subsequently.

Reversing measured values or nominals

The direction of nominal or measured curves can be reversed with the commands **NOM REV** or **MVA REV**. This procedure changes not only the **sequence of the curve points**, but also the **direction of travel and tangent direction**.

Changes

The start and end point of the curve are exchanged with one another due to the reversal, resulting in the following consequences:

– The numbering of the curve points changes.

– The direction of travel of the curve changes.

– The tangent directions are reversed.

– The normal vectors remain unchanged.

Start menu: KUM Main Menu, ➤ *"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

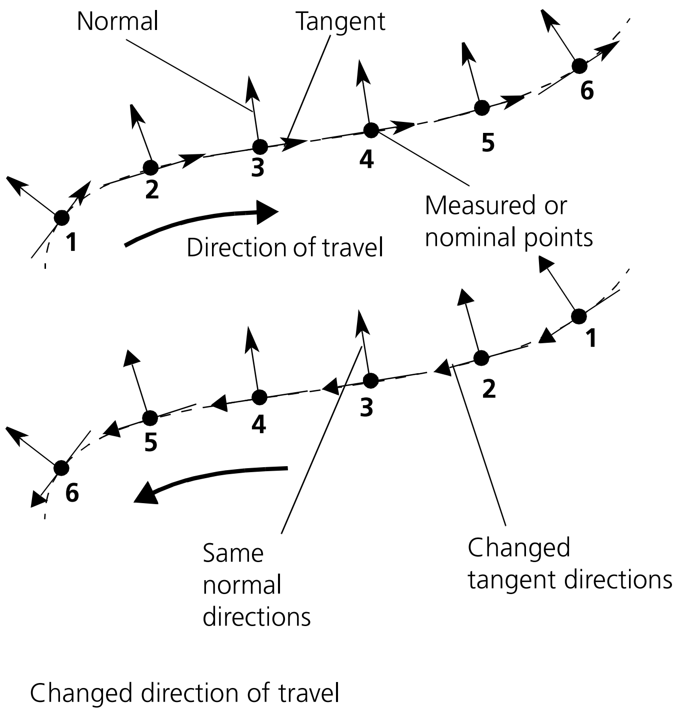
– Enter the KUM command in the data boxes.
Object: **NOM**, Action: **REV**
or
Object: **MVA**, Action: **REV**

DEFINE

– Press **<DEFINE>**.
No further dialog window is necessary with this function call, as no other parameters are required.

DEFINE

– Press **<DEFINE>**.
No further dialog window is necessary with this function call, as no other parameters are required.



Initial curve with the specified nominal or measured points.

The direction of travel, normal and tangent direction result from the definition of start and end point.

After calling up **NOM REV** or **MVA REV**, the start and end point are exchanged. The numbering of the curve points changes as a result

The reversal results in a change in the direction of travel and tangent direction.

Optimizing the measuring run

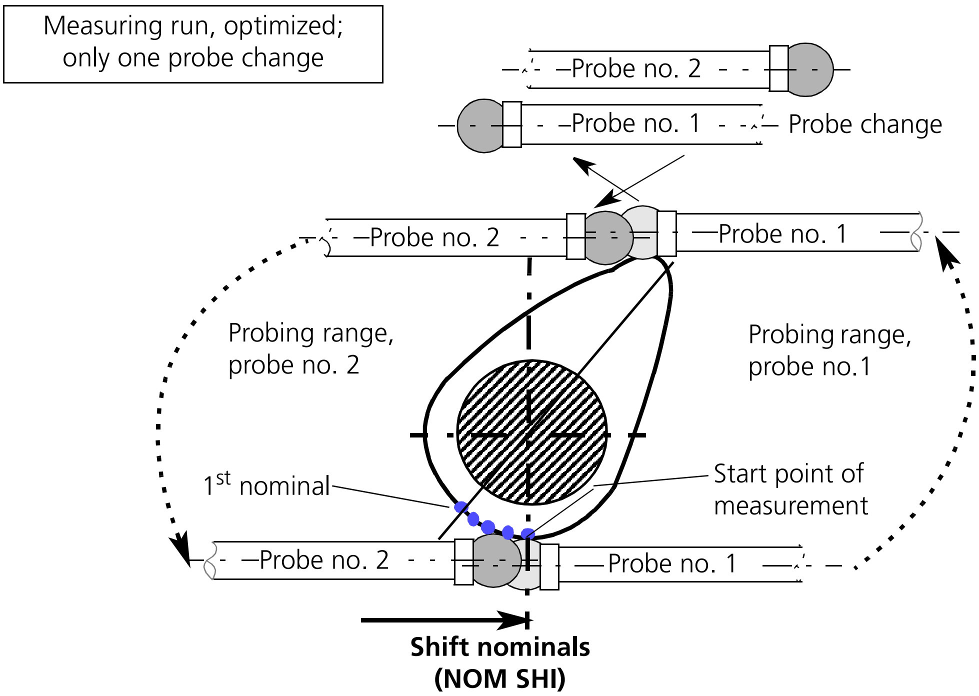
Probe change

In order to, for example, measure a cam completely over 360°, the probe may have to be changed several times during the measurement. Probing routes must also be covered for each probe change.

You can optimize the measuring run with the command **NOM SHI** or **NOM SHI**, by positioning the **start of the curve** so that *only one* probe change is required during a cam measurement. You can achieve this if you take the nominal point as point 1 of the measurement, which can be probed in an axis of the control coordinate system, i.e. whose normal lies *parallel to an axis* of the control coordinate system.

Renumber

With the command **NOM SHI** or **MVA SHI** the nominal or measured points are shifted by **renumbering**, i.e. the points are renamed. If, for example, you have 360 nominal points for a cam and shift these by 10 points, then point no. 10 becomes point no. 1 of the measurement and point nos. 1 to 9 become points no. 352 to no. 360 of the measurement.



Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

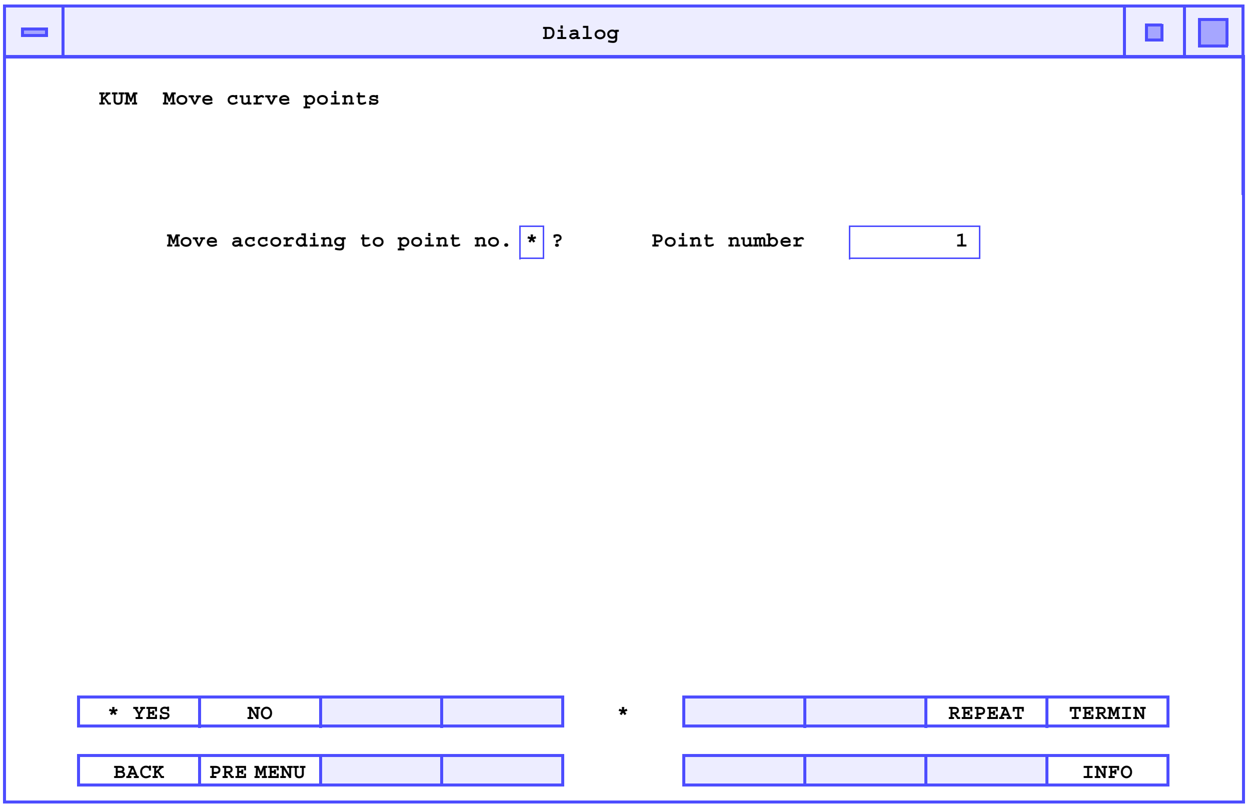
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM**, Action: **SHI**
  or
  Object: **MVA**, Action: **SHI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM Move curve points** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Move acc. to point number

If all curve points are to be moved so that the first point is given the position of a certain curve point which is to be specified.

Example

- To copy nominals **NOM COP**.
  Copy nominals to another curve number, for example from curve 1 to curve 5.
- To move nominals **NOM SHI**.
  Move nominals of curve 5, for example by 10 points.
- To measure.
  Measure as curve 5.
- To copy measured values **MVA COP**.
  Copy measured values from curve 5 to curve 1.
- Later evaluation **DEV CAL.**
  Calculate deviations for curve 1.

Chapter 8

Printer Output

This chapter deals with data output on a printer.

Selection of the printer as the current output device is preset in UMESS with direct input **<DI 1614>**.

This chapter is divided into the following sections, corresponding to the different ways of recording the measured variables available:

This chapter contains:

Nominal values record

The basic definition for output of the nominals on the printer can be made with **NOM LIS**.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

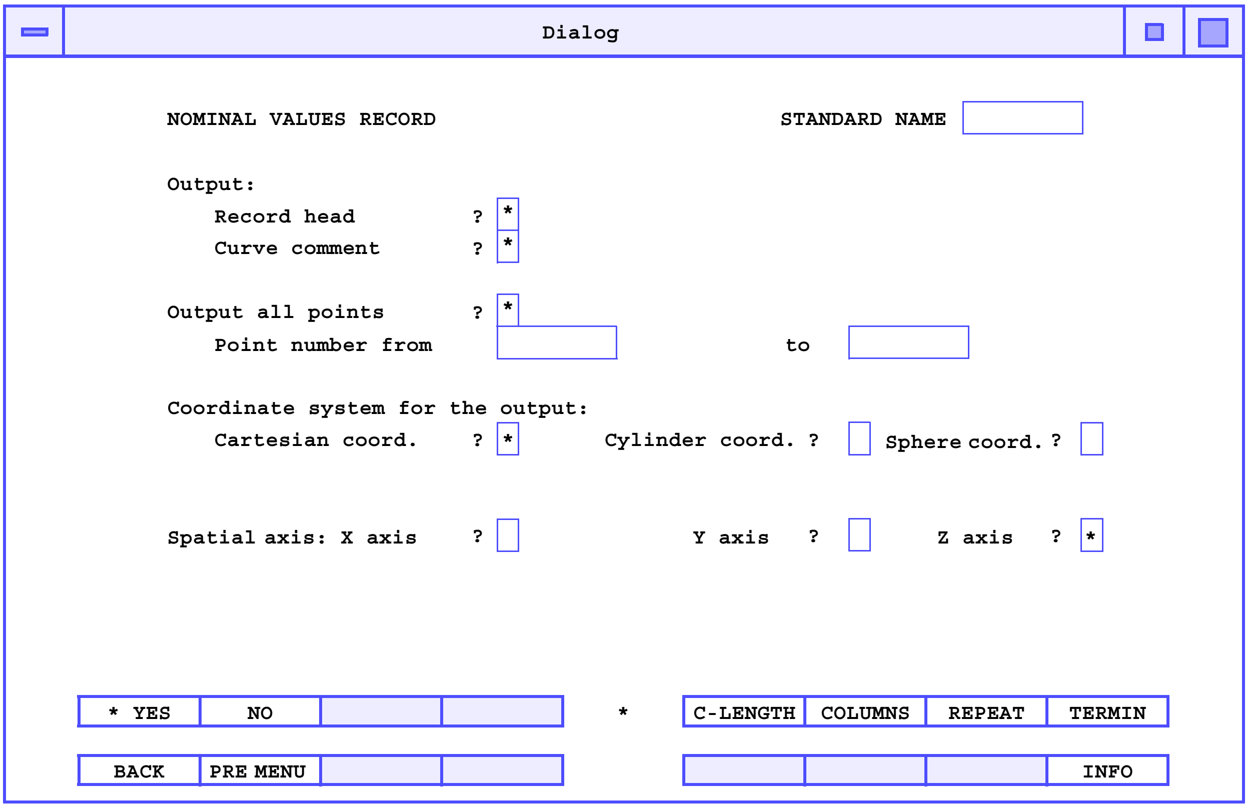
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM**, Action: **LIS**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **NOMINAL VALUES RECORD** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

COLUMNS

Program jump to ➤*"Output columns for nominals" on page 8-4*. The output columns for the nominal value record can be defined in the dialog window displayed here.

C-LENGTH

Program jump to ➤*"Output of total curve length (nominal curve)" on page 8-8*. In the dialog window displayed here, you can enter whether the total curve length and the reference surface are to be output.

Notes on the input and display boxes

STANDARD NAME Display box with designation of the standard.

Record head If this box is confirmed with **<YES>**, the record head defined in UMESS with **<DI 1610>** is subsequently output.

Curve comment If confirmed with **<YES>**, the comment text is also output.

Output all points Confirm with **<YES>**, if all points are to be output.

Point number from to If **<NO>** has been entered in the previous box, the range of points to be output can be defined in these two boxes.

Coordinate system for the output

Cartesian coord./ Cylinder coord./ Sphere coord. The required coordinate system must be selected before defining the output columns. The column designations suggested in the **<COLUMNS>** input menu are directly dependent on the respective coordinate system.

Spatial axis: X axis/Y axis/ Z axis The desired spatial axis must be defined here for cylinder or sphere coordinates.

NOTE

The current output device is set in UMESS with direct input:

Printer	=	**<DI 1614>**
Screen	=	**<DI 1615>**
Units	=	**<DI 1625>**

Output columns for nominals

This dialog window follows on from ➤*"Nominal values record" on page 8-2*. It is used to define the data columns required for the nominal value output on the printer.

However, not all output columns can be accessed in the KUM-UX software package. The abbreviations highlighted in the dialog window must be used to define the nominal value record (confirm each time with **<RETURN>**).

Columns missing

If the required *columns are missing* in the output record, despite preselection, *no* relevant *data exists*. The ER error code is only used in conjunction with the **Edit nominals** function.

Listing point by point

The sector by sector tolerances can now also be listed point by point, using the List nominals or deviations functions **NOM/DEV LIS**. The corresponding output columns lower tolerance, upper tolerance, curve jump tolerance or diagram position must be selected for this purpose.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

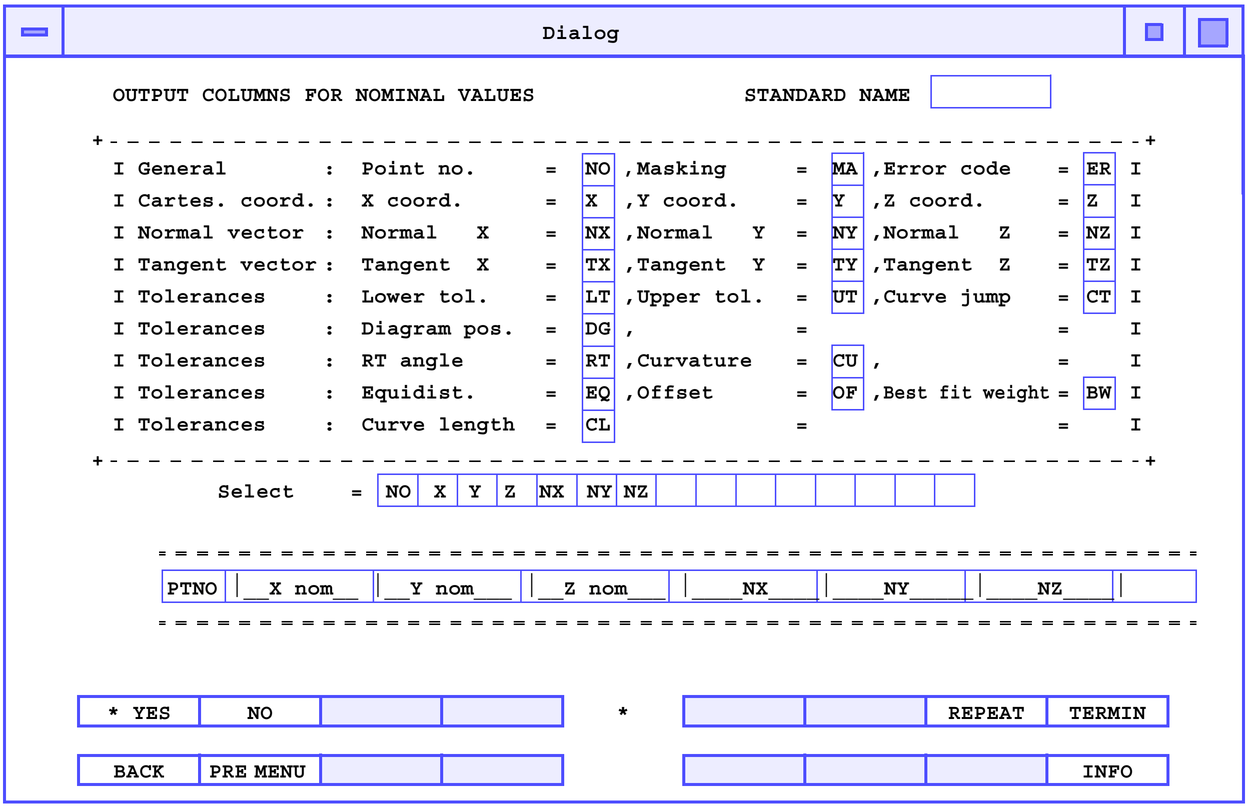
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **NOM**, Action: **LIS**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **NOMINAL VALUES RECORD** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

REPEAT

The subsequent printing format for the header line of the output columns is displayed in the lower section of the dialog window, in accordance with the abbreviation previously entered. If all the required data columns do not fit in the nominal values record, then the following message appears: **No. of characters too large**. The number of characters is independent of the printer. It is limited to 80.

Notes on the input and display boxes

Select

Data box for the output columns required (see measuring record example on ➤ *Page 8-6*)

Curve info:
Curve length = CL

Output of the total curve length (nominal curve), ➤ *"Output of total curve length (nominal curve)" on page 8-8.*

Example of a nominal data list (with error code)

```
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
MEASURING RECORD      ZEISS    KUM
Spindle
                                        MANUAL MEASUREMENT
DRAWING NO.          ORDER NO.          SUPPLIER/CUSTOMER               WORK CYCLE
                                        ZEISS                           1
2D evaluation        3D evaluation
OPERATOR             DATE               PART NO.
Pir                  2.12.92            2
TEXT
Type            Curve   Name    Creat. date       Modification          No. of pts
Nominal values: 1       PT1     02.12.1992        02.12.1992
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PTNO            X nom         Y nom         Z n                       ERROR RECOGNITION
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
1               10.0000       .0000         .0000                    - - - - - - - - - - - -
2               7.6604        6.4279        .0000                    - - - - - - - - - - - -
3                1.7365       9.8481        .0000                    - - - - - - - - - - - -
4               -5.0000       8.6603        .0000                    - -*-*- - - - - - - - -
5               -9.3969       3.4202        .0000                    - -*-*- - - - - - - - -
6               -9.3969       -3.4202       .0000                    - - - - - - - - - - - -
7               -5.0000       -8.6603       .0000                    - - - - - - - - - - - -
8               1.7365        -9.8481       .0000                    - - - - - - - - - - - -
```

Marking of data errors (here in the 3rd and 5th position)   1st position . . . 16th position

Interpretation of the marked data errors

1st position	Coordinates are inserted and not entered.
2nd position	Normals are inserted and not entered.
3rd position	Normals are masked.
4th position	Tangents are inserted and not entered.
5th position	Tangents are masked.
6th position	Tolerances are inserted and not entered.
7th position	Lower tolerance is greater than upper tolerance.
8th position	Decimal position is smaller than zero.
9th position	Lower tolerance or upper tolerance have not been entered.
10th position	Aut. vectors are inserted and not entered.
11th position	Rotary table error (planned).
12th position	Rotary table error (planned).
13th position	Offset error (planned).
14th position	Offset error (planned).
15th position	Best fit weighting factor (planned).
16th position	Best fit weighting factor (planned).

Output of total curve length (nominal curve)

You can define that the curve length is output in the record in the column with the heading **Length**. You must select **Curve -info: Curve length = CL** in the output columns for nominals, ➤*"Output columns for nominals" on page 8-4*.

- The first point for the output of the curve length has length 0 mm.
- The curve lengths are added from point to point.
- The length of the entire curve is output in the record header.

NOTE

- For an *open curve*, the length of the entire curve is equal to the curve length from the first to the last point. For a *closed curve*, the curve length between the last and the first point is added in order to obtain the entire curve length.
- As the curve length is calculated using the chord length (chord of an arc) between 2 consecutive points, the *accuracy* of the calculation increases, the smaller the **curve curvature**. For example, the curve length is calculated exactly for a line.
- With *increasing curve curvature* the **point density** during the measurement must also *increase*. The measuring method **Scanning with curve-dependent point density** can be used here, for example.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

- Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

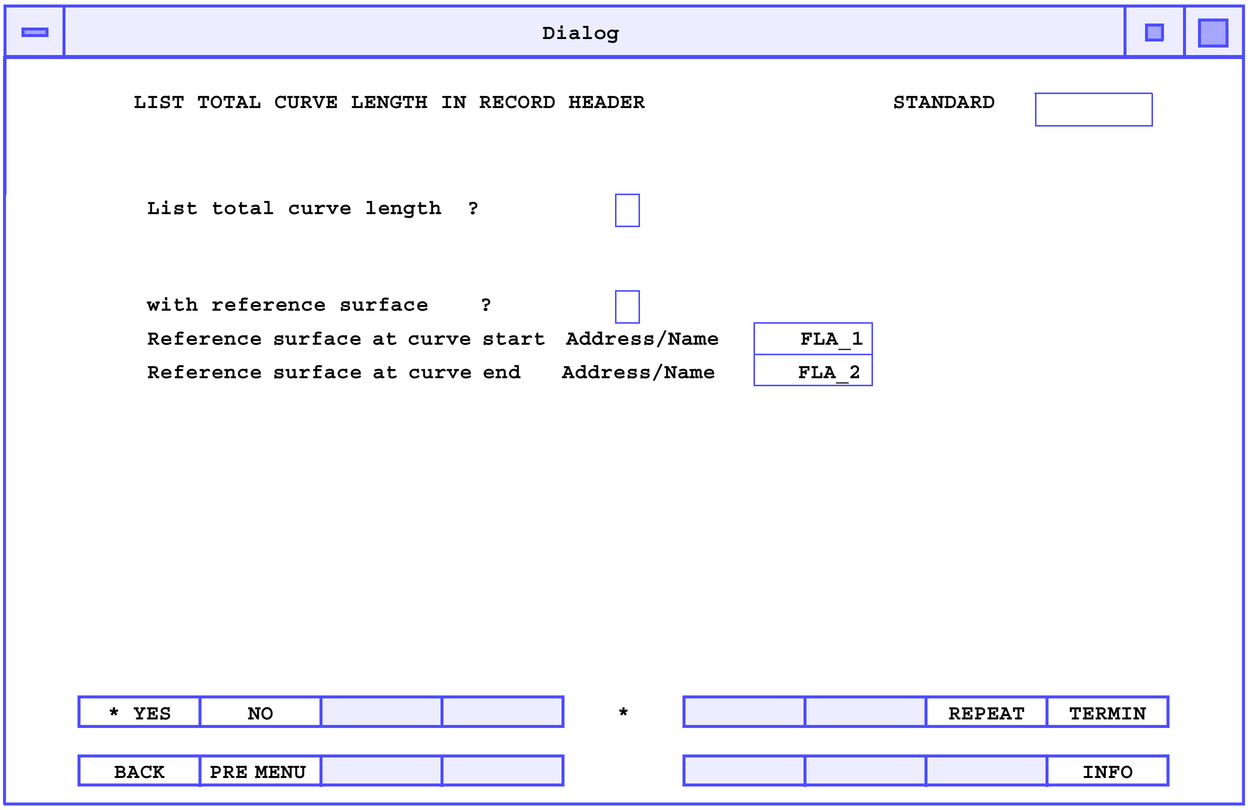
- Acknowledge the displayed line by pressing **<ENTER>**.
- Enter the KUM command in the data boxes.
  Object: **NOM**, Action: **LIS**

DEFINE

- Press **<DEFINE>**.
  The dialog window with the menu title **NOMINAL VALUES RECORD** is displayed.

C-LENGTH

- Press **<C-LENGTH>**.
  The dialog window with the menu title **LIST TOTAL CURVE LENGTH IN RECORD HEADER** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Total curve length List

Confirmation with **<YES>**, if the total curve length is to be output.

With reference surface

Confirm with **<YES>**, if the reference surface for the curve start or curve end is to be entered.

Reading nominals/measured values (ASCII-interface)

KUM nominals or measured data can be read from a sequential ASCII file with **Read nominals** (**NOM READ**) or **Read measured values** (**MVA READ**) and stored in KUM. The file name consists of **S_MASCH____nnB**; **nn** is the session number. The name of the directory is **home/zeiss/UA**.

File format

The first data set contains the number of points as an integer. The following data sets contain the $_{x, y, z}$ coordinates in workpiece coordinates and the normal vectors Nx, Ny, Nz in the format 6 times F12.5. A space is used as separating symbol between the values.

Example of the data format

10.00000	0.00000	0.00000	0.00000	0.00000	1.00000
20.00000	0.00000	0.00000	0.00000	0.00000	1.00000
30.00000	0.00000	0.00000	0.00000	0.00000	1.00000
40.00000	0.00000	0.00000	0.00000	0.00000	1.00000
50.00000	0.00000	0.00000	0.00000	0.00000	1.00000
60.00000	0.00000	0.00000	0.00000	0.00000	1.00000
70.00000	0.00000	0.00000	0.00000	0.00000	1.00000
80.00000	0.00000	0.00000	0.00000	0.00000	1.00000

Measured values record

The basic definition for the output of the measured values on the printer can be made with **MVA LIS**.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

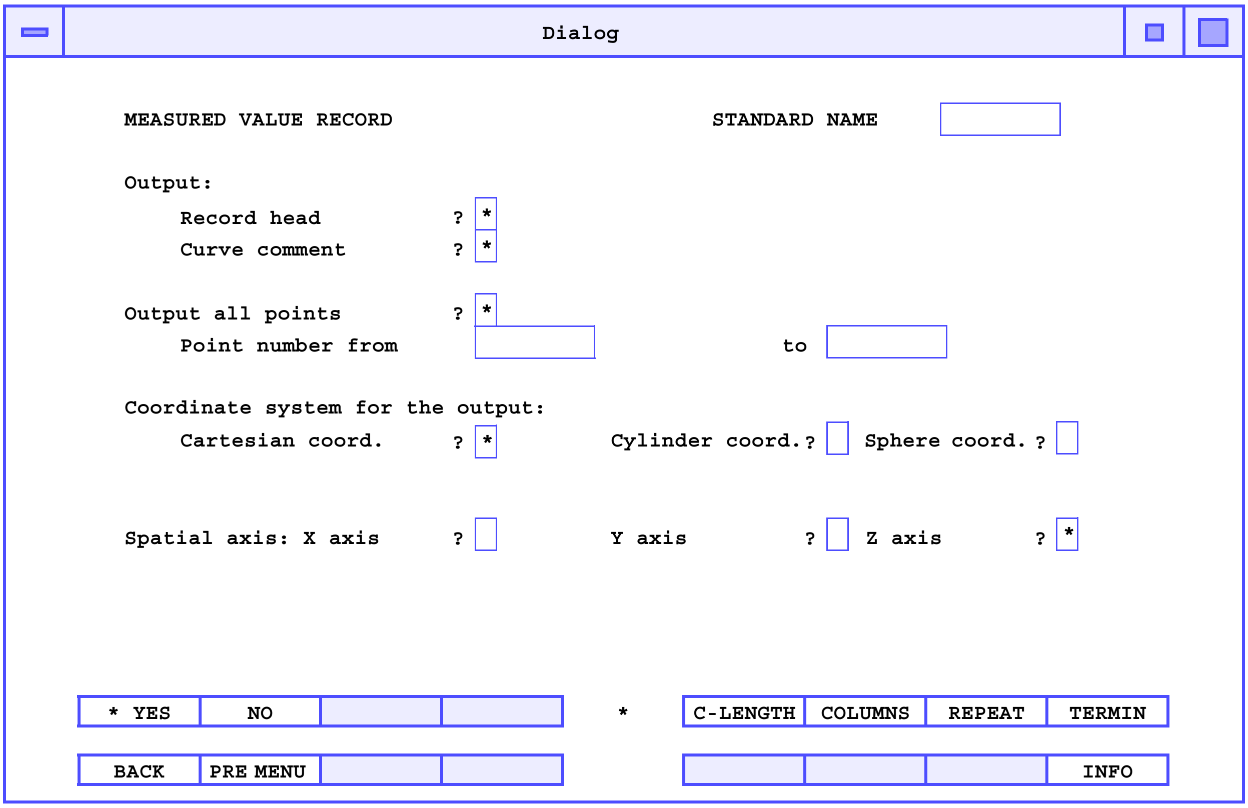
ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **MVA**, Action: **LIS**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **MEASURED VALUE RECORD** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

COLUMNS

Program jump to ➤*"Output columns for measured values" on page 8-13*. The output columns for the measured value record can be defined in the dialog window displayed here.

C-LENGTH

Program jump to ➤*"Output of total curve length (measured curve)" on page 8-15*. In the dialog window displayed here you can enter whether the total curve length and the reference surface are to be output or not.

Notes on the input and display boxes

STANDARD NAME — Display box with designation of the standard.

Record head — If this box is confirmed with **<YES>**, the record header defined with **<DI 1610>** in UMESS is output subsequently.

Curve comment — If confirmed with **<YES>**, the comment text is also output.

Output all points — Confirm with **<YES>**, if all points are to be output.

Point number from to — If **<NO>** has been entered in the previous box, the range of points to be output can be defined in these two boxes.

Notes on the input and display boxes

STANDARD NAME — Display box with designation of the standard.

Record head — If this box is confirmed with **<YES>**, the record head defined with **<DI 1610>** in UMESS is output subsequently.

Curve comment — If confirmed with **<YES>**, the comment text is also output.

Output all points — Confirm with **<YES>**, if all points are to be output.

Point number from to — If **<NO>** has been entered in the previous box, the range of points to be output can be defined in these two boxes.

Coordinate system for the output

Cartesian coord./ Cylinder coord./ Sphere coord.

The coordinate system required must be selected before defining the output columns. The column designations suggested in the **<COLUMNS>** input menu are directly dependent on the respective coordinate system.

Spatial axis: X axis/Y axis/ Z axis

The spatial axis required must be defined here for cylinder or sphere coordinates.

NOTE

The current output device is set in UMESS with the direct input

Printer	=	**<DI 1614>**
Screen	=	**<DI 1615>**
Units	=	**<DI 1625>**

Output columns for measured values

Definition of the data columns required for the output of the measured values on the printer. However, not all output columns can be selected in the software version described.

The abbreviations highlighted in the dialog window must be used for defining the measured value record (acknowledge each time with **<RETURN>**).

If the desired columns are missing in the output record despite preselection, no relevant data exists.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

RETURN

– Acknowledge the displayed line by pressing **<RETURN>**.
– Enter the KUM command in the data boxes.
  Object: **MVA**, Action: **LIS**

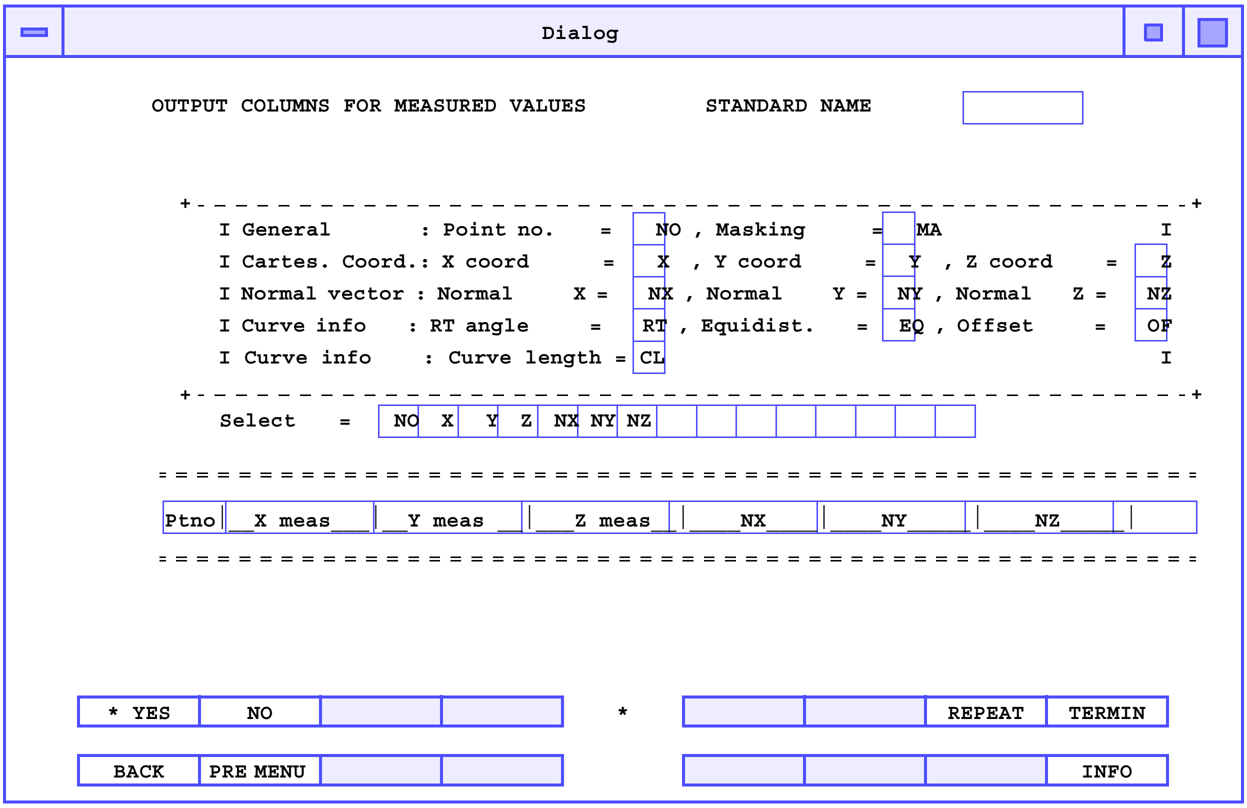
DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **MEASURED VALUE RECORD** is displayed.

COLUMNS

– Press **<COLUMNS>**.

The dialog window with the menu title **OUTPUT COLUMNS FOR MEASURED VALUES** is displayed.



NOTE

Not every combination in the dialog window can be output, even if it is defined here!

Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

REPEAT

The later format for the header line of the output columns is displayed in the lower part of the dialog window, in correspondence with the abbreviation previously entered. If all the data columns required do not fit in the record, then the following message is displayed: **No. of characters too large**.

Notes on the input and display boxes

Select

Data box for the output columns required.

Curve info: Curve length = CL

Output of total curve length (measured curve), ➤*"Output of total curve length (measured curve)" on page 8-15*.

Output of total curve length (measured curve)

You can define that the curve length is output in the record in the column with the heading **Length**. You must select **Curve info: Curve length = CL** in the output columns for measured values, ➤*"Output columns for measured values" on page 8-13*.

- The first point for the output of the curve length has length 0 mm.
- The curve lengths are added from point to point.
- The curve length of the entire curve is output in the record header.

NOTE

- For an *open curve*, the curve length of the entire curve is the same as the curve length from the first to the last point. For a *closed curve*, the curve length between the last and the first point is added in order to obtain the total curve length.
- As the curve length is calculated using the chord length (chord of an arc) between 2 consecutive points, the *accuracy* of the calculation increases, the smaller the **curve curvature**. For example, the curve length is calculated exactly for a line.
- With *increasing curve curvature*, the point density during the measurement must also increase. The measuring method **Scanning with curvature-dependent point density** can be used here, for example.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

- Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

- Acknowledge the displayed line by pressing **<ENTER>**.

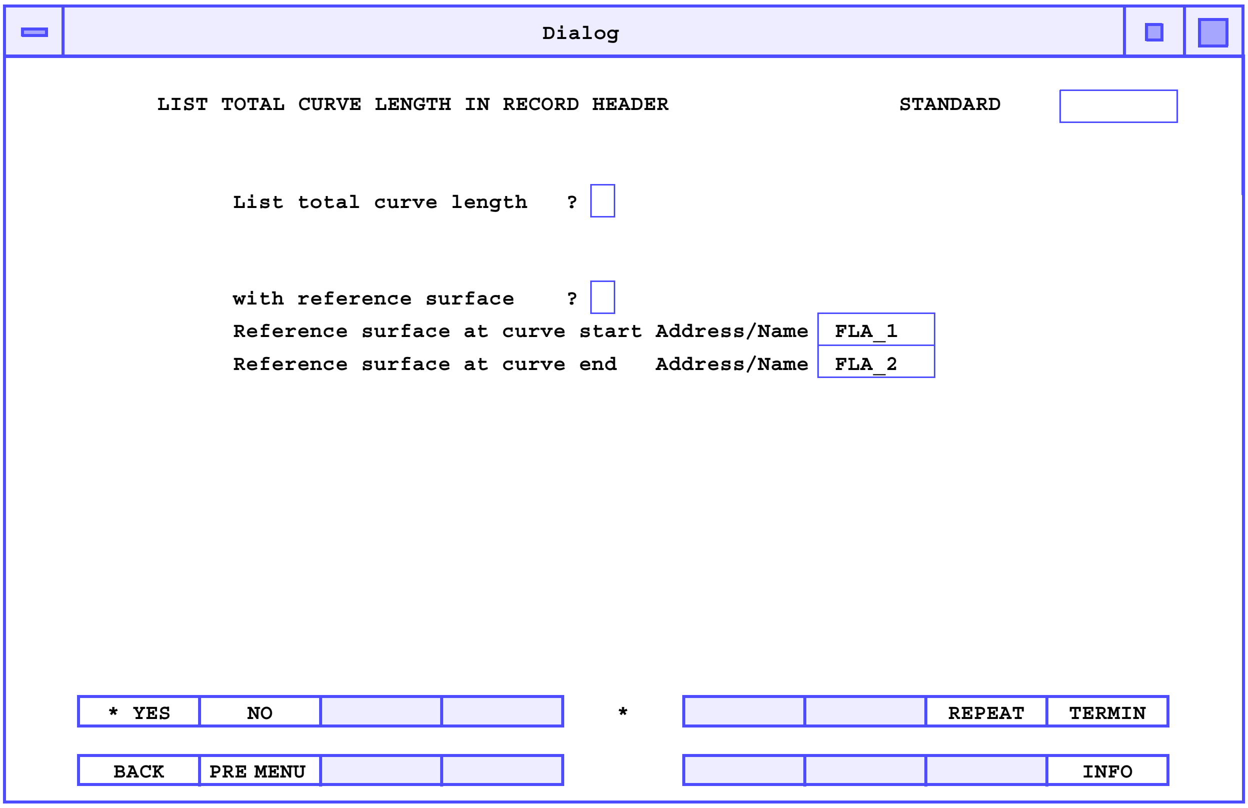
– Enter the KUM command in the data boxes.
Object: **MVA**, Action: **LIS**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **MEASURED VALUE RECORD** is displayed.

C-LENGTH

– Press **<C-LENGTH>**.
The dialog window with the menu title **LIST TOTAL LENGTH IN RECORD HEADER** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Total curve length List
Confirm with **<YES>**, if the total curve length is to be output.

With reference surface
Confirm with **<YES>**, if the reference surface for the curve start or the curve end is to be entered.

Deviation record

Basic definition for output of the deviations on the printer.

Curve jump tolerance

For the List deviations function **DEV LIS**, the curve jump tolerance was taken into consideration previously when calculating whether the tolerances had been exceeded. As the Calculate tolerances function **TOL CAL** does not calculate any curve jump tolerances, this data is **undefined**, unless previously entered using the Edit tolerances function **TOL EDI** or Edit nominals, **NOM EDI**.

By selecting or not selecting the output column **Curve jump exceeded** (CJ), you can control whether or not the curve jump tolerance is to be taken into consideration when calculating if the tolerances have been exceeded. This control option is available for point by point tolerances and if the data box **Output only with tolerance exceeded** has been activated.

Listing point by point

The sector by sector tolerances can now also be listed point by point using the List nominals or deviations functions **NOM/DEV LIS**. The corresponding output columns lower tolerance, upper tolerance, curve jump tolerance or diagram position must be selected.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

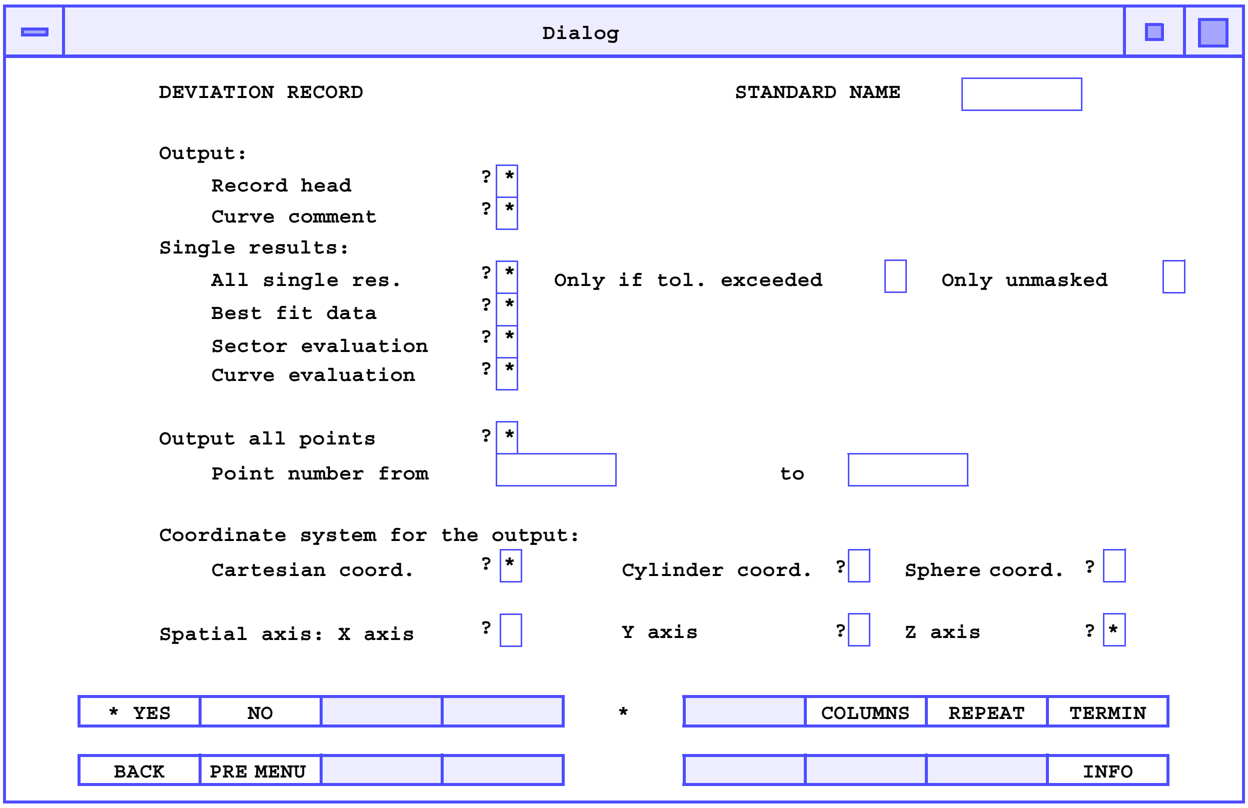
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **DEV**, Action: **LIS**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **DEVIATION RECORD** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

COLUMNS

Program jump to ➤*"Editing deviations" on page 8-21*. The output columns for the deviation record can be defined in dialog window displayed here.

Notes on the input and display boxes

Output: Record head

Enter **<YES>** or **<NO>**, depending on whether the record head defined with **<DI 1610>** is to be output or not.

Curve comment	Confirm with **<YES>**, if the curve comment is also to be output in the deviation record.
Single results: **All single res.**	Confirm with **<YES>**, if all single results are to be output.
Only if tol. exceeded	Confirm with **<YES>**, if the single results are to be output only when the tolerances are exceeded.
Only unmasked	Confirm with **<YES>**, if only unmasked single results are to be output. In the deviation record, **Point number xxx is masked** is displayed for the masked points. If you have also selected the function **Only if tol. exceeded**, only the unmasked points are checked for tolerances exceeded and listed if necessary. The curve evaluation in both cases is only made for points which are listed.
Best fit data	Confirm with **<YES>**, if the best fit data is also to be output.
Sector evaluation	A sector evaluation takes place when confirmed with **<YES>** only if the tolerances have been entered sector by sector (see **Edit nominals**).
Curve evaluation	Enter **<YES>** or **<NO>**, depending on whether a curve evaluation is to be performed or not.
Output all points	Confirm with **<YES>**, if all points are to be output.
Point number from to	If the previous box has been entered with **<NO>**, the required point range can be entered here.
Coordinate system for the output: **Cartesian coord.** **Cylinder coord.** **Sphere coord.**	The required coordinate system must be selected before defining the output columns. The column designations suggested in this input menu are directly dependent on the respective coordinate system.
Spatial axis: **X axis/Y axis/** **Z axis**	The spatial axis required must be defined here when using cylinder or sphere coordinates.

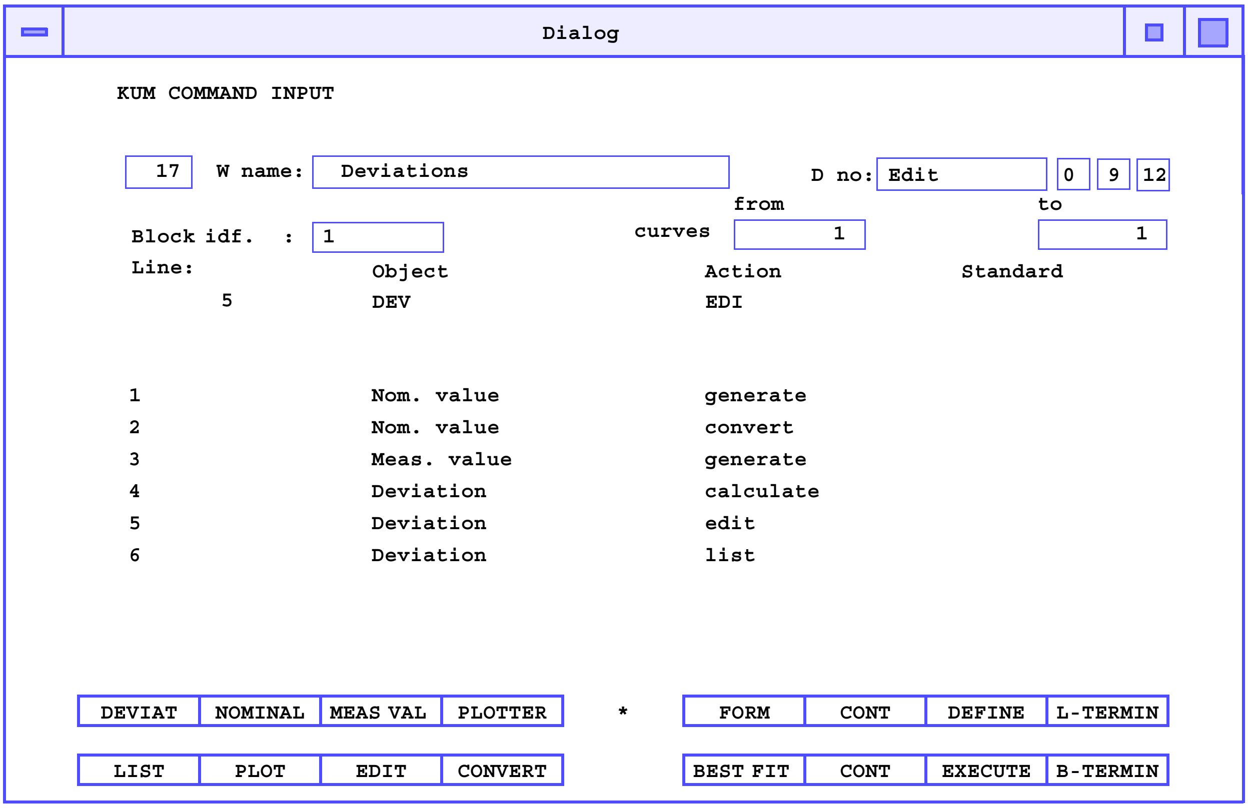
NOTE

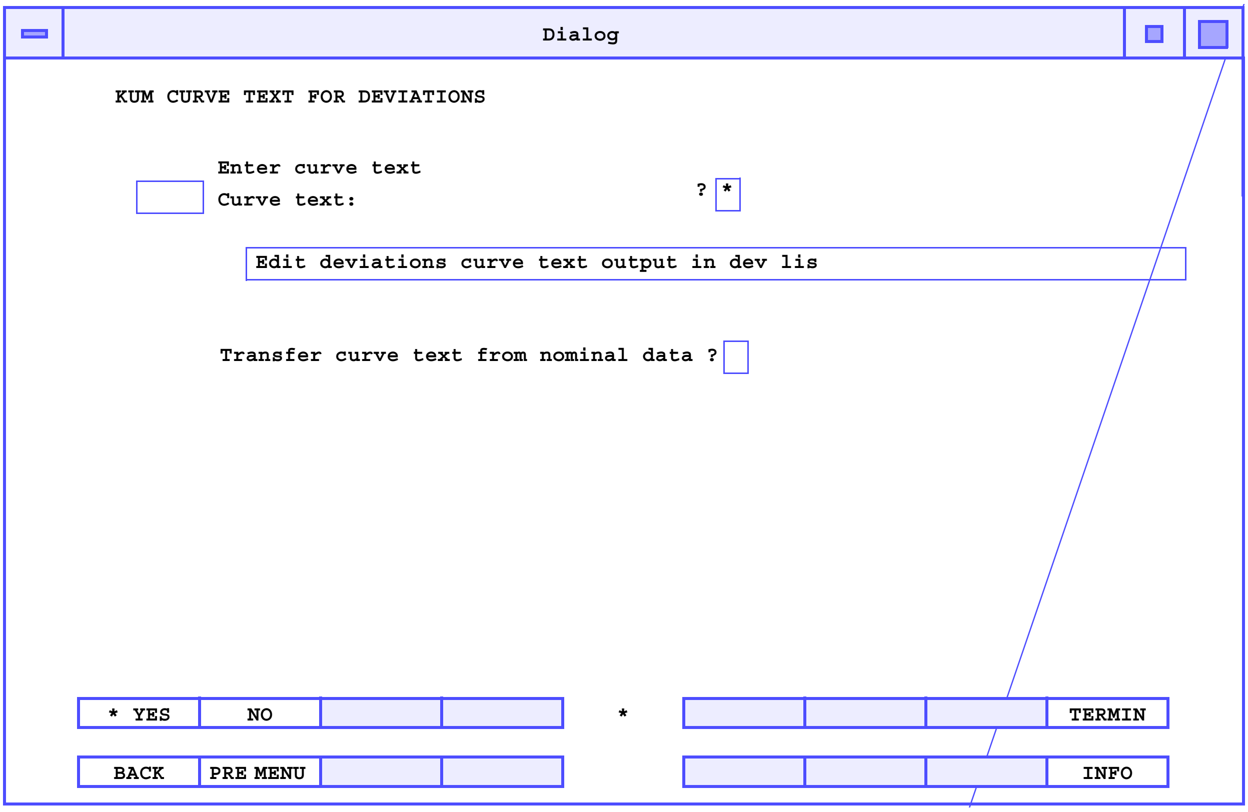
The current output device is set in UMESS with direct input:

Printer	=	**<DI 1614>**
Screen	=	**<DI 1615>**
Units	=	**<DI 1625>**

Editing deviations

The command input **DEV EDI** is inserted into a command block before a **DEV LIS** command. The text of the dialog window **DEV EDI** is output in the deviation record after the record header.





Output columns for deviations

Definition of the required data columns for output of the deviations on the printer.

The abbreviations highlighted in the dialog window must be used to define the deviation record (confirm each time with **<RETURN>**).

If the desired columns are missing in the output record despite preselection, no relevant data exists.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

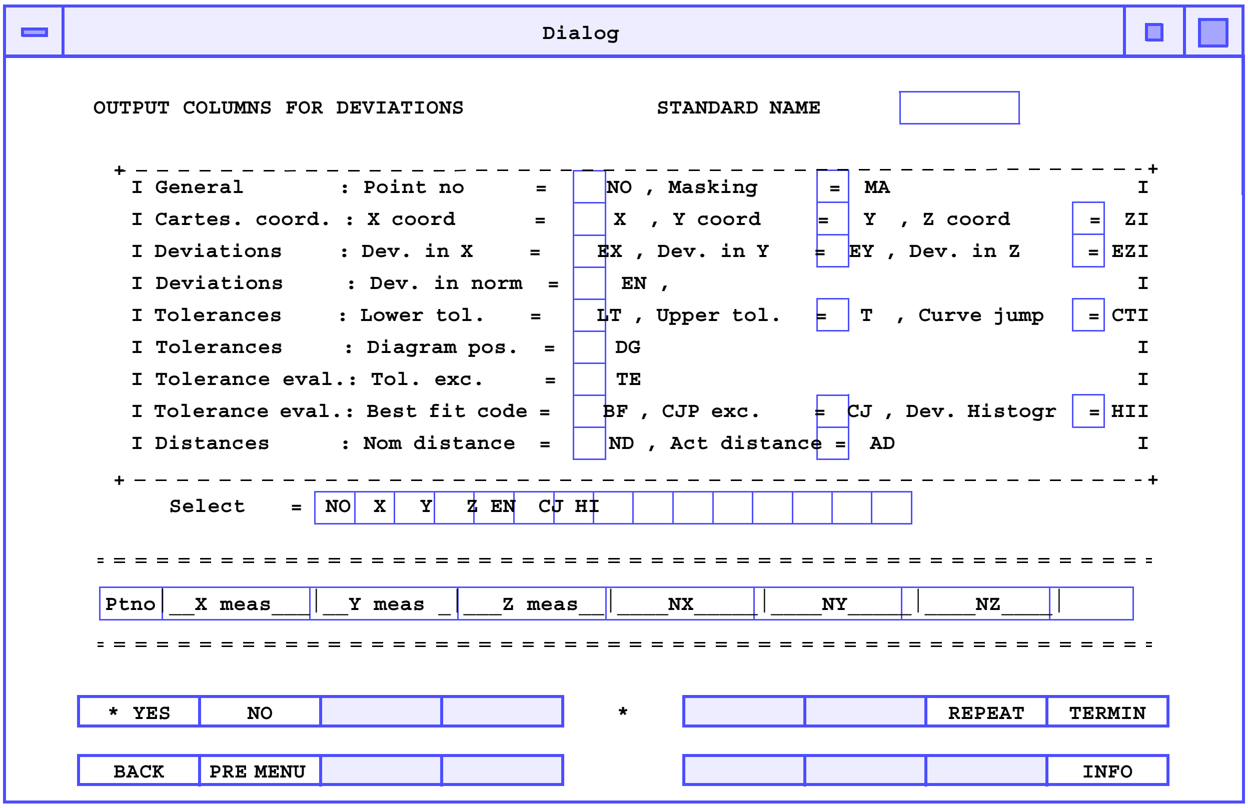
– Enter the KUM command in the data boxes.
  Object: **DEV**, Action: **LIS**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **DEVIATION RECORD** is displayed.

COLUMNS

– Press **<COLUMNS>**.
  The dialog window with the menu title **OUTPUT COLUMNS FOR DEVIATIONS** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

REPEAT

The later format for the header line of the output columns is displayed in the lower part of the dialog window, in correspondence with the abbreviation previously entered. If all the required data columns do not fit in the record, then the following message is displayed: **No. of characters too large**.

Notes on the input and display boxes

Select

Data box for the desired output columns.

Listing blade parameters

Function

With the KUM command List blade parameters **BRA LIS**, it is possible to either mirror the data or leave it unchanged for the function **Calculate radii on the leading- and trailing edge**.

Case 1

Data remains unchanged.

If the data of the leading and trailing edge remains unchanged for the calculation of the mean value ellipse, then the calculation result is very dependent on the dispersion and form (open curve) of the nominal and measured data. If the data shows a large dispersion or does not correspond to part of an ellipse with regard to form, then the calculation of a mean value ellipse is not possible. In this case, a corresponding message is displayed in the record instead of the result.

Case 2

Data is mirrored

First of all the data is mirrored on a mirror axis, i.e. the connecting line between the first and last point of the leading and trailing edge. You then get a closed curve which is used for the calculation of the mean value ellipse.

As a closed curve is used for this method, the result is stable for large dispersions of the nominal and measured data and depends mainly on the position of the mirror axis.

The position of the mirror axis can be defined with the **Identify nominals/measured data** function.

Blade parameters

The blade parameters are saved and printed in the form of UMESS results. **Statistical data**, which is calculated from the relevant nominal data and deviations, is saved with the results.

All calculations are made equally for nominal and measured data - the results from the KUM nominal data are used as nominal values for the UMESS results. Example: The blade thickness of the nominal curve is used as nominal dimension for the blade thickness of the measured curve.

The shift and rotation tolerances of the nominal values are used as tolerances.

Prerequisites

Prerequisites for using the **BRA LIS function**

– The areas of the nominal data and measured data must have been identified, **NOM IDE**, **MVA IDE**➤*"Identifying nominals or measured values" on page 5-58*.

ATTENTION!
A measured value conversion **MVA CON** is required for the probe sphere radius correction.

– The minimum number of nominal and measured data is 6 points.

– Deviations must be available **DEV CAL** or **MVA BFT**.

– The tolerances of the KUM nominal data must have been entered for a result output with tolerances, **TOL EDI** or **NOM EDI**, otherwise a reduced result output is made.

– The plane code number of the nominal data must not be = 0.

Reference curve

The reference curve is the **curve area** (**sector**) whose coordinates and tangents are used for the calculation of the intersection points with the opposite curve area. The selection of the reference curve influences the result of the calculation.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

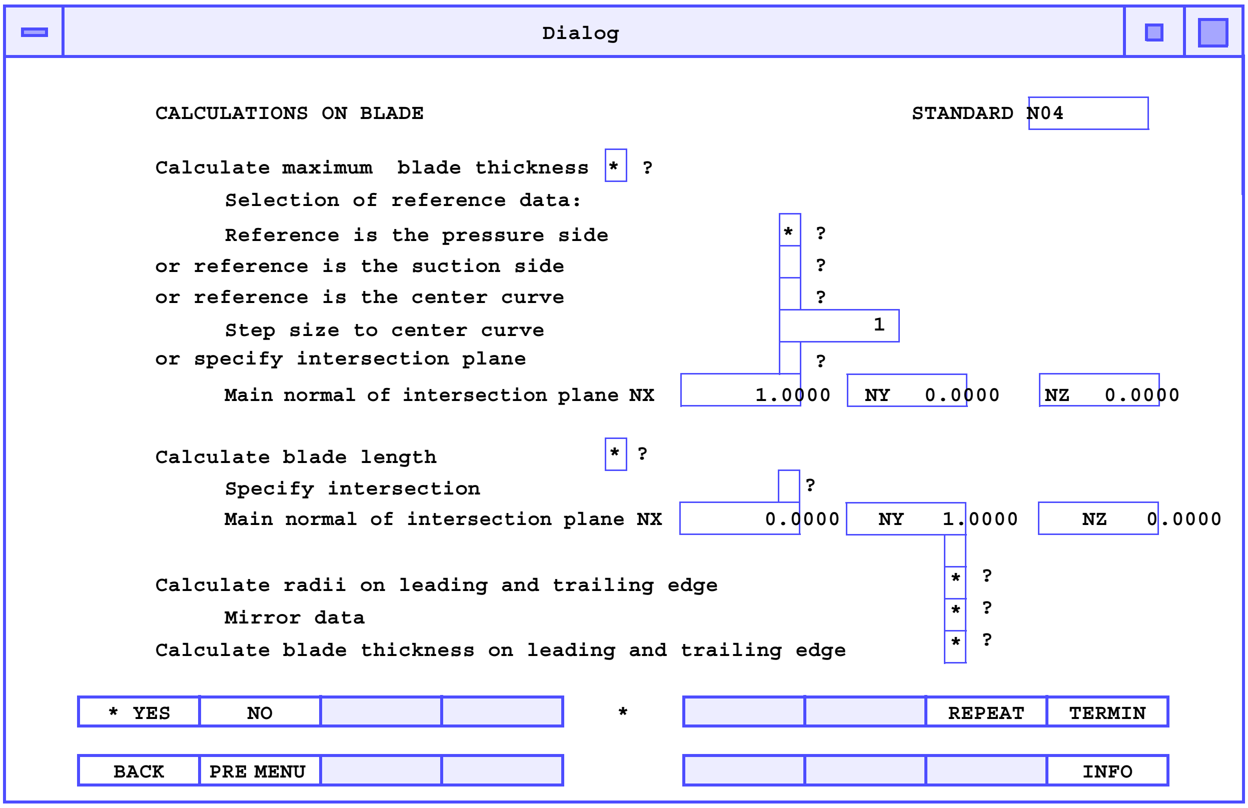
ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

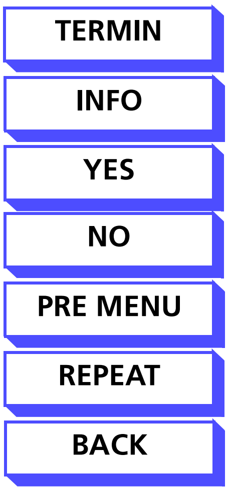
– Enter the KUM command in the data boxes.
  Object: **BRA**, Action: **LIS**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **CALCULATIONS ON BLADE** is displayed.



Softkey functions



See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Calculate maximum blade thickness

If confirmed with **<YES>**, the maximum blade thickness is calculated. Information on the direction of the blade thickness calculation is taken from the reference data. The tangents are also the main normals of the intersection planes for the blade thickness calculation. The result is printed in the form of two circles.

X, Y, Z = coordinates of the reference point (1st circle) or measured point opposite (2nd circle); D = Blade thickness

Reference is the pressure side

If confirmed with **<YES>**, the tangents from the pressure side are used for calculating the maximum blade thickness.

or reference is the suction side

If confirmed with **<YES>**, the tangents from the suction side are used for calculating the maximum blade thickness.

Reference is the center curve

If confirmed with **<YES>**, the tangents from the center curve are used for calculating the maximum blade thickness. The center curve must be available as nominal and measured curve. The center curve can have any direction of travel. This is calculated by calculating a central tangent from all tangents.

Step size to center curve

Input of the step size to the center curve.

or specify intersection plane

If confirmed with **<YES>**, the main normal of the intersection plane can then be entered.

Main normal of intersection plane Nx, Ny, Nz

Input of the main normal of the intersection plane.

Calculate blade length

If confirmed with **<YES>**, the blade length is calculated. The result is printed in the form of two circles.

X, Y, Z = Coordinates of the reference point (1st circle) or measured point opposite (2nd circle), D = Blade length

Specify intersection plane

<YES>
The intersection plane gives information on the direction of the blade length calculation.

<NO>
The blade length is calculated as if you were measuring with a slide gage. The slide gage is rotated around the blade until the largest dimension is displayed.

Main normal of intersection plane Nx, Ny, Nz

Input of the main normals of the intersection plane.

Calculate radii on the leading and trailing edge

If confirmed with **<YES>**, semi-ellipses are calculated on the leading and trailing edges. The ellipses can be printed as the result.

1^{st} ellipse	=	Leading edge
2^{nd} ellipse	=	Trailing edge
D_1	=	Large ellipse diameter
D_2	=	Small ellipse diameter
X, Y, Z	=	Coordinates of the center of gravity of the ellipse
A	=	Angle to the main axis

Mirror data

If confirmed with **<YES>**, the same semi-ellipses are used on the leading and trailing edge.

Calculate blade thickness on leading and trailing edge

Nominal thickness: The distance between the first and last point on the leading and trailing edge is calculated.

Actual thickness: Nominal distance + error in normal direction.

The result is printed in the form of two circles.

X, Y, Z = Coordinates of the first (1^{st} circle) or last measured point (2^{nd} circle).

D = Blade thickness

Chapter 9

Plotter Output

Chapter 9 shows the various options for data output on a plotter (see also alternative output on printer in ➤*"Printer Output" on page 8-1*). As well as using different plotter types, a graphics window, record graphics or laser device III can also be selected as output device by direct input (in UMESS with **<DI 1625>**).

mm/inch

In UMESS you can define whether dimensions are to be input in mm or inches, see UMESS manual. The dimensions are entered in the selected unit.

This chapter contains:

Procedure for creating a plot

Procedure

– Select plotter **<DI 1625>**.

– Initialize plotter with command **PLO INI** (➤*“Plot Init Main Menu” on page 9-6*). It is possible to arrange one or several plots on a page.
  One plot
  Drawing field size = frame size
  Several plots
  Limit frame size, enter position of frame with field reference. Re-initialize plotter for each frame.

TYP FACE

IMAGINFO

CURVINFO

PAGE ARR

You can call up 4 further pages for initialization with the 4 softkeys on the Init Main Menu page, **<TYP FACE>**, **<IMAGINFO>**, **<CURVINFO>** and **<PAGE ARR>**, ➤*“Character sizes, fonts and colors” on page 9-9* to ➤*“Page layout: Curve results” on page 9-16*.

– Print form with the command **FOR PLO** (➤*“Plot form” on page 9-29*)

FORMAT

CHART

AX/GRID

TRANS

– Call up Plot Main Menu with the command **MVA PLO**, **DEV PLO** or **NOM PLO** (➤*“Plot Main Menu” on page 9-33*) and define plot tasks. Call up further pages with the 3 softkeys **<FORMAT>**, **<CHA-RT>**, **<AX/GRID>** and **<TRANS>**, ➤*“Plot format” on page 9-38* to ➤*“Automatic plot transformation” on page 9-47*.

Different plot tasks can be selected with the KUM command inputs **NOM PLO**, **MVA PLO** and **DEV PLO**. The same dialog window is displayed in all three cases (➤*“Plot Main Menu” on page 9-33*).
Amongst others, the following plots can be created:

– 2D/3D representation

– Tolerance zone

– Net plot

– System of coordinates

– Labeling etc.

The command **CRF PLO** contains the functions **NOM PLO** and **DEV PLO**. This ensures that the tolerances and deviations are plotted with the same parameters, ➤*“Plotting a certificate” on page 9-53*.

Plot application examples

1st example

The first example shows the basic procedure for the following tasks:

– Recording measured values,
– Calculating deviations and
– output of deviation plot.

NOTE

With these tasks, it should be noted that certain conditions must be fulfilled before the actual measurement can begin. These are:

– Preparation of nominals (normal, tangent, etc.)
– Tolerances edited
– Data checked with **NOM PLO** (with normals and tolerances)

To record measured values

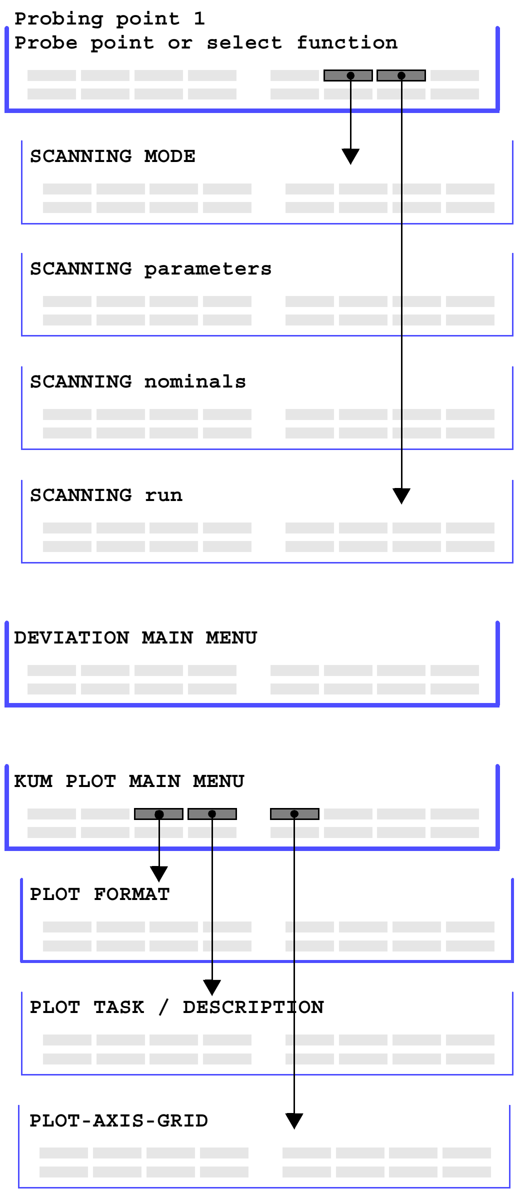
- Scanning mode
- Scanning run
- Scanning according to nominals

To calculate deviations

- Call up deviation main menu and define required criteria (**DEV CAL** in ➤ *"Deviations - Main menu" on page 7-16*)

To plot deviations

- Call up Plot Main Menu with DEV PLO (➤ *"Plot Main Menu" on page 9-33*) and define criteria (➤ *"Plot format" on page 9-38* to ➤ *"Axis and grid" on page 9-44*)



2nd example

The following illustration shows the procedure for evaluating existing data. The actual task is as follows:

- Plot nominals,
- Plot measured values and
- Plot deviations.

NOTE

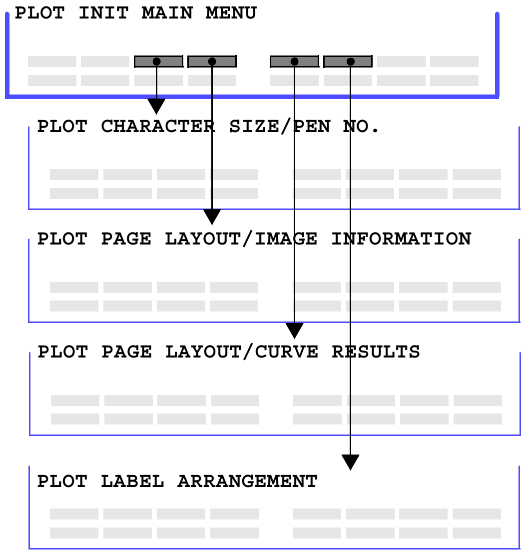
With these tasks, it should be noted that certain conditions must be fulfilled before the actual measurement can begin. These are:

- Check output device

- Output mode: Graphics mode
- Activate plotter device

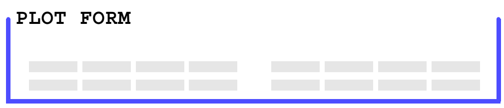
Preparation in UMESS

Initialize plotter



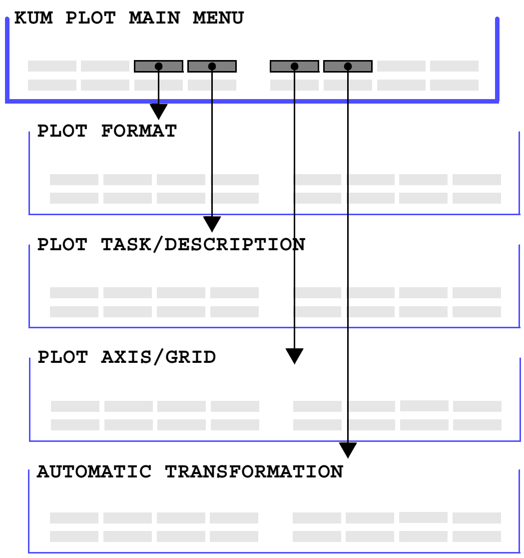
- Call up Plot Init Main Menu with PLT INI (➤ *"Plot Init Main Menu" on page 9-6*) and specify criteria for:
- Character size/pen no. ➤ *"Character sizes, fonts and colors" on page 9-9*.
- Page layout/image information ➤ *"Page lay-out: Image information" on page 9-11*.
- Page layout/curve results ➤ *"Page layout: Curve results" on page 9-16*.
- Label arrangement ➤ *"Label arrangement" on page 9-20*.

Plot form



Enter command **FOR PLO** and specify the necessary criteria ➤ *"Plot form" on page 9-29*.

Plot results



The commands **NOM PLO**, **MVA PLO** or **DEV PLO** are used to call up the Plot Main Menu (➤ *"Plot Main Menu" on page 9-33*), which allows the following criteria to be defined:

- Plot format ➤ *"Plot format" on page 9-38*.
- Task description ➤ *"Plot task description" on page 9-40*.
- Axis/grid ➤ *"Axis and grid" on page 9-44*.
- Automatic transformation ➤ *"Plot Main Menu" on page 9-33*

Plot Init Main Menu

Defining basic data for plot.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

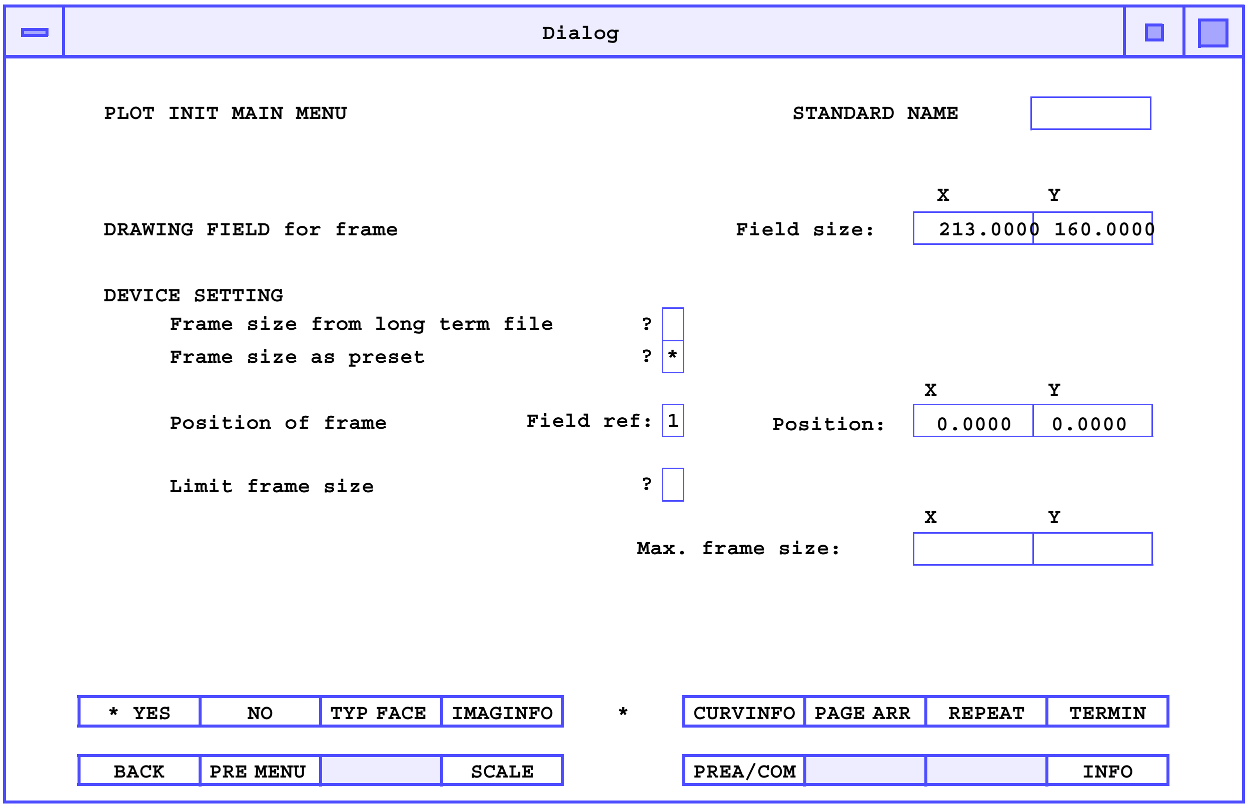
ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **PLT**, Action: **INI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **PLOT INIT MAIN MENU** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

TYP FACE

Definition of the character size and color, ➤*"Character sizes, fonts and colors" on page 9-9*.

IMAGINFO

Definition of the page layout for **Image information**, ➤*"Page layout: Image information" on page 9-11*.

CURVINFO

Definition of the page layout for **Curve results**, ➤*"Page layout: Curve results" on page 9-16*.

PAGE ARR

Definition of the arrangement of the data to be output in the boxes **Image information** and **Curve results**, ➤*"Label arrangement" on page 9-20*.

SCALE

Position scale symbol anywhere on the drawing page, ➤*"Positioning the scale character" on page 9-26*.

PREA/COM

Call up the dialog window for preassignment of standards and/or input of a comment, description ➤*"Standard preassignment/comment" on page 5-54*

Notes on the input and display boxes

DRAWING FIELD for frame: Field size

Definition of the field size for the frame on the drawing area of the plotter. For recommended values see **<DI 1625>** in the UMESS basic manual.

Frame size from long term file

In this case, the values for the frame size are read from the long term file (**<DI 1625>** in the UMESS basic manual).

Frame size as preset

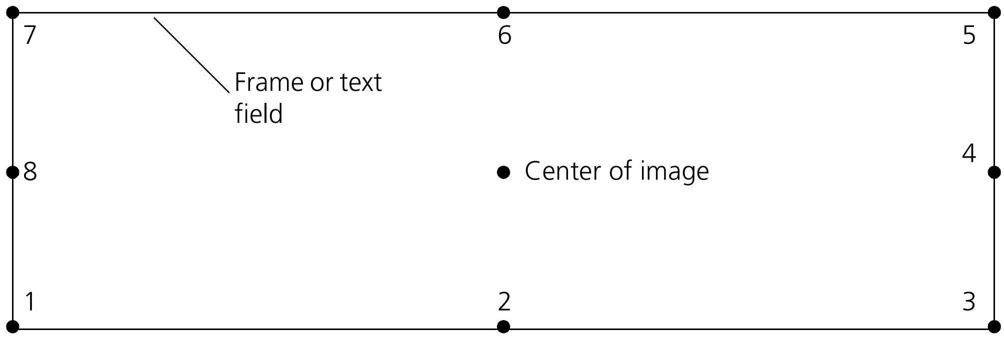
In this case, the frame must be positioned in the specified drawing field. If the frame size is not limited, the values are transferred from the **Drawing field for frame** (drawing field for frame = frame size).

The ability to limit the frame size means that several frames can be output on a page. The required frame sizes must be entered in the **max. frame size** box.

Position of frame
Field ref

The reference point grid shown below is assigned to each field (both frame and text field) regardless of form and size.

This grid enables the relative positioning of fields in a simple way. For the field reference it is only determined which grid point of the frame is to coincide with a certain grid point of a text field.



Position

Input of the XY coordinates for an absolute positioning of the frame (input values in mm or inch).

Limit frame size

Enter **<YES>** or **<NO>** depending on the requirements.

Max. frame size

Input of the max. frame size (in mm or inch).

Prerequisite for an output to scale

- The frame size (according to preset or from the long term file) must not exceed the page size permitted by the device manufacturer; see recommended values in the UMESS manual (**<DI 1625>**).
- The frame size must be limited because otherwise an enlargement or reduction is made automatically.
- If several devices are active at the same time, an output to scale only takes place on the first device in list 1625.

Character sizes, fonts and colors

Input menu for defining the character size, font and color.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

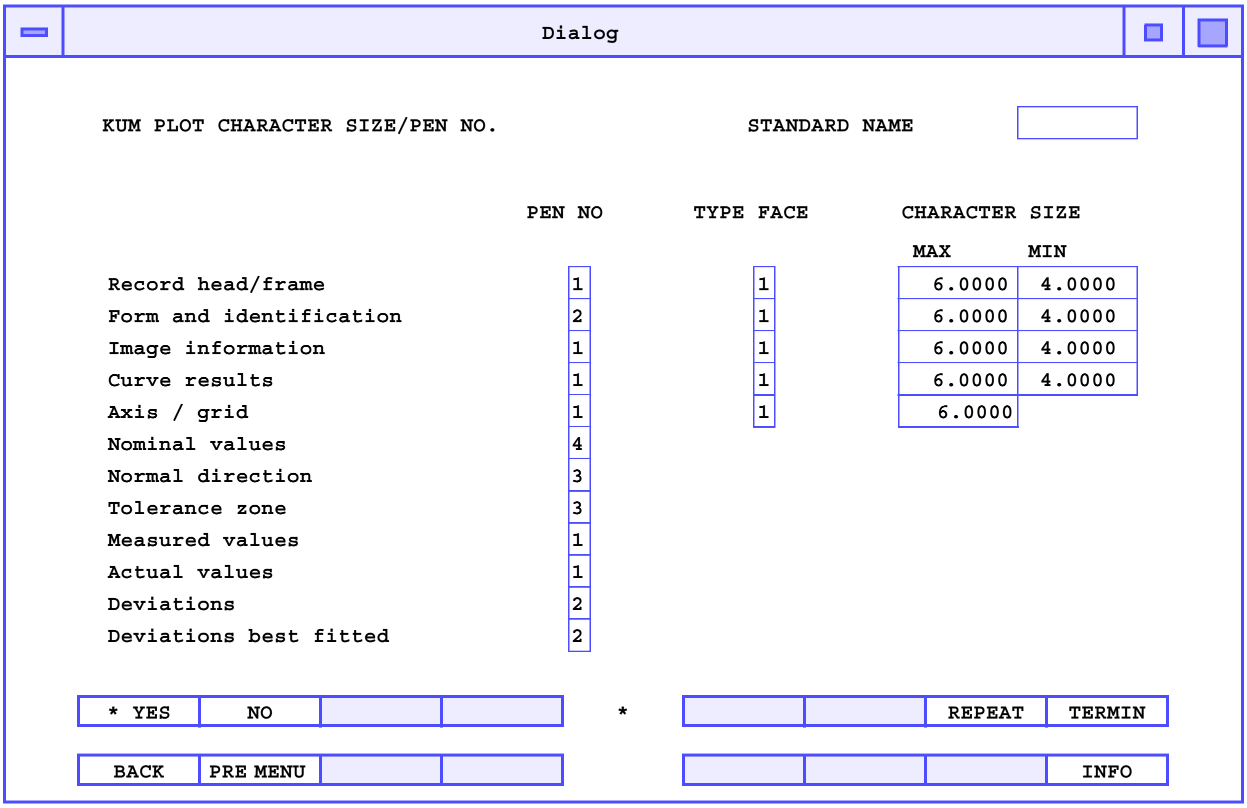
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **PLT**, Action: **INI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **PLOT INIT MAIN MENU** is displayed.

TYP FACE

– Press **<TYP FACE>**.
  The dialog window with the menu title **KUM PLOT- CHARACTER SIZE/PEN NO** is displayed.



TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

Softkey functions

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

PEN NO

The number of the color pen desired must be entered here corresponding to the plotter type and the existing magazine component. The assignment of pen no. to color for different printers can be entered in the table below.

Pen no.	PaintJet XL 300
1	Black
2	Green
3	Red
4	Blue
5	Yellow
6	Brown
7	Magenta
8	Cyan

TYPE FACE

Different type faces can be selected by entering the relevant code number, depending on the plotter type.

CHARACTER SIZE MAX, MIN

With the plot output, each piece of information is entered in a box. The program tries to perform the output with the largest character size. If the specified field limits are exceeded, the character size is reduced, either until the information can be entered in the relevant output field, or until the minimum character size is reached. The data is entered in mm, in relation to the A3 page format. The character size is enlarged or reduced accordingly with other page formats.

Page layout: Image information

Definition of the page layout for the **Image information** box.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

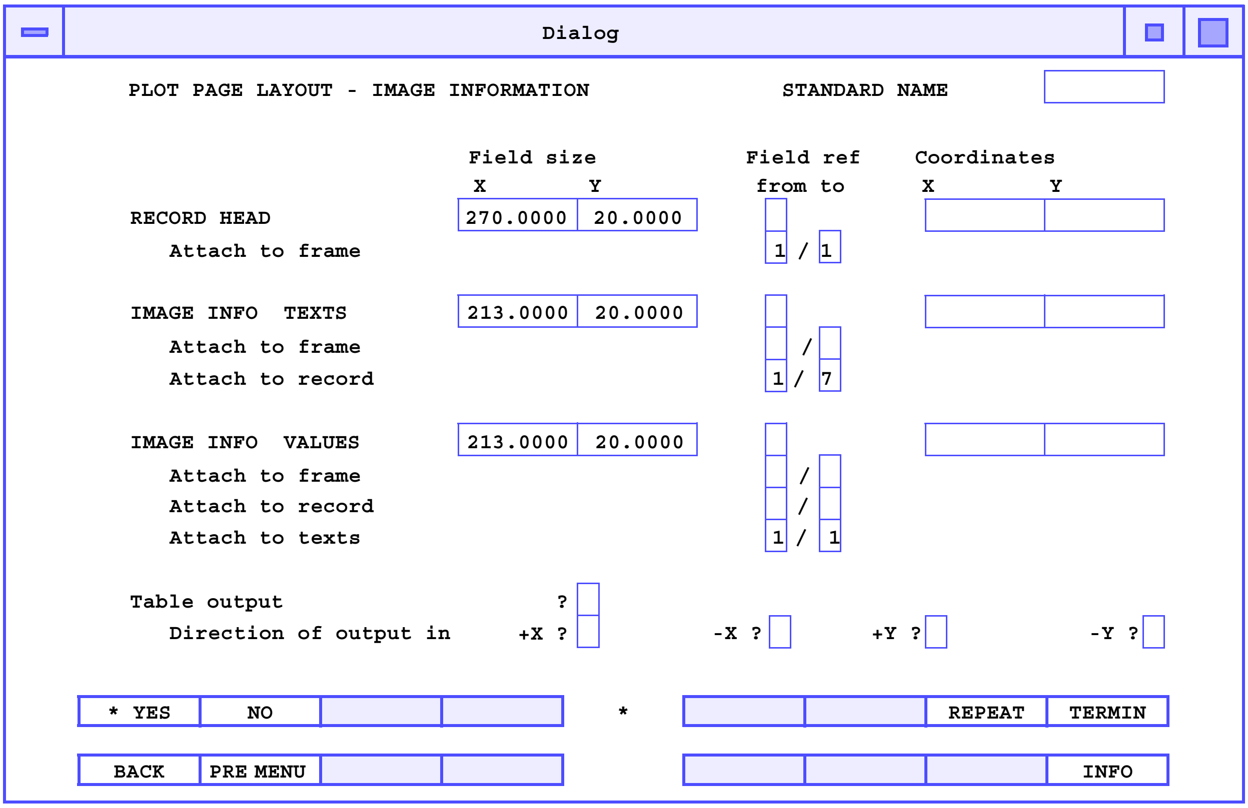
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **PLT**, Action: **INI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **PLOT INIT MAIN MENU** is displayed.

IMAGINFO

– Press **<IMAGINFO>**.
  The dialog window with the menu title **PLOT- PAGE LAYOUT -IMAGE INFORMATION** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

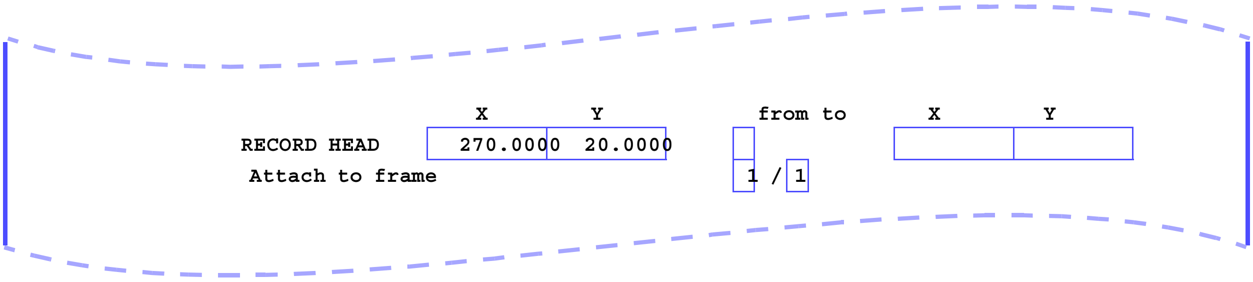
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10.*

Notes on the input and display boxes

RECORD HEAD

The height and position of the field for the record head is already set in the KUM software version. The field size is 270 mm x 20 mm; this is automatically joined to the frame 1/1.



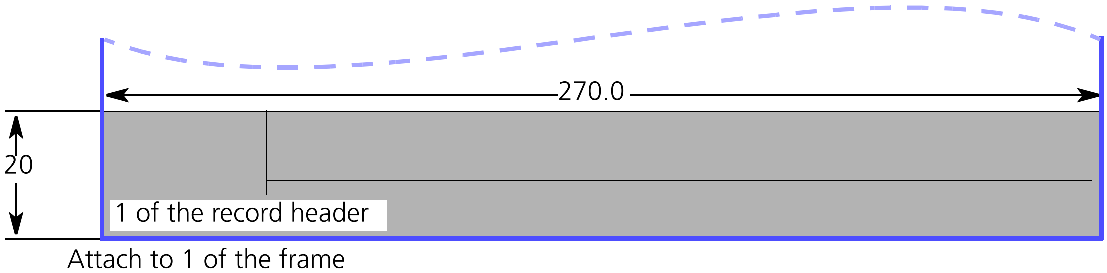
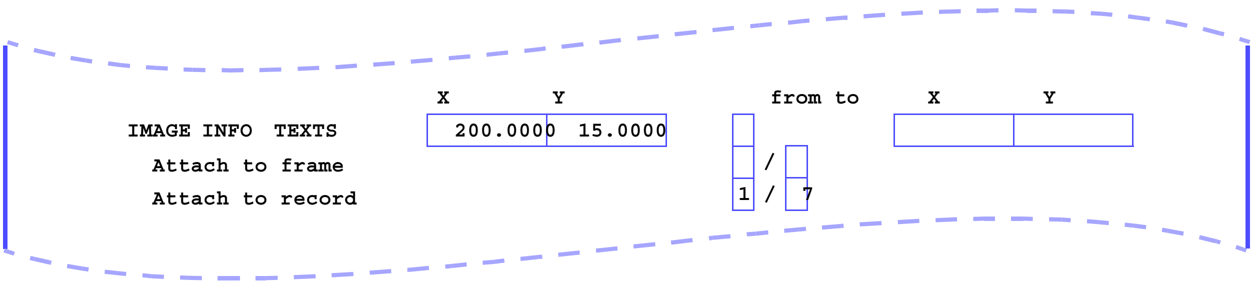


IMAGE INFO TEXTS

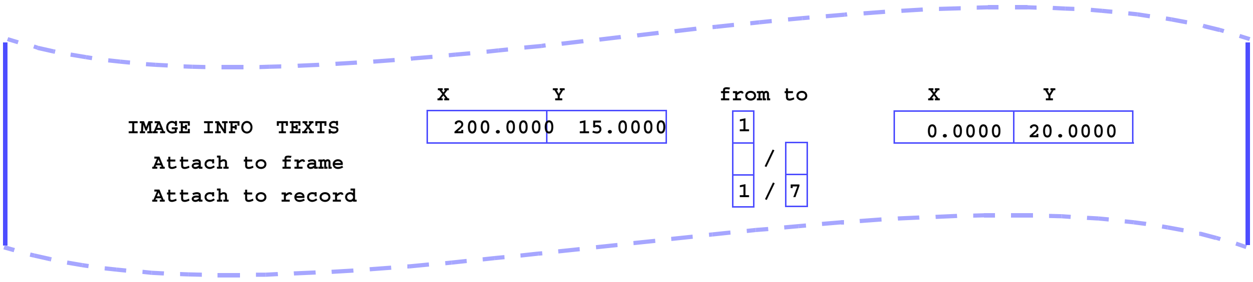
Definition of the size and position of the field for image information texts.

This is clarified by the following example:

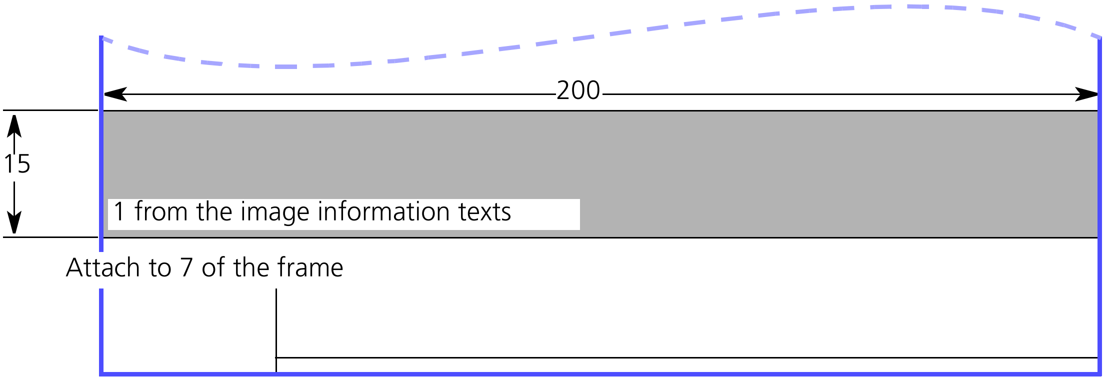
Field size = 200 mm x 15 mm, joining to the record with field reference 1/7



or field reference of 1 according to coordinates X = 0, Y = 20



leads to the following result:



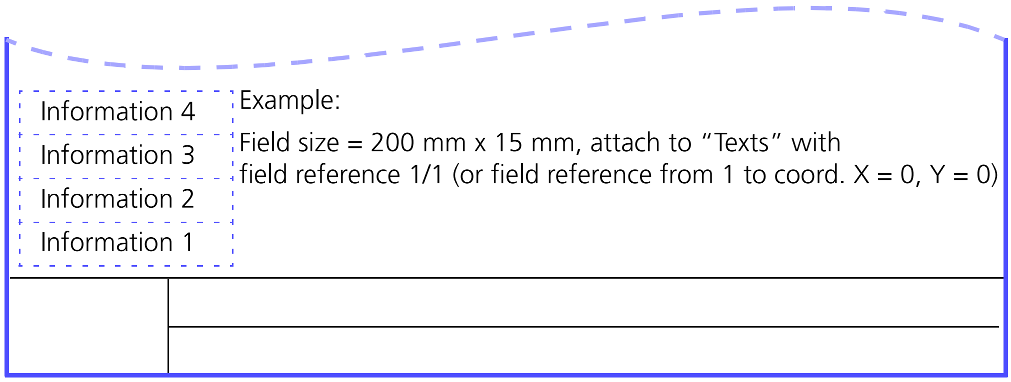
Plotting of the image information texts takes place with **PLO FOR** (➤*"Plot form" on page 9-29*).

The required output can be selected in the menu **Plot label arrangement** (➤*"Label arrangement" on page 9-20*), e.g. zero point in X, Y, Z; displacement in X, Y, Z; rotation about X, Y, Z; curve number; magnification or total magnification of the deviation; enlargement; type of representation; output in mm/inch.

Attach to frame Input of field reference from … to …

Attach to record Input of field reference from … to …

IMAGE INFO VALUES Definition of the size and position of the field for the image information values (see also example “Image information texts” on the previous page).



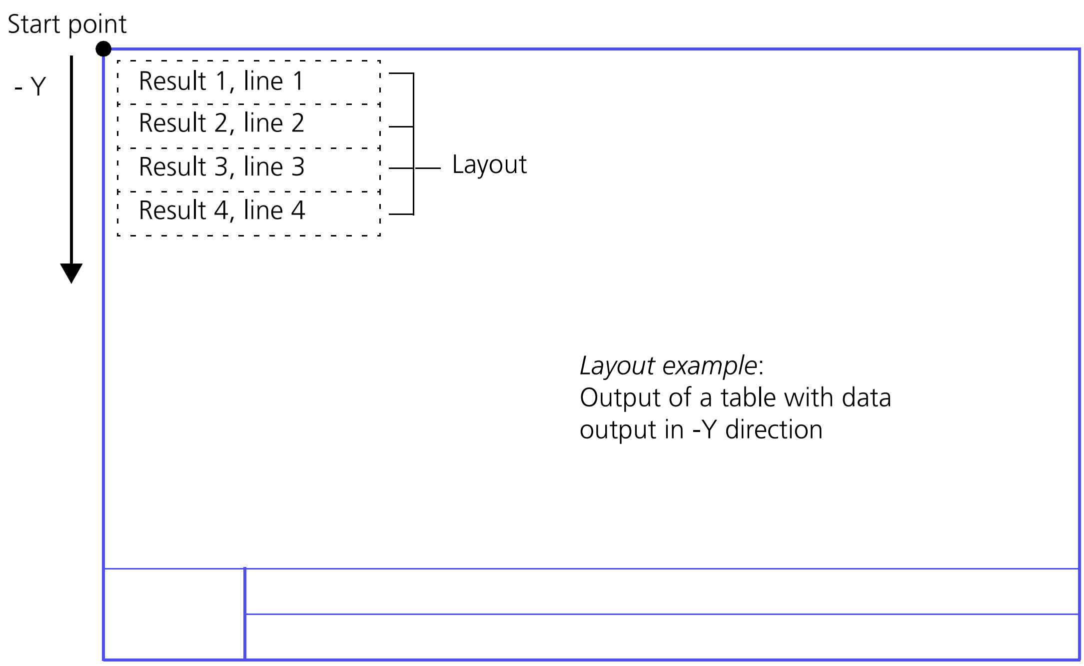
Attach to frame Input of field reference from … to …

Attach to record Input of field reference from … to …

Attach to texts Input of field reference from … to … **Table output**

It is possible to output information on several measurements in the form of a table on the same page. If this box is answered with **<YES>**, the direction of the output must then be entered.

Direction of output in +X -X +Y -Y Input of the direction of the output from the desired corner.



Page layout: Curve results

Definition of the page layout for the curve results.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

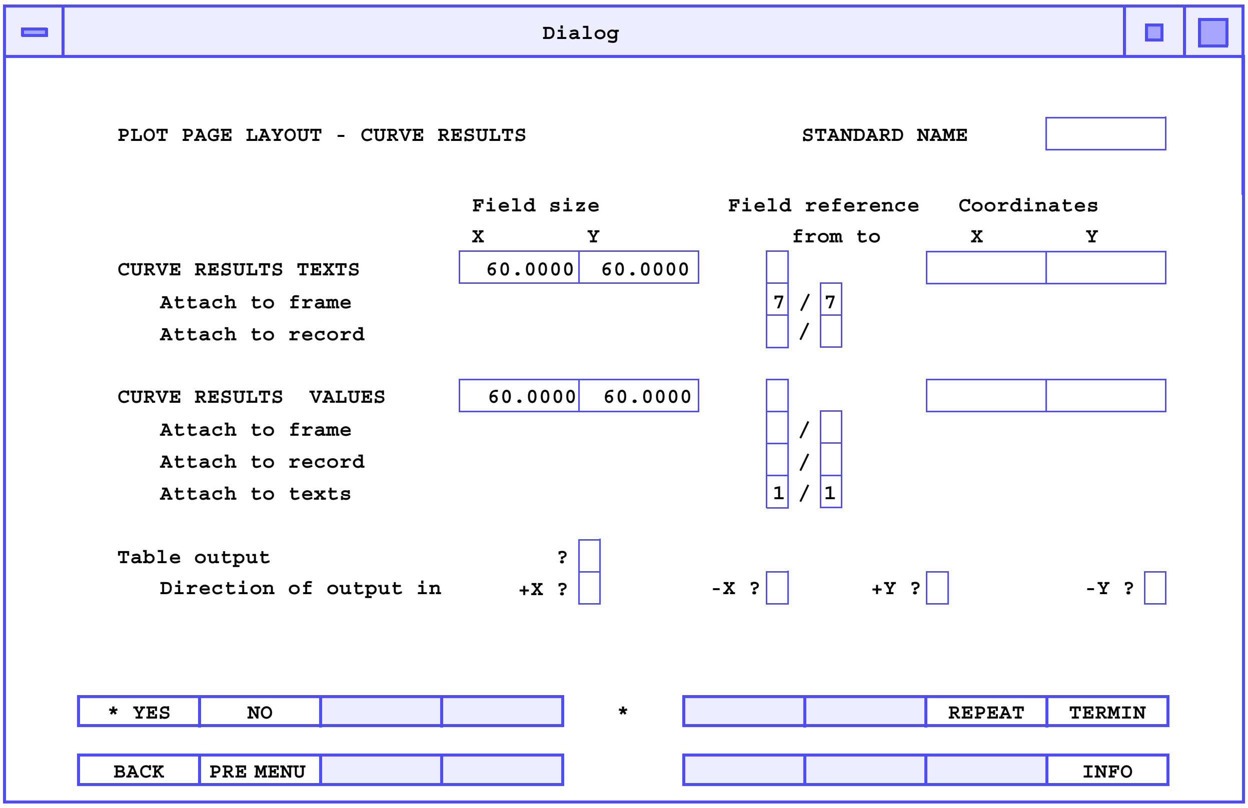
– Enter the KUM command in the data boxes.
  Object: **PLT**, Action: **INI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **PLOT INIT MAIN MENU** is displayed.

CURVINFO

– Press **<CURVINFO>**.
  The dialog window with the menu title **PLOT PAGE LAYOUT - CURVE RESULTS** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

CURVE RESULTS TEXTS Definition of the size and position of the field for curve result texts.

The curve results include:

– Center of gravity in X, Y, Z
– Displacement in X, Y, Z
– Rotation about X, Y, Z
– Curve number
– Part number
– Type of best fit
– Offset

Field size Definition of the field size (in mm or inch).

Coordinates X, Y Input of the coordinates for attaching.

Attach to frame Input of field reference from … to …

Attach to record Input of field reference from … to …

CURVE RESULTS VALUES Definition of the size and position of the field for curve result values; see example below.

Attach to frame, to record or to texts Input of field reference from … to …

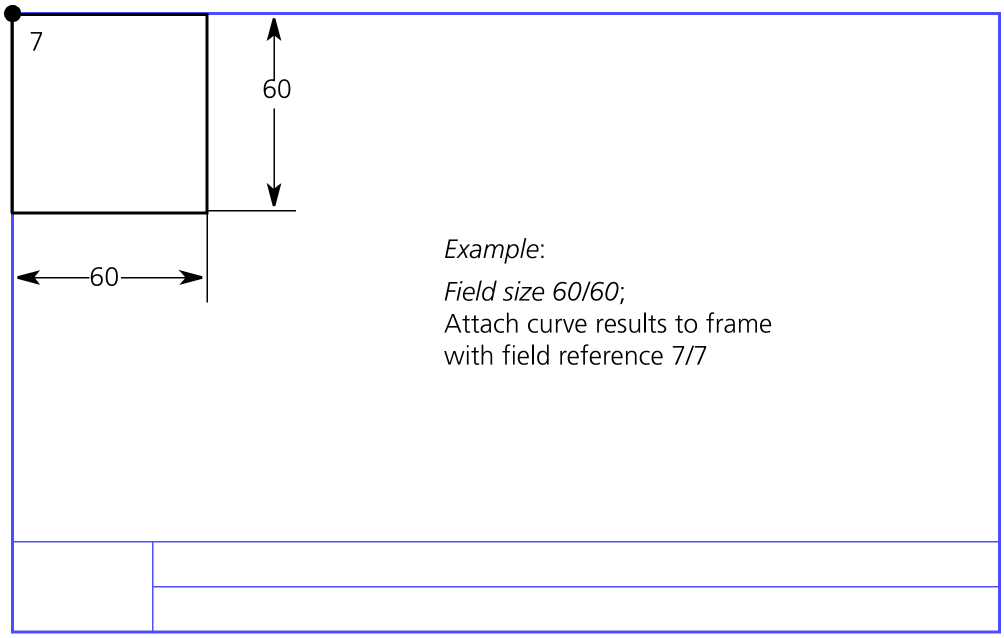


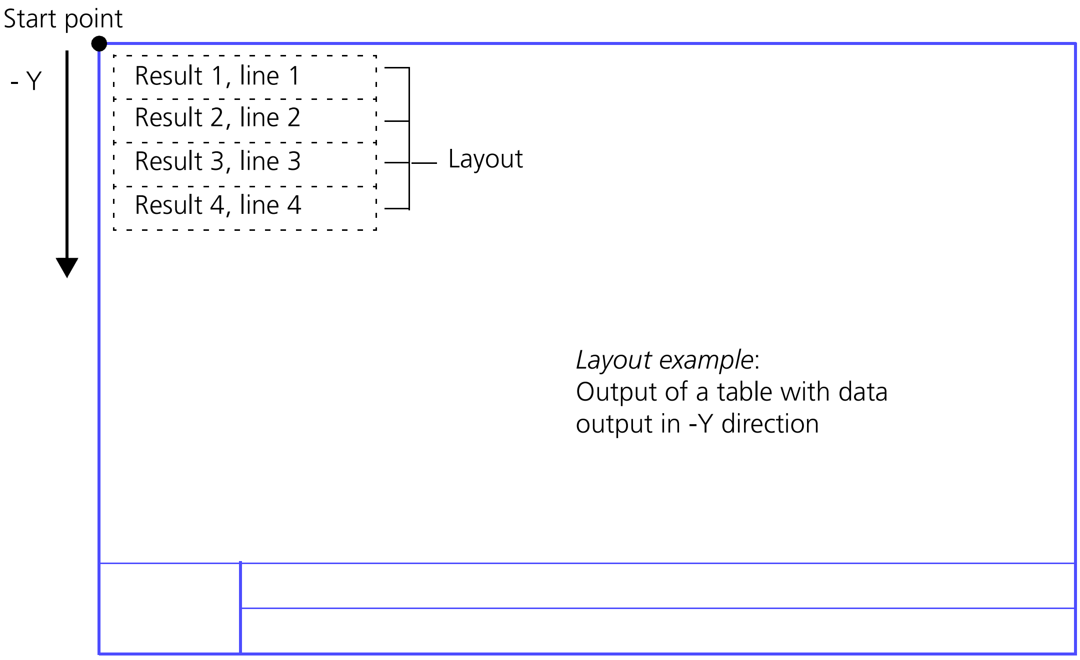
TABLE OUTPUT

It is possible to output the results from several measurements in the form of a table on the same page. If this box is answered with **<YES>**, the direction of the output must then be entered.

Direction of the output in +X/-X/+Y/-Y

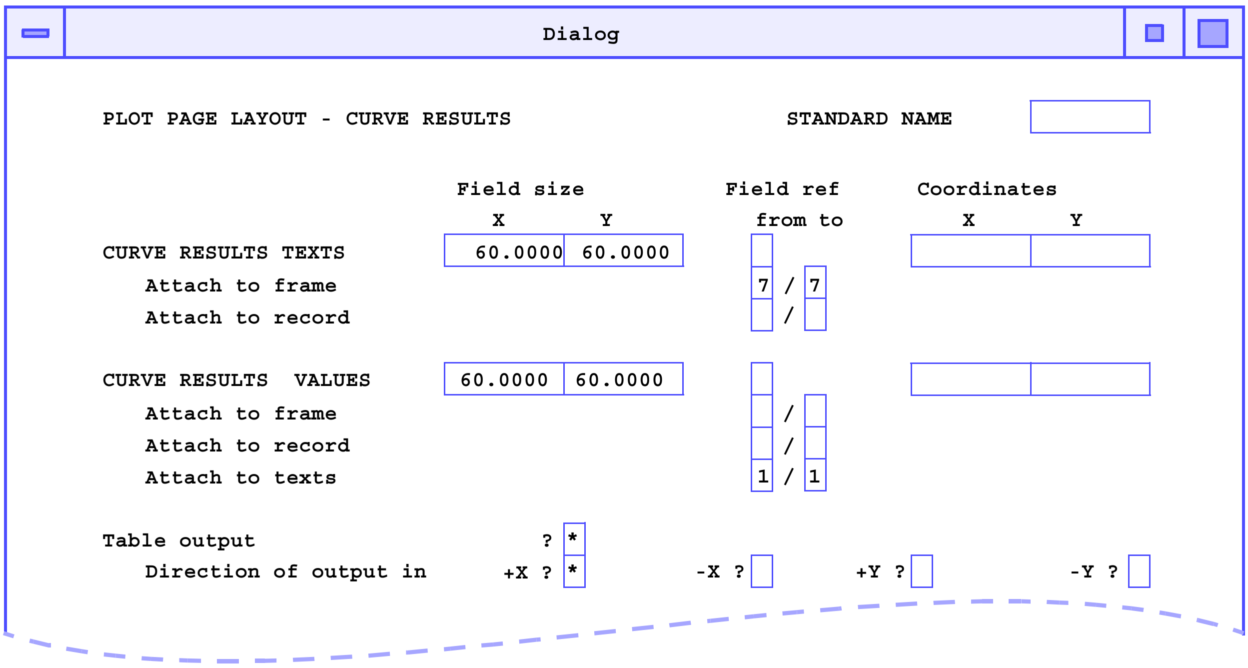
Specification of the automatic attachment in the desired corner

- The start point for texts is defined by the inquiry in **Curve results texts, Attach to frame/record**
- The start point for values is defined by the inquiry **Curve results values, Attach to frame, record, texts**.
- The labeling layout is defined by the menu **Plot label arrangement**; see next page.
- With the table layout, certain limitations apply for the line-column layout (see ➤*"Label arrangement" on page 9-20*).

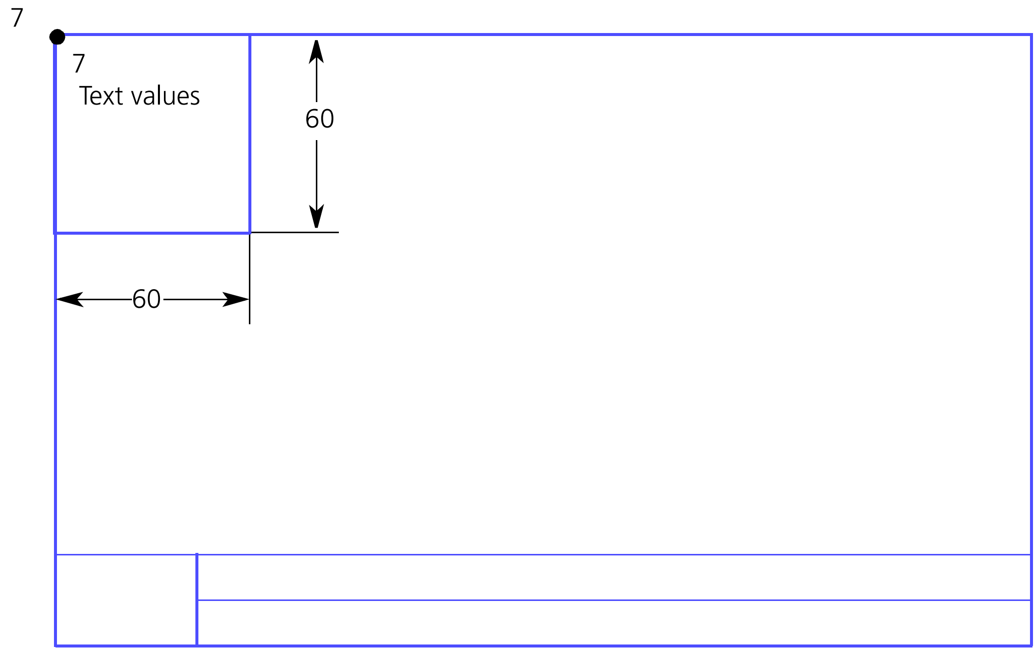


Input example

If you make the following inputs in the dialog window, you will get the graphics output shown below.



… you will get this output.



Label arrangement

Line/column layout for plotting the **Image information** and **Curve results**.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

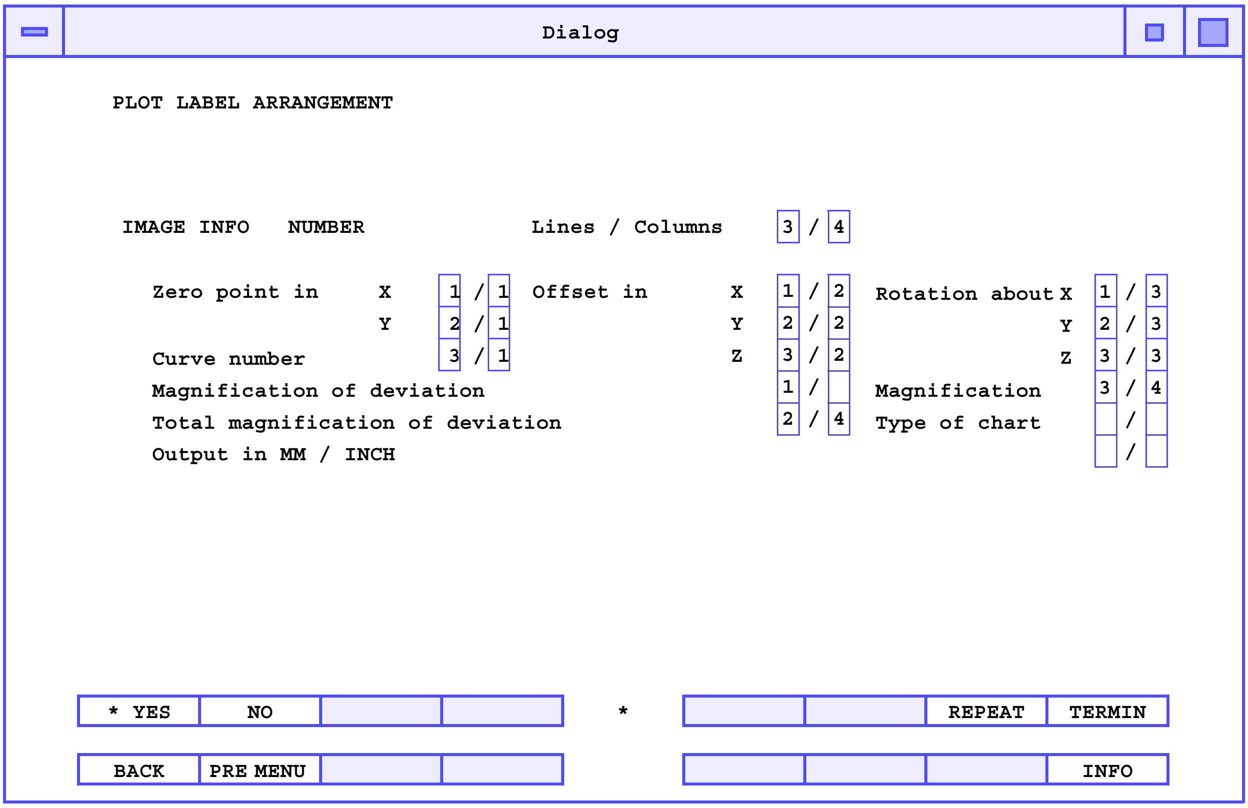
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **PLT**, Action: **INI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **PLOT INIT MAIN MENU** is displayed.

PAGE ARR

– Press **<PAGE ARR>**.
  The dialog window with the menu title **PLOT LABEL ARRANGE-MENT** is displayed.



Softkey functions

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

TERMIN

When this dialog window is completed, a follow-on page is called up.

Notes on the input and display boxes

IMAGE INFO NUMBER Lines / Columns

The character size and the amount of information to be output should be selected so that the predefined field sizes (curve results page layout, image information page layout) are not exceeded, as otherwise pieces of information will be written over the top of each other. Limitations for table output of the curve results and image information:

- With output in +X or -X: All texts and values must be in one column (number of lines = any, number of columns = 1)
- With output in +Y or -Y: All texts and values must be in one line (number of lines = 1, number of columns = any).

Zero point in X, Y

Position of the workpiece zero point in the drawing field for frame.

Offset in X, Y, Z

Plot offset (line/column).

Rotation about X, Y, Z

Rotation of the workpiece when plotting (line/column).

Curve number

Number of the output curve (line/column). **Magnification of deviation**

Scale for deviations (line/column).

Magnification

Scale for nominals and measured data

Total magnification of deviation

Magnification of deviation x enlargement factor (line/column)

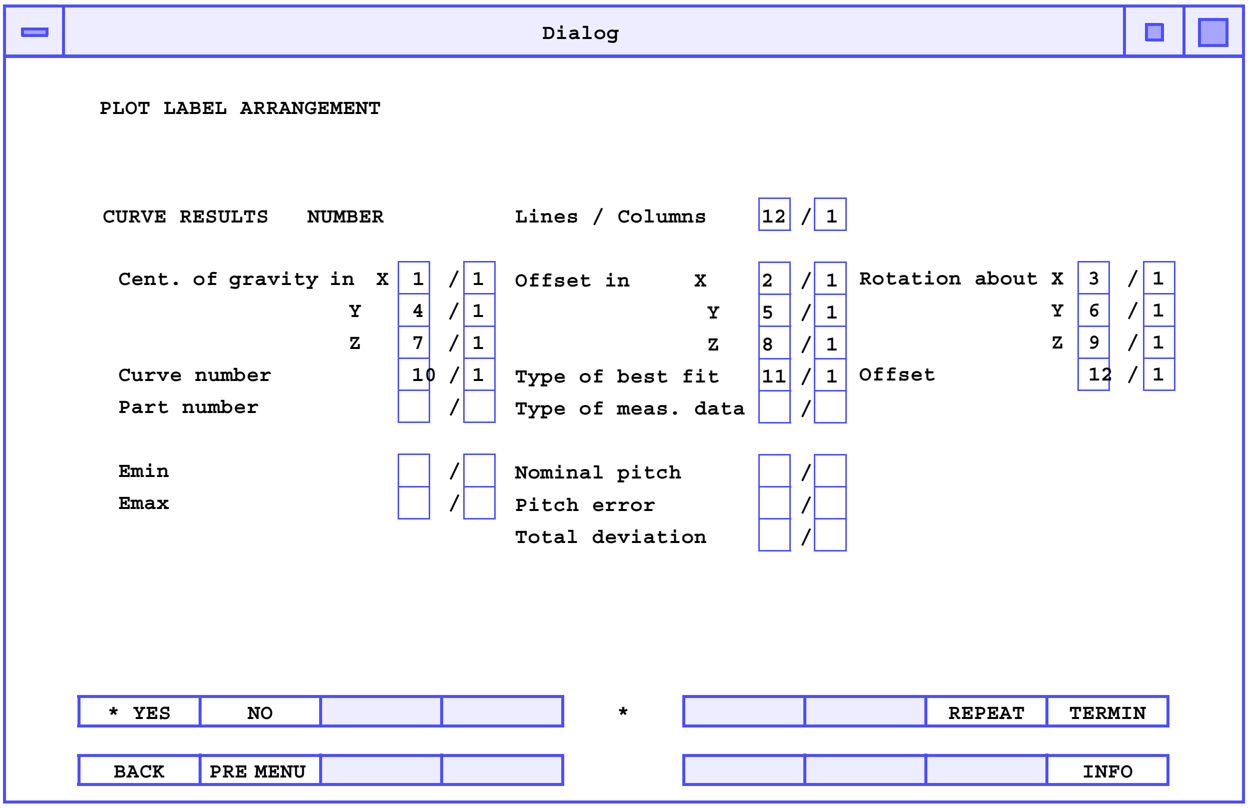
Type of chart

Curve representation (line/column)

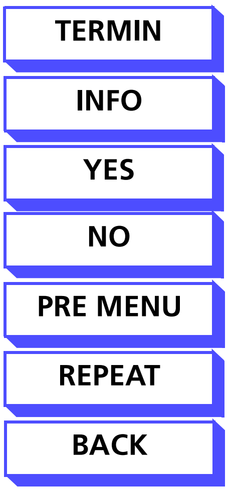
Output in MM/INCH

Display box for numerical values in mm or inches (line/column)

Follow-on page



Softkey functions



See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the input and display boxes

CURVE RESULTS NUMBER Lines/Columns	Number of lines and columns.
Cent. of gravity X, Y, Z	Center of gravity of the curve to be output (line/column).
Offset in X, Y, Z	Offset calculated during the translational best fit (line/column).
Rotation about X, Y, Z	Rotation angle calculated in degrees during the rotational best fit (line/column).
Curve number	Input of the curve number (line/column).
Type of best fit	Only with the function **DEV PLO**: Display box for defining whether the type of best fit is translational **TRS** and/or rotational **ROT**.
Offset	Data box is not activated.
Part number	Input of part number (line/column)
Type of measured data	Only with the function MVA PLO: Display box for defining whether the measured values are available as **Probe sphere center points** or **Surface points**.
E_{min}/E_{max}	Input of E_{min}/E_{max} (line/column). Output of the value is made in all deviation plots: Plot deviations (**DEV PLO**), Plot certificate (**CRF PLO**), Plot linear deviations (**LDE PLO**) and Plot compensation line (**ASG PLO**).

The corresponding point number is plotted in brackets on the right of the E_{min} or E_{max} text. For a polar plot, the rounded-off polar angle is plotted in brackets. The deviations are normally calculated in the direction of the nominal normals. If the command **Calculate radials** (**RAV CAL**) is executed before the plot command, then the deviations are calculated in the radial direction.

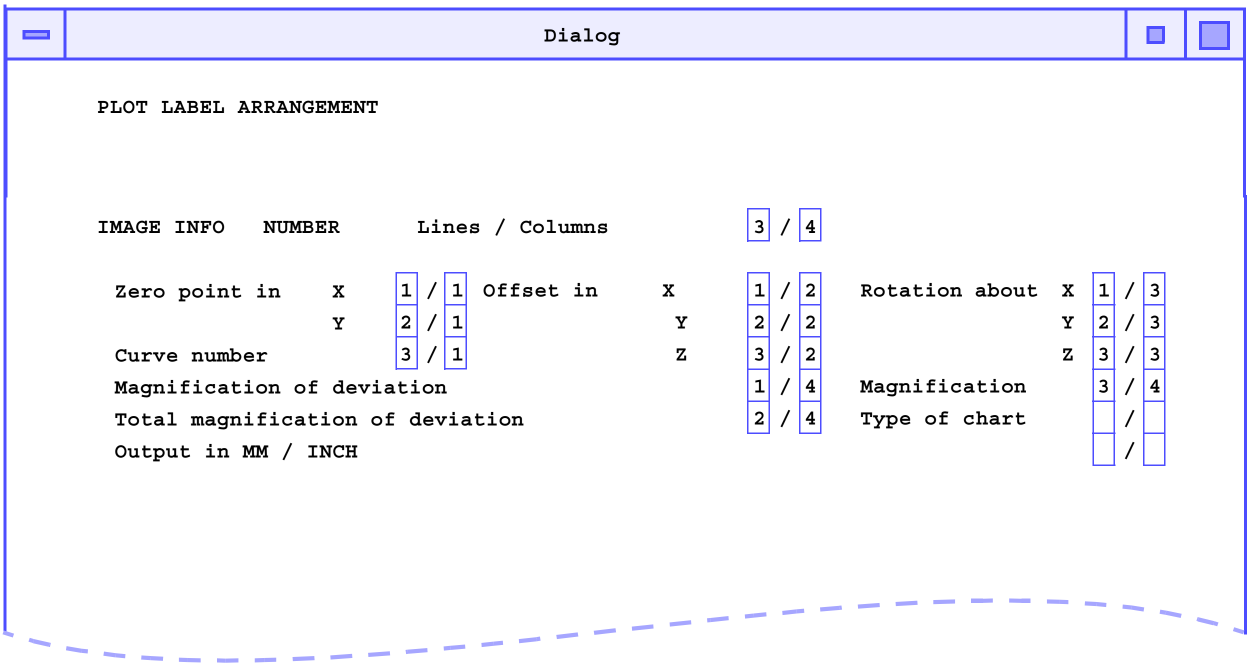
NOTE

Converted nominals and deviations are required for the calculation. If no nominal data is available, then the following calculations cannot be made. Projection of the deviations in the direction of the nominal normal, Calculate radials, Calculate polar angle.

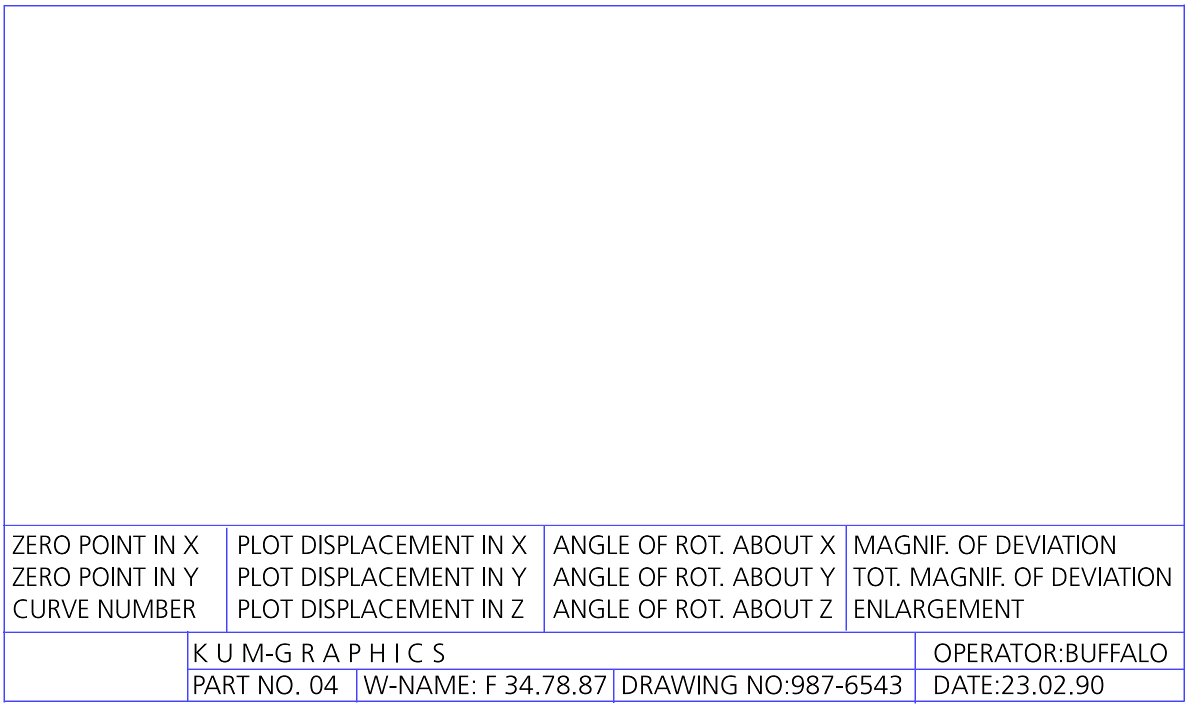
Nominal pitch	Input of the nominal pitch (line/column).
Pitch error	Input of the pitch error (line/column).
Total deviation	Input of the total deviation (line/column).

Input example

If you make the following input in this window…



… you will get this output.



Positioning the scale character

You can position the scale character anywhere within the drawing field.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

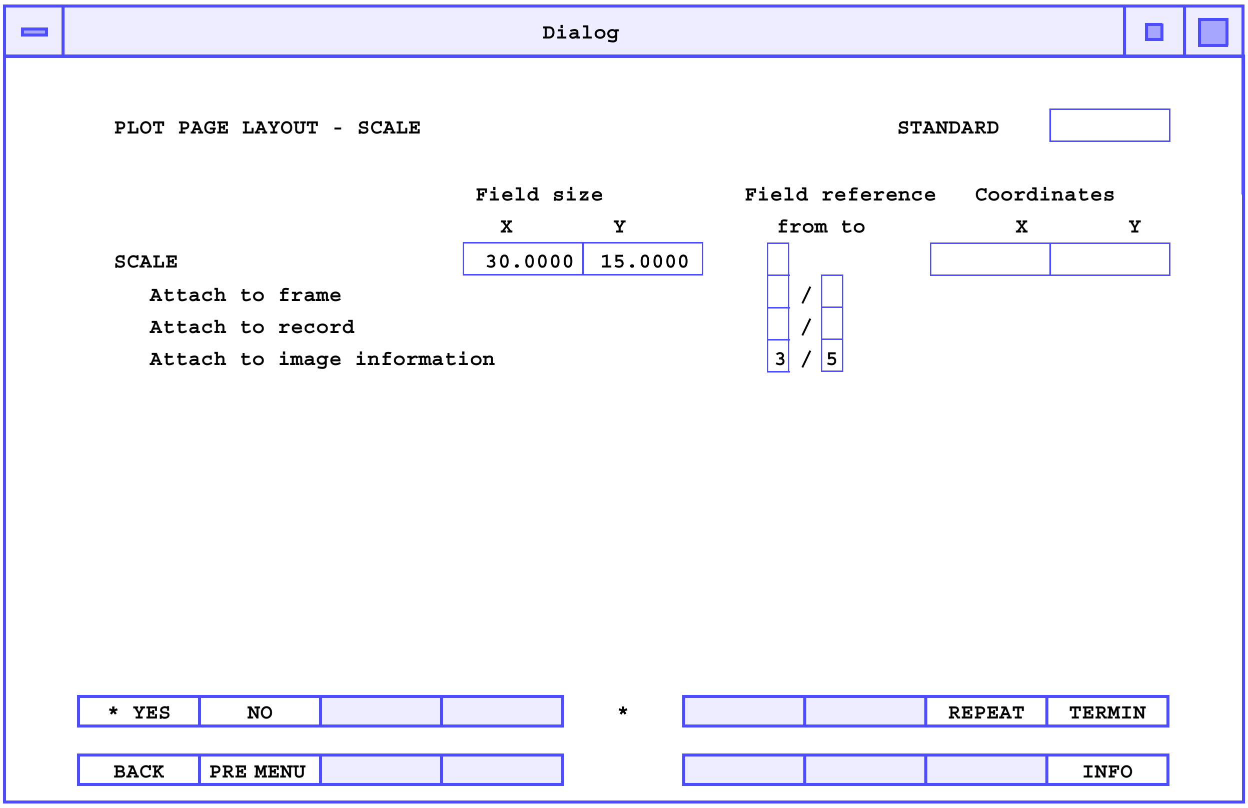
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **PLT**
  Action: **INI**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **PLOT INIT MAIN MENU** is displayed.

SCALE

– Press **<SCALE>**.
  The dialog window with the menu title **PLOT PAGE LAYOUT - SCALE** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10.*

Notes on the input and display boxes

Field size

Definition of the size of the field in which the scale character is located.

Field reference coordinates

The position of the field with the scale character can be assigned to the reference point grid (➤*"Plot Init Main Menu" on page 9-6*) or coordinates.

Attach to frame

Attach to record

Attach to image information

Input of field reference (reference point grid) from to …

Plot form

This mask allows you to define the conditions for the **Plot form**.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

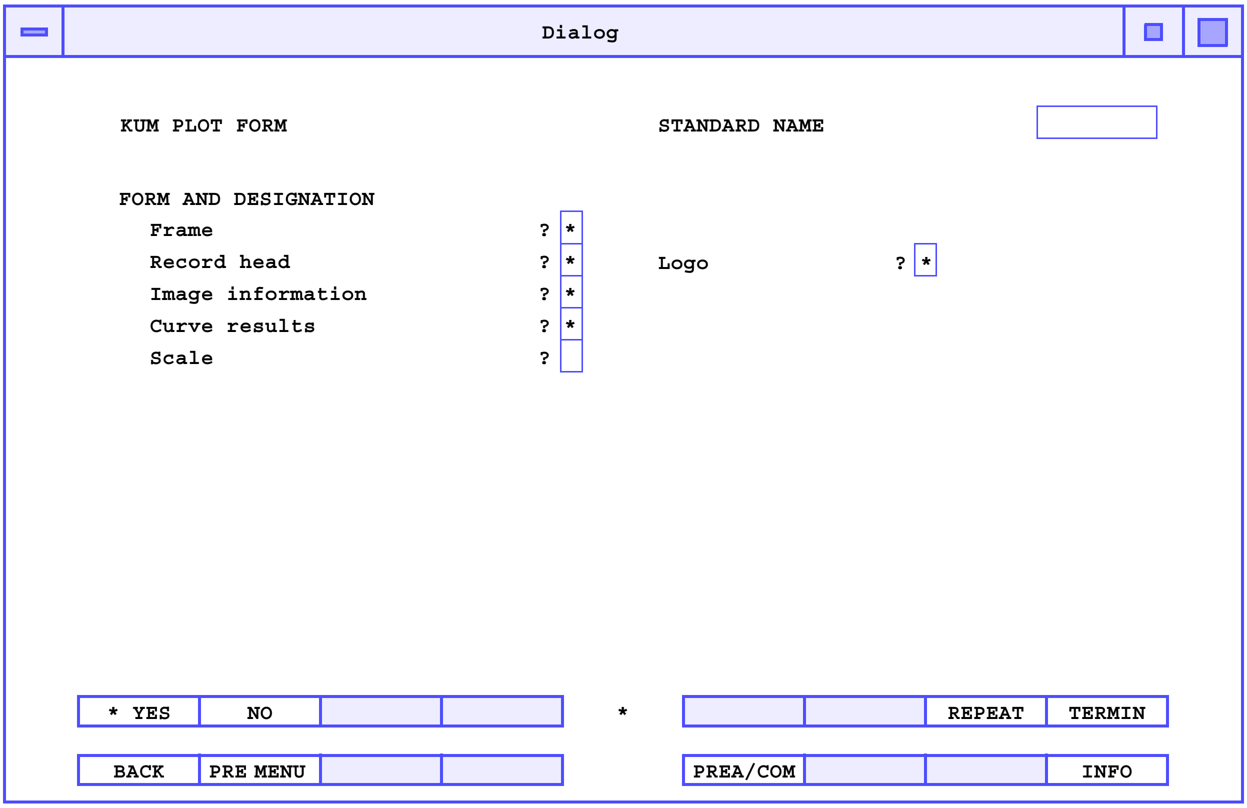
ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **FOR**
  Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM PLOT FORM** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

PREA/COM

Call up of the dialog window for preassigning standards and/or input of a comment, description ➤*"Standard preassignment/comment" on page 5-54*.

Notes on the input and display boxes

Frame

To draw the frame.

Record head

To plot the frame and the texts of the record head.

Image information

Output of the texts for the image information according to the definitions made when initializing the plotter.

Curve results

Output of the texts for the curve results according to the definitions made when initializing the plotter.

Scale

A scale character in the form of a line 10 mm long is plotted.

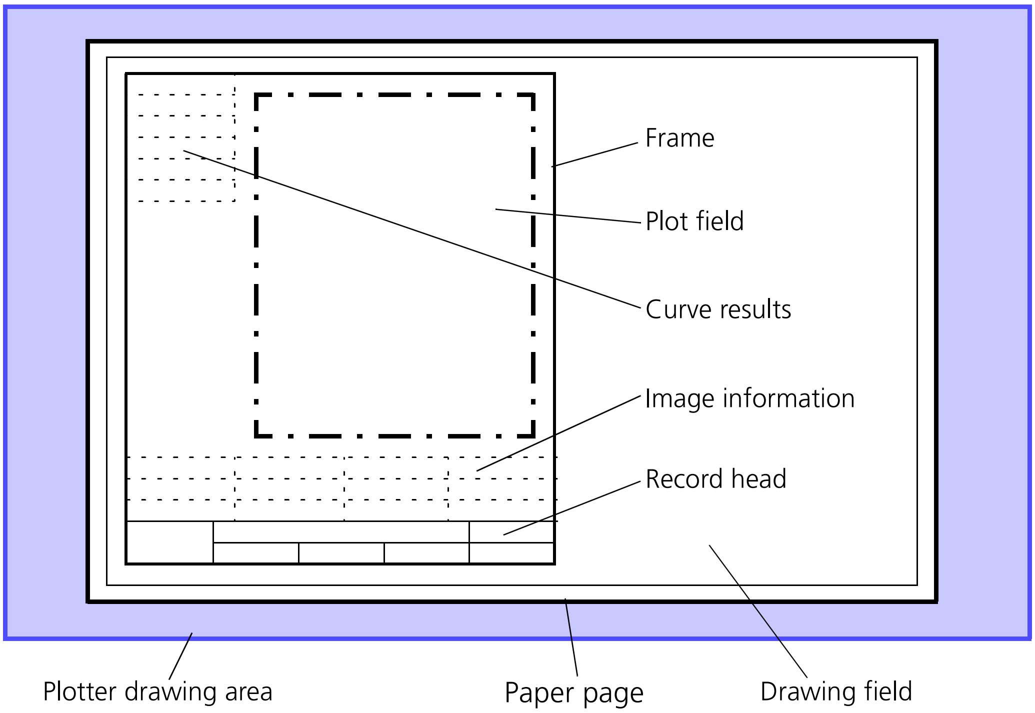
The scale character is labeled if, in the main page of a plot function for which the deviations, speeds or accelerations are plotted, i.e. for the commands **DEV PLO** (➤*"Plot Main Menu" on page 9-33*), **LDE PLO**, **ASG PLO**, **LIF PLO**, **SPE PLO** and **ACC PLO**, you answer the **Scale** data box with **<YES>**.

You can position the scale character wherever you like within the **Initialize plotter** function (**PLT INI**) with **<SCALE>**, ➤*"Positioning the scale character" on page 9-26*.

Logo

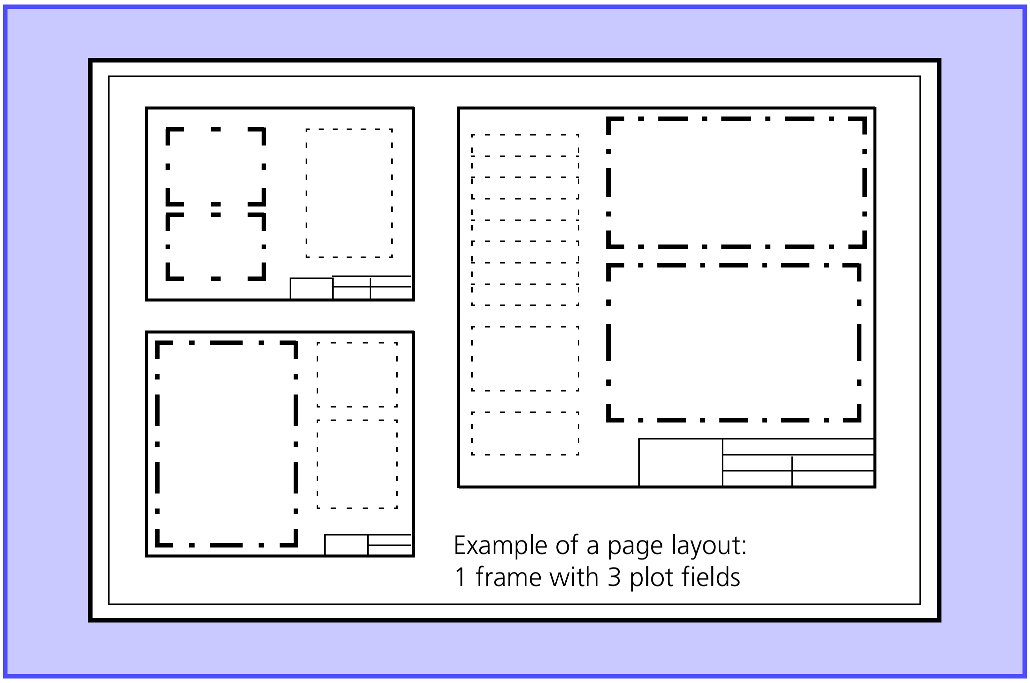
Plotting the logo.

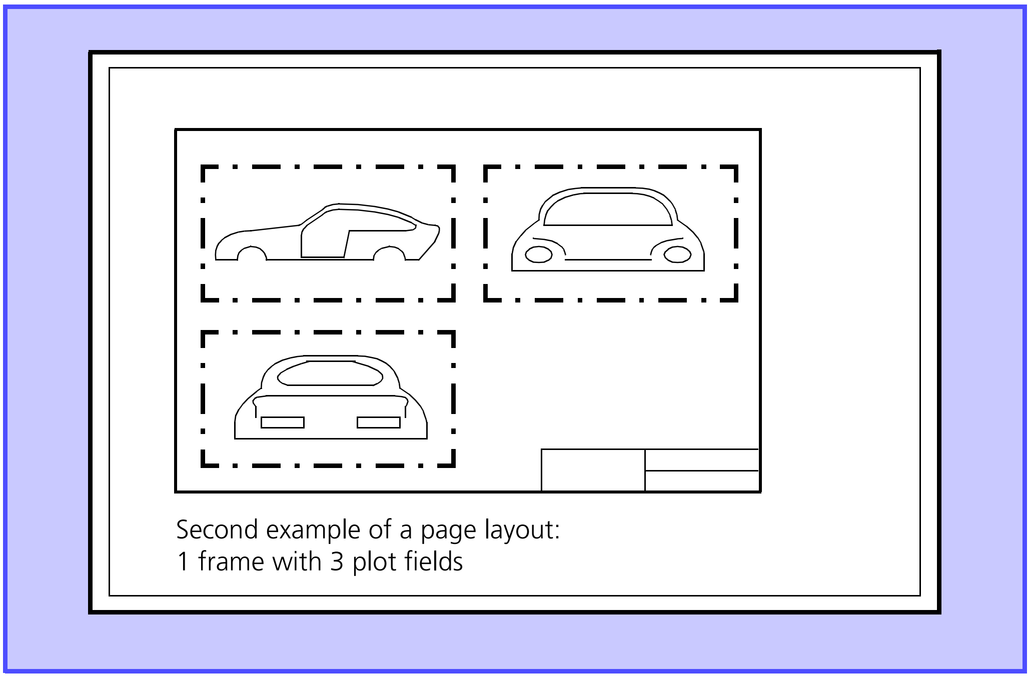
Explanation of the plot terms



Plotter (device)	UMESS basic manual, **<DI 1625>**.
Paper page	Sheet size A4/A3/A2/A1/A0/roll.
Drawing field	Field which can be labeled on the paper page.
Frame	Combination of plot field, curve results, image information and record head into one unit, where the individual fields can be defined as any size. The maximum size of the frame can be as large as the drawing field; several frames can be arranged on the drawing field.
Plot field	The plotter printout is found inside this field.
Curve results	Texts and values.
Image information	Texts and values.
Record head	ZEISS logo and texts.

Two examples of the layout of a page.





Plot Main Menu

Definition of the plot output and branching to the plot- submenus.

There are different commands for calling up the dialog window.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
Object: **NOM**, Action: **PLO**
or
Object: **MVA**, Action: **PLO**
or
Object: **DEV**, Action: **PLO**
or
Object: **CRF**, Action: **PLO**
or
Objects: **LIF**, **LDE**, **SPE** *or* **ACC**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM PLOT MAIN MENU** is displayed.

```
Dialog

KUM PLOT MAIN MENU                          STANDARD NAME [        ]

PLOT TASKS
    Record head                  ? [ ]          Scale              ? [ ]
    Image information            ? [ ]          Curve results      ? [ ]
    Draw axis/grid               ? [ ]          Draw network       ? [ ]

CURVE TRANSFORMATION
   Automatic transformation      ? [ ]
    Input in KUM PLOT TRANSFORMATION    Softkey:<TRANS>

Manual transformation            ? [*]
    Magnification                = [  1.0000]
    Axes zero point     in    RX = [106.0000]  in    RX [ 95.0000]  RX,RY: Frame
    Curve displacement  in     X = [  0.0000]  in     X [ 0.0000]   in     Z [ 0.0000]
    Rotation            about  X = [  0.0000]  about  X [ 0.0000]   about  Z [ 0.0000]

Magnification of deviations/tolerances           = [100.0000]

| * YES | NO | FORMAT | CHART |   *   | AX/GRID | TRANS | REPEAT | TERMIN |

| BACK | PRE MENU |  |  |             | PREA/COM |  |  | INFO |
```

Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

FORMAT — Definition of the plot field ➤*"Plot format" on page 9-38*.

CHART — Definition of the plot output of the curve trend ➤*"Plot task description" on page 9-40*.

AX/GRID — Definition of the axes markings and a grid.

TRANS — Specifications for automatic curve transformation.

PREA/COM — Call up of the dialog window for preassigning standards and/or input of a comment, description ➤*"Standard preassignment/comment" on page 5-54*.

Notes on the input and display boxes

PLOT TASKS

Select which information is to be output.

Record head

Output of the record head ➤*"Label arrangement" on page 9-20*. This contains information on the operator, part no., W name, drawing no. and date, which are read from the UMESS record head, **<DI 1610>**.

Scale

The scale character is labeled. The scale character, a line 10 mm in length, is plotted, if for the **Plot form** function (**FOR PLO**) you answer the **Scale** data box with **<YES>**.

You can position the scale character wherever you like within the **Initialize plotter** function (**PLT INI**) with the **<SCALE>** softkey function.

Image information

Output of the values. The position and size of the type refer to the definition made when initializing the plotter, ➤*"Page layout: Image information" on page 9-11*.

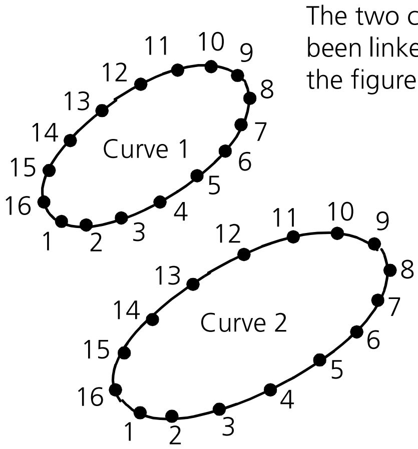
Curve results

Output of the values. The position and size of the type refer to the definition made when initializing the plotter, ➤*"Page layout: Curve results" on page 9-16*.

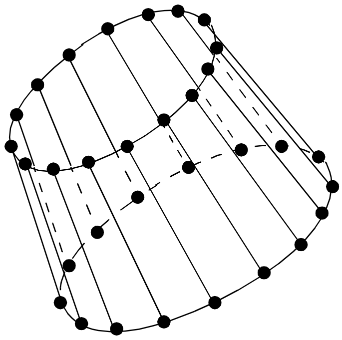
Draw axis/grid

Output of an axes system and/or a grid. Draw network

Two nominal curves with the same number of points (illustration on the left) are linked together by the relevant lines (see illustration on the right). When drawing the grid, any masking of the curves to be joined is not taken into account.



The two curves on the left have been linked by a grid as shown in the figure on the right.



CURVE TRANSFORMATION

Definition of the position and magnification of the curve in the specified plot frame.

Automatic transformation

The program calculates all transformation values (except rotation) for optimum representation of the curves (see ➤*"Special features in graphic representations" on page 9-58*). The following inputs are required: Plot format, representation, automatic trans., axis / grid.

ATTENTION!
If nominals, measured values and deviations are plotted in succession, different transformation values can be calculated.
Remedy:
Switch to manual transformation and adapt values.

Manual transformation

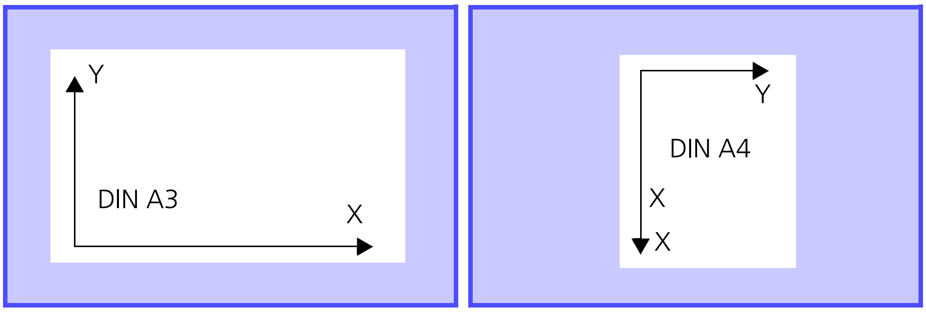
All transformation values must be entered manually.

Magnification

Input of the magnification.

Axes zero point in RX, in RY, in RZ

The values for the zero point refer to the left lower corner of the plot frame. The X axis is always the "long axis" and the Y axis the "short axis" with reference to the page size. This is explained by the following example:



Curve displacement in X, in Y, in Z

The curve can be displaced translationally in all three axes.

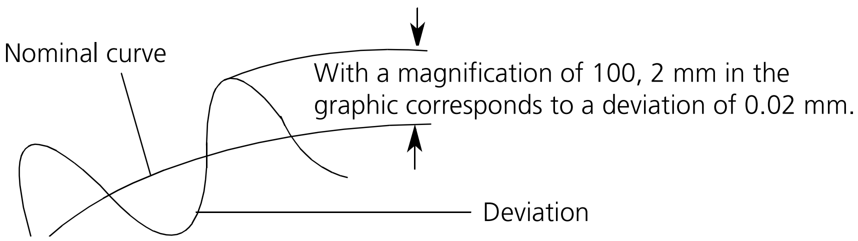
ATTENTION!
The magnification is included in the offset. E.g.: A magnification x 3 and offset of 10 mm causes a displacement by 30 mm!

Rotation about X, about Y, about Z

When plotting, the curve can be rotated about all 3 axes. This input has no influence on the curve values, but only applies for the current plot output.

Magnification of deviations/ Tolerances

The deviations can be shown enlarged with this function (regardless of the curve magnification).



Plot format

Definition of the size and position of the plot field

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

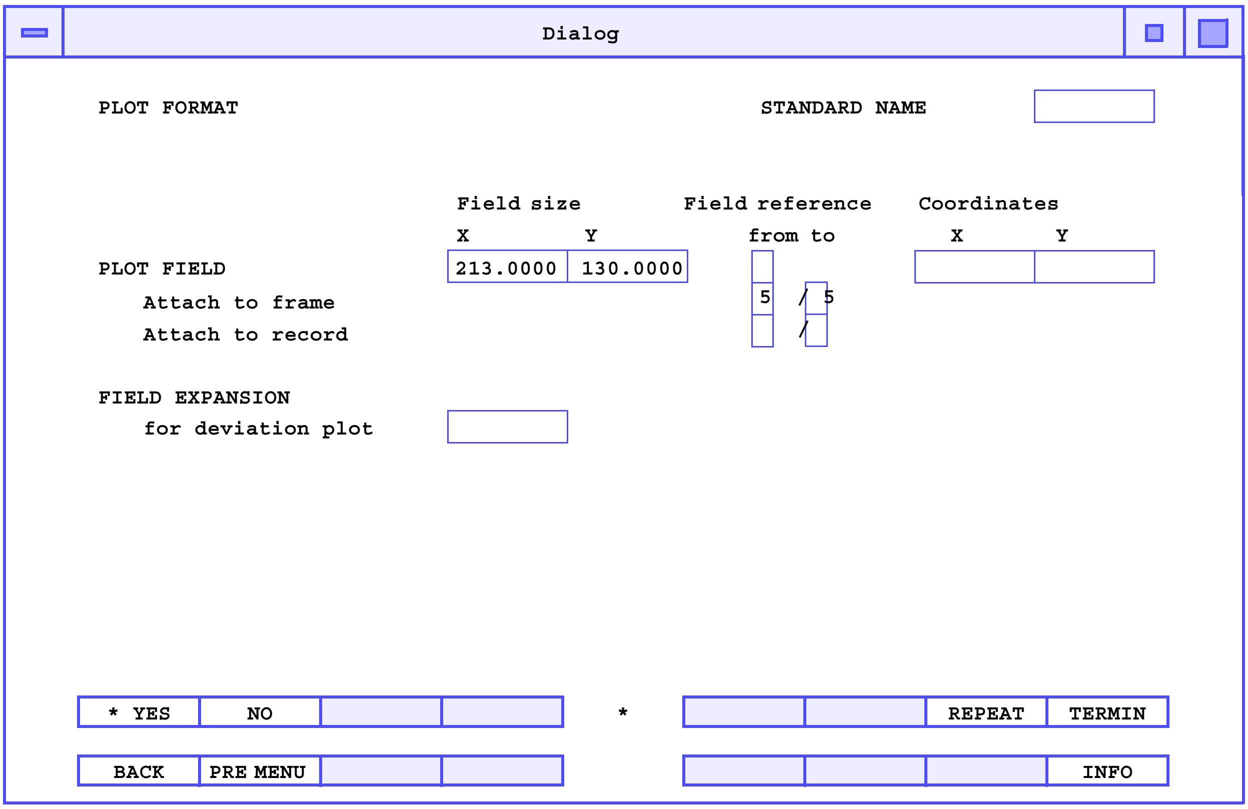
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Objects: **DEV**, **ACC**, **SPE**, **LIF**, **LDE**, **MVA**, **NOM** *or* **CRF**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM PLOT MAIN MENU** is displayed.

FORMAT

– Press **<FORMAT>**.
  The dialog window with the menu title **PLOT FORM** is displayed.



Softkey functions

- **TERMIN**
- **INFO**
- **YES**
- **NO**
- **PRE MENU**
- **REPEAT**
- **BACK**

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

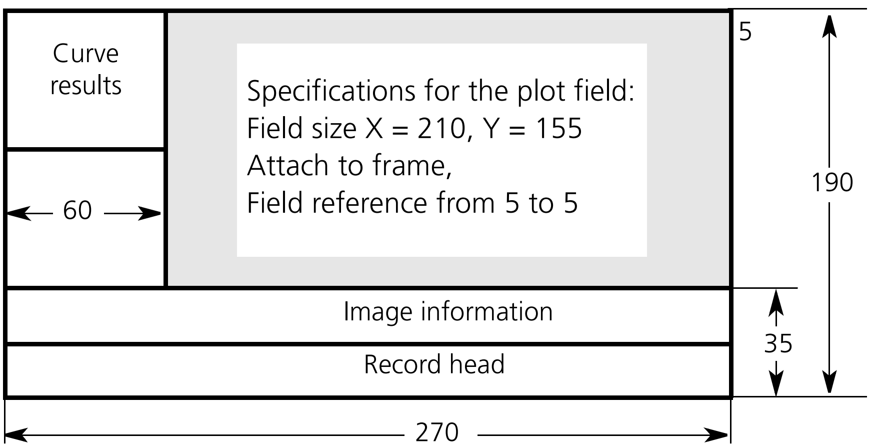
PLOT FIELD

Specification of the field for the plot display (example on ➤ *page 9-40*).

The field size entered is only stored in the short term format, i.e. the input is only valid for this one printer printout.
The relevant data boxes for Field reference and Coordinates, as well as for Attach to frame and/or record correspond to those for the page layout of curve results, see explanations ➤*"Page layout: Curve results" on page 9-16*.

Example of plot field definition

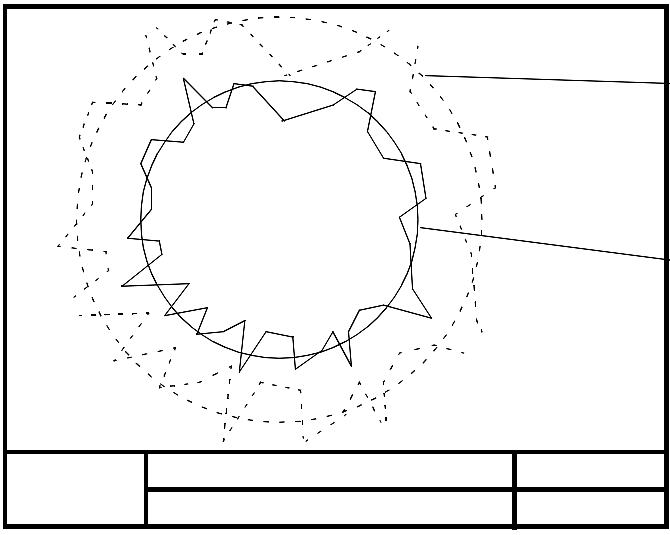
The plot field should always be smaller than the specified frame (➤*"Plot Main Menu" on page 9-33*). In order to avoid overwriting the other fields (record head, image information and curve results), the plot field should be dimensioned so that these areas do not overlap.



FIELD EXPANSION for deviation plot

This field expansion only applies for automatic transformation. The nominals are fitted as well as possible into the field and enlarged. However, because the deviations can be greater than the nominals, they do not always fit into the specified field.

For this reason, the field for the deviation plot can be expanded. This is done by reducing the field for the nominals by the value entered here in X and Y, see example.



Plot task description

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

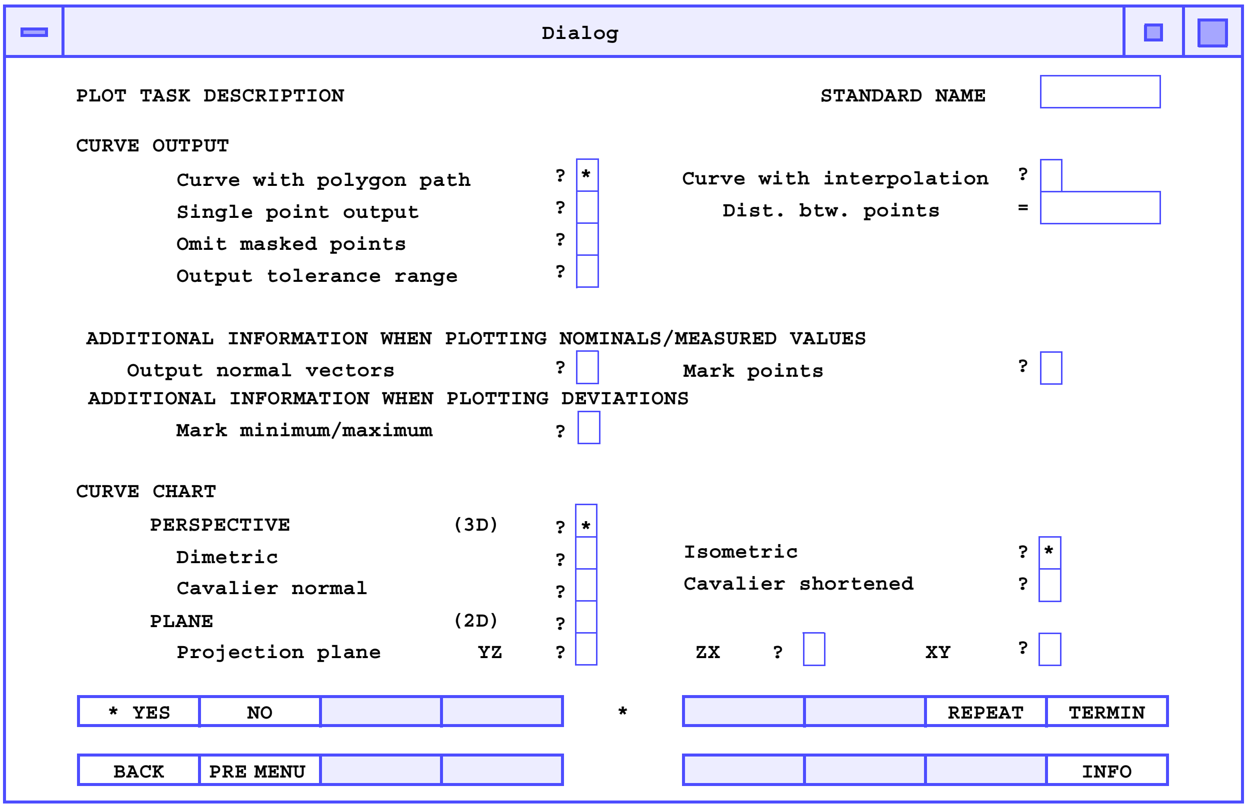
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
Objects: **DEV**, **MVA**, **NOM** *or* **CRF**, Action: **PLO** *or* with reduced functionality, see ➤*"Output of results" on page 11-15*.
Objects: **ACC**, **SPE**, **LIF** *or* **LDE**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM PLOT MAIN MENU** is displayed.

CHART

– Press **<CHART>**.
The dialog window with the menu title **PLOT- TASK- DESCRIP-TION** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

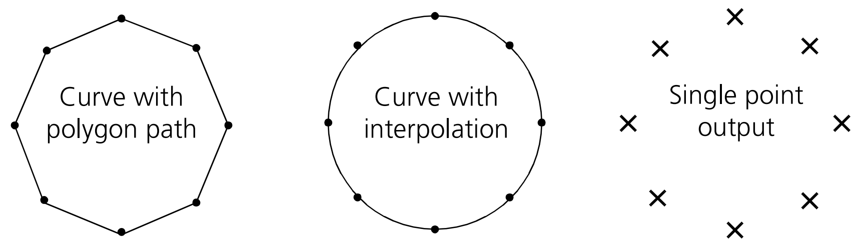
Notes on the input and display boxes

CURVE OUTPUT
Curve with polygon path

The consecutive curve points are linked linearly to a curve path. For further ways of displaying curves, see sketch and explanations on the next page.

Curve with interpolation

Smoothing of the curve to be displayed using a spline function (interpolation). In the spline calculation, the curve is split up into single points (taking account of the preset distance between the points). However, care is needed in the case of curves with sharp changes of direction: These may result in overshots when calculating the new curve.



Single point output Distance between points

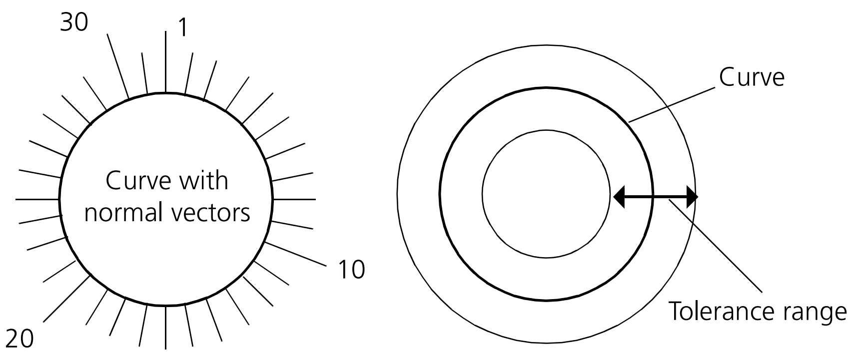
Each point is shown by an "**X**" (see sketch above). The required distance between points must be given (in mm). With the special case **Plot deviations**, **DEV PLO**, the deviations are drawn in the normal direction of the nominal data (see porcupine plot, bottom left). Here the length of the line is equivalent to the size of the deviation.

Omit masked points

The masked points are not plotted. The curve has gaps in these places.

Output normal vectors

Only effective with the function **Plot nominals**. The normals are output for all points of the curve. Every 10^{th} normal is drawn a little longer.



Output tolerance range

Only effective with the **Plot nominals** function. In this case the preset tolerance range is output. The magnification of the deviation is preset in the nominal plot main menu (➤*"Plot Main Menu" on page 9-33*).

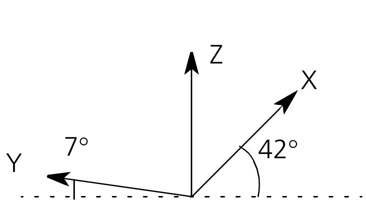
Example: With a tolerance of ± 0.002 mm and a deviation magnification of 1000, a tolerance band width of ± 2 mm results on the plot.

Mark points

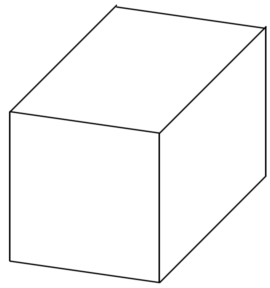
Every 10th point of the curve is marked with an "**X**".

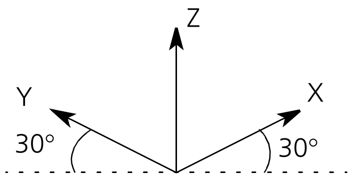
Mark minimum/maximum

Only effective with the **Plot deviation** function. The maximum negative or positive deviations are marked with "**O**" or "**X**" respectively.

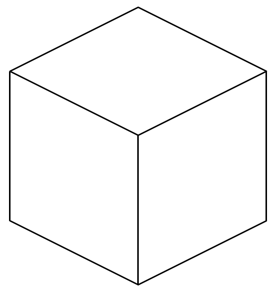


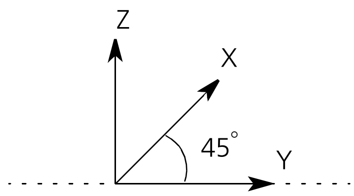
Dimetric representation



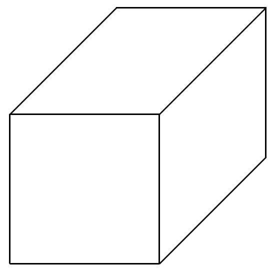


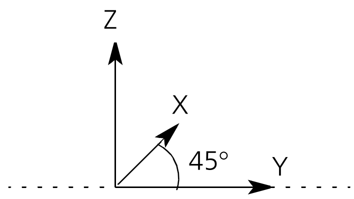
Isometric representation



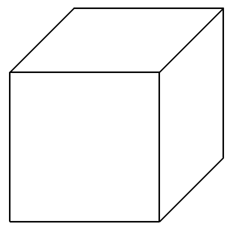


Cavalier, normal representation





Cavalier, shortened representation



CURVE CHART 3D PERSPECTIVE

The four most common perspectives are available for selection for 3D representation of the curve data. **PLANE (2D)**, **Projection plane YZ, ZX, XY**

Two-dimensional representation of the curve. The plane in which the representation is to be made must be specified.

Axis and grid

Alternative definition of the coordinate axes or of a grid.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

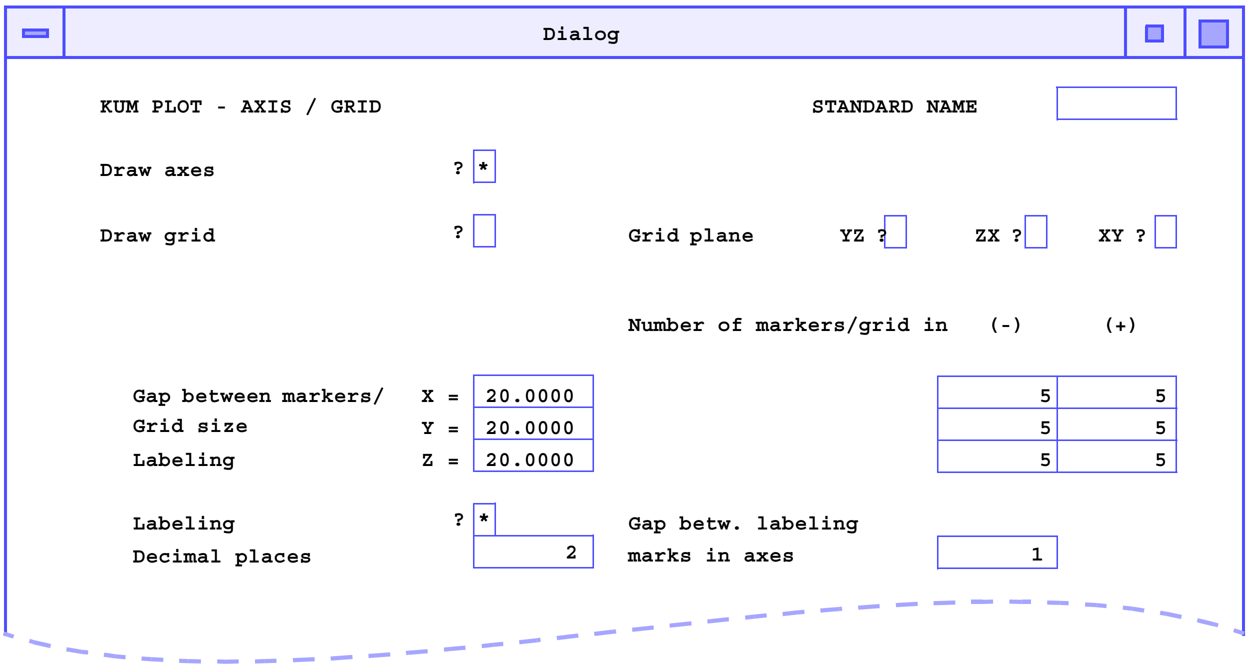
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Objects: **DEV**, **MVA**, **NOM** *or* **CRF**, Action: **PLO**
  or with fixed grid plane, see ➤*"Output of results" on page 11-15*.
  Object: **ACC**, **SPE**, **LIF** *or* **LDE**, Action: **PLO** *or*
  Object: **DEV**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM PLOT MAIN MENU** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Draw axes

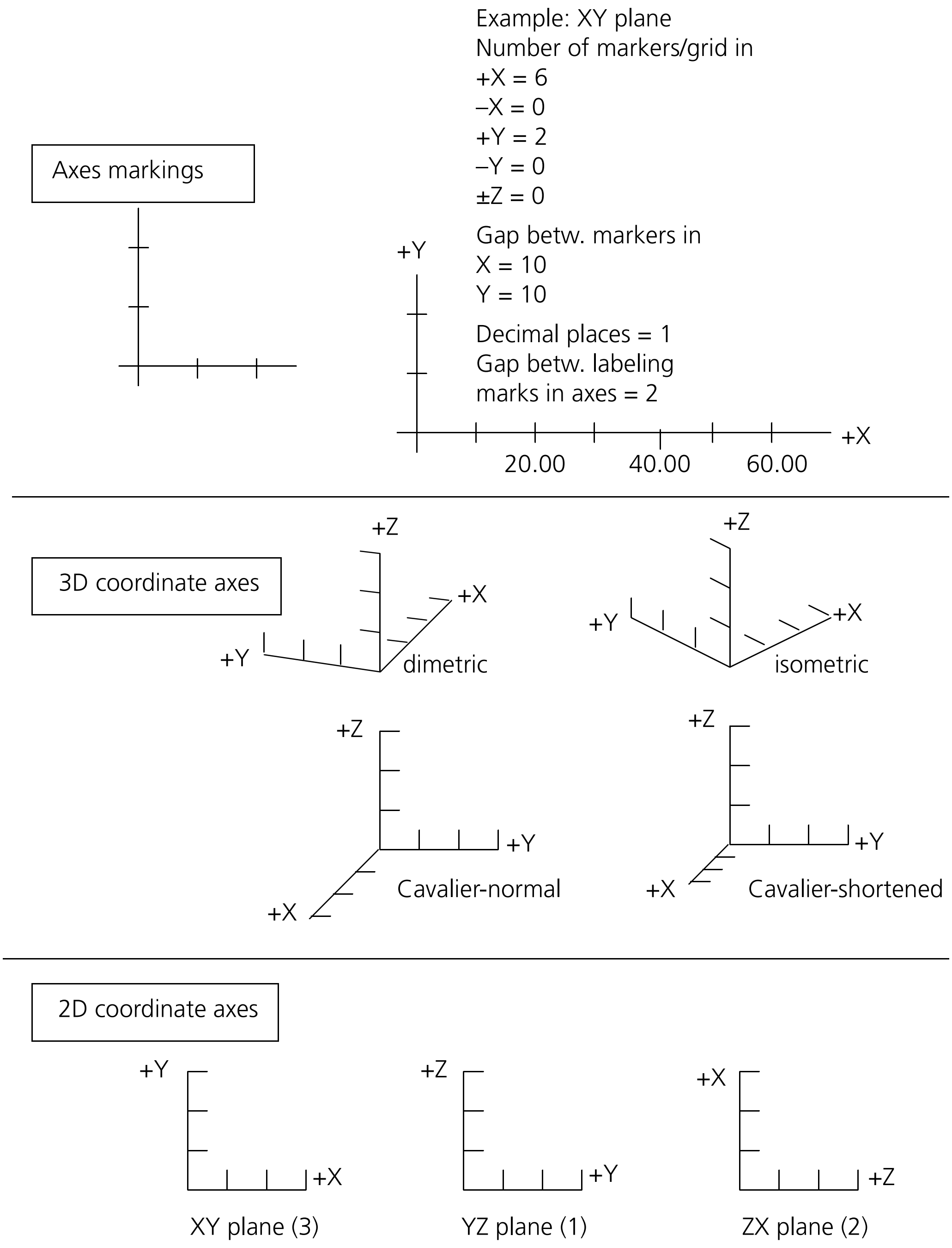
If **<YES>** is entered, the axes are plotted; if **<NO>** is entered, the **Draw grid** box is jumped to.

Draw grid
Grid plane YZ, ZX, XY

Alternative input to **Draw axes**. If confirmed with **<YES>** the plane must be specified in which the grid is to be drawn. If **<NO>** is entered, the **Draw axes** box is returned to.

Gap betw. markers/
Grid size X/Y/Z

The length of the individual axes can be determined in positive and negative direction. If you enter the value 0, no axes representation takes place.



Axes markings
Example: XY plane
Number of markers/grid in
+X = 6
–X = 0
+Y = 2
–Y = 0
±Z = 0
Gap betw. markers in
X = 10
Y = 10
Decimal places = 1
Gap betw. labeling
marks in axes = 2
+Y
+X
20.00
40.00
60.00
3D coordinate axes
+Z
+X
+Y
dimetric
+Z
+Y
+X
isometric
+Z
+Y
+X
Cavalier-normal
+Z
+Y
+X
Cavalier-shortened
2D coordinate axes
+Y
+X
XY plane (3)
+Z
+Y
YZ plane (1)
+X
+Z
ZX plane (2)

Automatic plot transformation

Definition of the inputs for automatic transformation.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

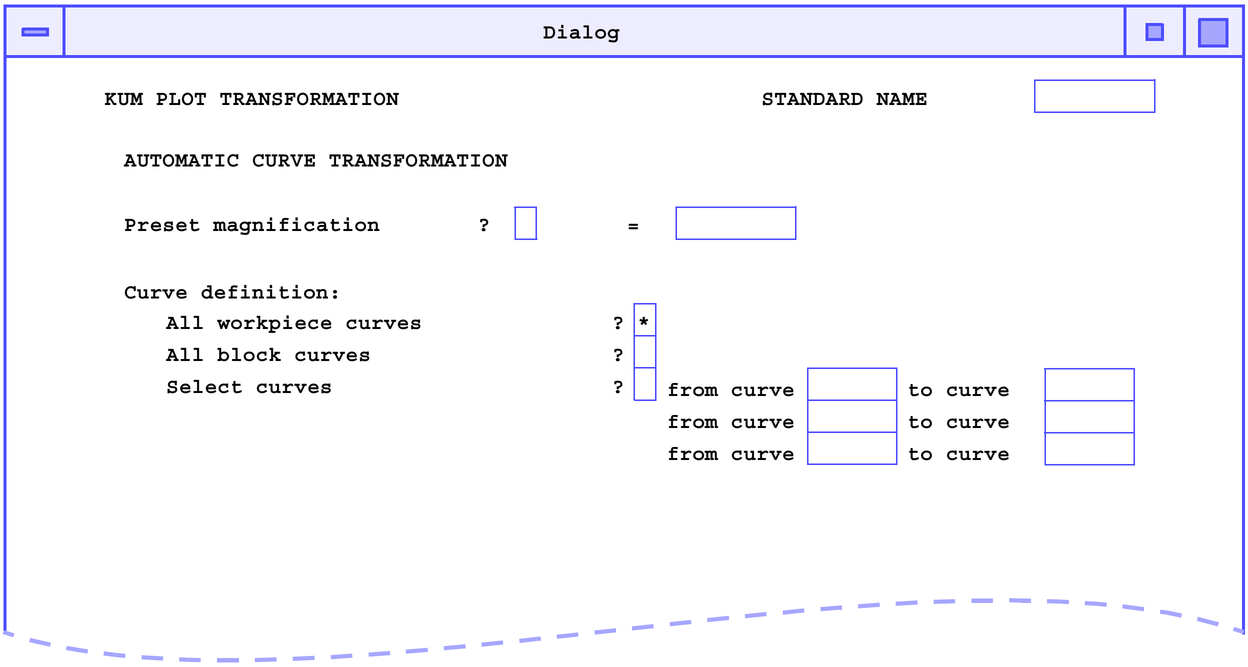
– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Objects: **DEV**, **ACC**, **SPE**, **LIF**, **LDE**, **MVA**, **NOM** *or* **CRF**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM PLOT MAIN MENU** is displayed.

TRANS

– Press **<TRANS>**.
  The dialog window with the menu title **KUM PLOT-TRANSFORMATION** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the input and display boxes

Preset magnification

If the first field is answered with **<YES>**, the required magnification can be specified in the next field. The curve is then enlarged accordingly and the position of the curve determined by the system. If too high a magnification is entered, the program uses the maximum permissible value.

Curve definitions

Data on the curves which are to be used for calculating the magnification and position of the curve.

All workpiece curves

All curves existing when the invocation is made are taken into consideration.

All block curves

All curves are included in the calculation which have been specified in the KUM Main Menu in the data box **Curves from: to:**, ➤*"General softkey functions" on page 1-10*.

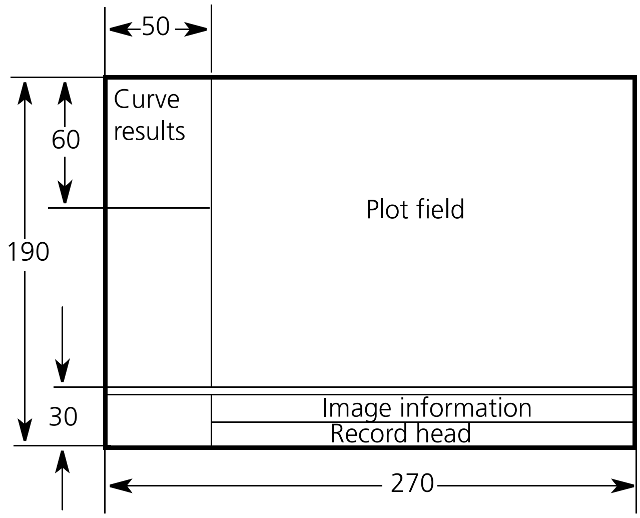
Select curves

If this field is confirmed with **<YES>**, the required curves are then defined in the boxes **from curve/to curve**.

Comment on the field dimensioning

With automatic transformation, the curves to be output are fitted into the specified plot field and enlarged accordingly. The definition of the zero point, the magnification and the curve displacement does not take place manually, but is carried out by computer.

Make sure that the plot field is selected so that no data for the image information, the curve results or record head can be overwritten. Also make sure that the plot field is attached to the correct position on the frame. The following example clarifies this.



Permissible field size for the plot field in the example on the left:
X = 220 and Y = 160

Note!
If the plot field has been made too large, there is a risk that the data of other fields may be over-written.

Plotting the linear deviation

Display

The linear plot is a two-dimensional (2D) display.

Either the polar angle [unit of measurement: degrees] or the point numbers (1 to number of deviations) is displayed on the horizontal X axis (abscissa).

The deviations [unit of measurement: mm or inch] are displayed on the vertical Y axis (ordinate).

Prerequisite

Polar display is only possible for curves whose curve center of gravity is located in the workpiece zero point. The display of camshafts, amongst others, is given as an application example here.

All other deviation curves can be displayed as a linear plot, if the point numbers are plotted on the abscissa.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

DEFINE

– Enter the KUM command in the data boxes.
  Object: **LDE**, Action: **PLO**

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM LINEAR PLOT MAIN MENU** is displayed.

```
Dialog

KUM LINEAR PLOT - MAIN MENU                   STANDARD NAME          N04

PLOT TASKS
    Record head                    ? [ ]          Scale                 ? [ ]
    Image information              ? [ ]          Curve results         ? [ ]
    Draw axis/grid                 ? [ ]

CURVE TRANSFORMATION
  Automatic transformation         ? [ ]
    Input in KUM PLOT TRANSFORMATION      Softkey:<TRANS>

  Manual   transformation          ? [*]
    Magnification         in  X    = [  0.0000]  in  Y  = [ 1.0000]
    Axes zero point       in  RX   = [106.0000]  in  RY = [95.0000]  RX,RY: Frame
    Curve displacement    in  X    = [  0.0000]  in  Y  = [ 0.0000]
    Rotation about spatial axis    = [  0.0000]

    Abscissa axis polar            ? [*]

 * YES | NO       | FORMAT | CHART    *    AX/GRID  | TRANS | REPEAT | TERMIN
 BACK  | PRE MENU |        |               PREA/COM |       |        | INFO
```

Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

FORMAT Definition of the drawing field.

CHART Definition of the plot output of the curve trend.

AX/GRID Definition of the axes markings and/or a grid.

TRANS Specifications for automatic curve transformation.

PREA/COM Call up of the dialog window for preassigning standards and/or input of a comment, description ➤*"Standard preassignment/comment" on page 5-54*.

Notes on the input and display boxes

PLOT TASKS Selection of which information is to be output.

Record head Output of the record head (see ➤*"Label arrangement" on page 9-20*). This contains information on the operator, part no., W-name, drawing no. and date, which are read from the UMESS record head, see **<DI 1610>**.

Scale The scale character is labeled. If for the **Plot form** function (**FOR PLO**) you answer the **Scale** data box with **<YES>**, the scale character is plotted, a line 10 mm in length.

You can position the scale character anywhere you like within the **Initialize plotter** function (**PLT INI**) with the **<SCALE> softkey function**.

Image information Output of the values. Position and size of the type refer to the definition made during plotter initialization, ➤*"Character sizes, fonts and colors" on page 9-9* to ➤*"Page layout: Curve results" on page 9-16*.

Curve results

Output of the values. Position and size of the type refer to the definition made during plotter initialization, ➤*"Character sizes, fonts and colors" on page 9-9* to ➤*"Page layout: Curve results" on page 9-16*.

Draw axis/grid

Output of an axes system and/or a grid.

CURVE TRANSFORMATION

Definition of position and magnification of the curve in the specified plot frame.

Automatic transformation

The program calculates all transformation values (except rotation) for optimum representation of the curves (see ➤*"Special features in graphic representations" on page 9-58*). The following inputs are required: Plot format, representation, automatic transformation, axis/grid.

NOTE!
If nominals, measured values and deviations are to be plotted in succession, different transformation values can be calculated.
Remedy: Switch to manual transformation and adapt values.

Manual transformation

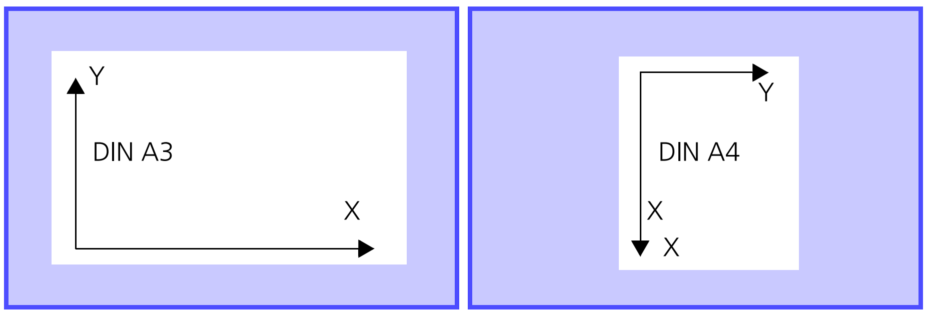
All transformation values must be entered manually.

Magnification

Input of the magnification.

Axes zero point in RX, in RY, in RZ

The values for the zero point refer to the left bottom corner of the plot frame. The X axis is always the "long axis" and the Y axis the "short axis" when referring to the page size. This is clarified by the following example:



Curve displacement in X, in Y, in Z

The curve can be displaced by translation in all three axes.

NOTE!
The magnification is included in the displacement. E.g.: A magnification x 3 and offset 10 mm causes a displacement by 30 mm!

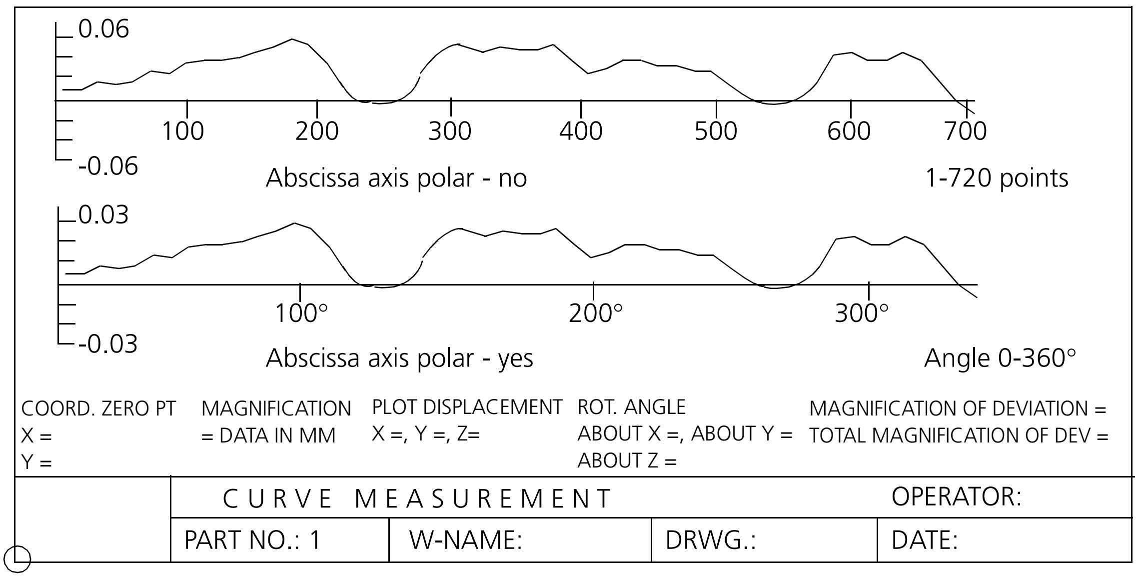
Rotation about spatial axis

When plotting, the curve can be rotated about the spatial axis. This input has no influence on the curve values, but only applies for the current plot output.

Abscissa axis polar

<YES>
The polar angle is represented [unit of measurement: degrees] on the abscissa (horizontal X axis).

<NO>
Output of the abscissa with point numbers.



Plotting a certificate

Same parameters

The command Plot certificate **CRF PLO** contains the two functions Plot nominals **NOM PLO** and Plot deviations **DEV PLO**. This means that the nominals, tolerances and deviations are plotted with the same parameters. This also applies for automatic transformation.

Masked points

NOTE

The nominal curve and the tolerance band are plotted in full for the certificate. Masking (of the nominals) is only taken into consideration for deviations.

The following data boxes are marked in the Plot tasks description menu, ➤*"Plot task description" on page 9-40*:

– additional information when plotting nominals/measured values,

– additional information when plotting deviations.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

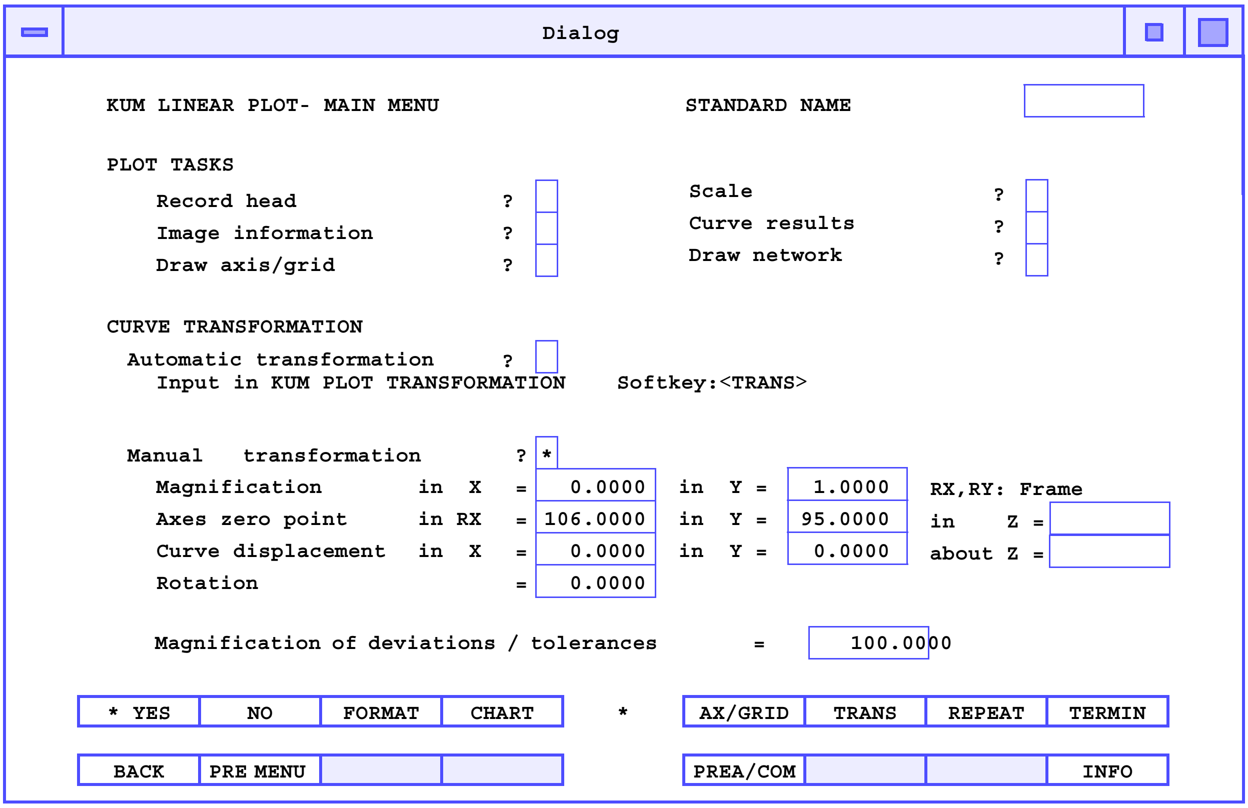
ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **CRF**
  Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM PLOT MAIN MENU** is displayed.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

FORMAT

Definition of the drawing field.

CHART

Definition of the plot output of the curve trend.

AX/GRID

Definition of the axes markings and/or a grid.

TRANS

Specifications for automatic curve transformation.

PREA/COM

Call up of the dialog window for preassigning standards and/or input of a comment, description ➤*"Standard preassignment/comment" on page 5-54*.

Notes on the input and display boxes

PLOT TASKS

Selection of which information is output.

Record head

Output of the record head ➤*"Label arrangement" on page 9-20*. This contains information on the operator, part no., W-name, drawing no. and date, which are read from the UMESS record head, **<DI 1610>**.

Scale

The scale character is labeled. If for the **Plot form** function (**FOR PLO**) you answer the **Scale** data box with **<YES>**, the scale character is plotted, a line 10 mm in length.

You can position the scale character anywhere you like within the **Initialize plotter** function (**PLT INI**) with the **<SCALE> softkey function**.

Image information

Output of the values. Position and size of the type refer to the definition made during plotter initialization, ➤*"Character sizes, fonts and colors" on page 9-9* to ➤*"Page layout: Curve results" on page 9-16*.

Curve results

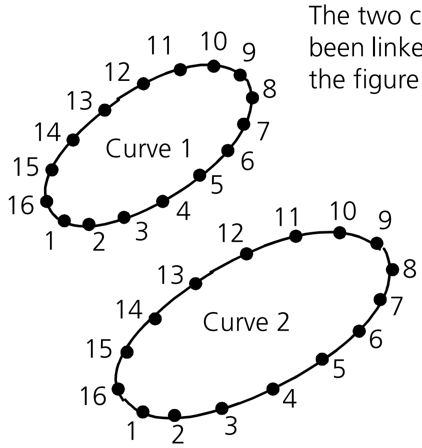
Output of the values. Position and size of the type refer to the definition made during plotter initialization, ➤*"Character sizes, fonts and colors" on page 9-9* to ➤*"Page layout: Curve results" on page 9-16*.

Draw axis/grid

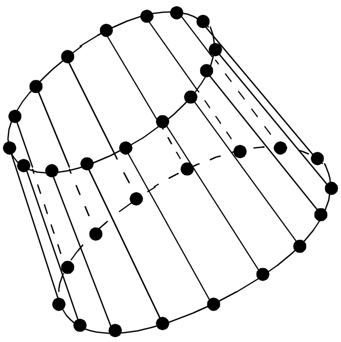
Output of a axes system and/or a grid.

Draw network

Two curves with the same number of points (illustration on left) are linked by the relevant lines (see illustration on the right). If the **Draw network** field is activated, then both the nominal points and the deviations of the various curves are linked by lines.



The two curves on the left have been linked by a grid as shown in the figure on the right.



CURVE TRANSFORMATION

Definition of position and magnification of the curve in the specified plot frame.

Automatic transformation

The program calculates all transformation values (except rotation) for an optimum representation of the curves (see ➤*"Special features in graphic representations" on page 9-58*). The following inputs are required: Plot format, representation, automatic trans., axis/grid.

NOTE!
If nominals, measured values and deviations are to be plotted in succession, different transformation values can be calculated.
Remedy: Switch to manual transformation and adapt values.

Manual transformation

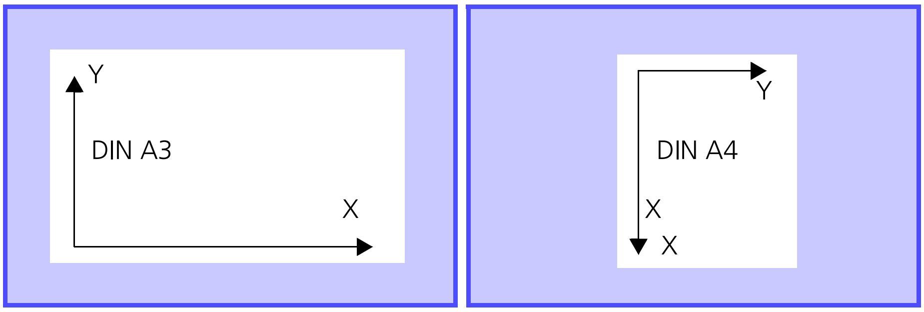
All transformation values must be entered manually.

Magnification

Input of the magnification.

Axes zero point in RX, in RY, in RZ

The values for the zero point refer to the left bottom corner of the plot frame. The X axis is always the "long axis" and the Y-axis the "short axis" when referring to the page size. This is clarified by the following example:



Curve displacement in X, in Y, in Z

The curve can be displaced by translation in all three axes.

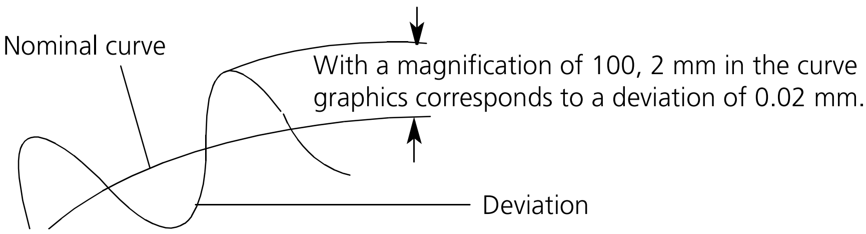
NOTE!
The magnification is included in the displacement. E.g.: A magnification x 3 and offset of 10 mm causes a displacement by 30 mm!

Rotation about X, about Y, about Z

When plotting, the curve can be rotated about all 3 axes. This input has no influence on the curve values, but only applies for the current plot output.

Magnification of deviations/ Tolerances

The deviations can be shown enlarged with this function (regardless of the curve magnification).



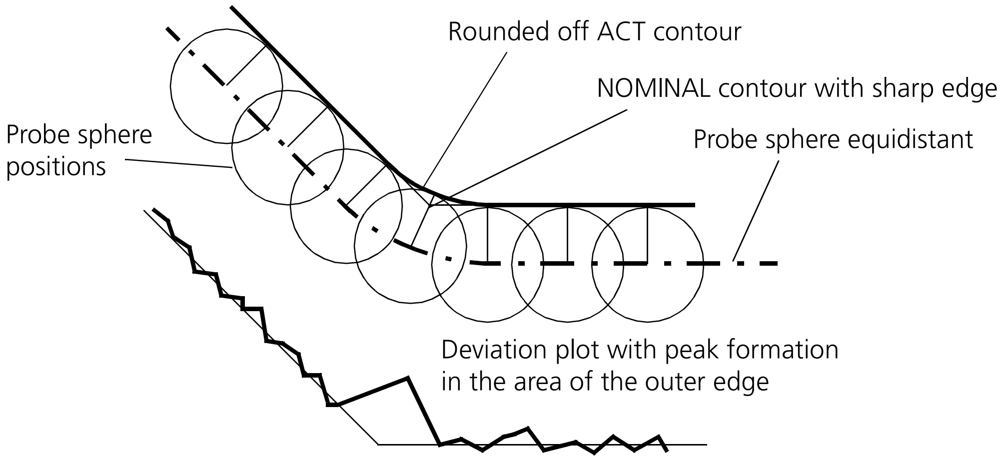
Special features in graphic representations

Paper change

After a paper change with the command **PGE CHA**, graphics are output immediately on the screen. The screen is deleted by the paper change. With external devices (plotter), the graphics output does not take place until the paper change.

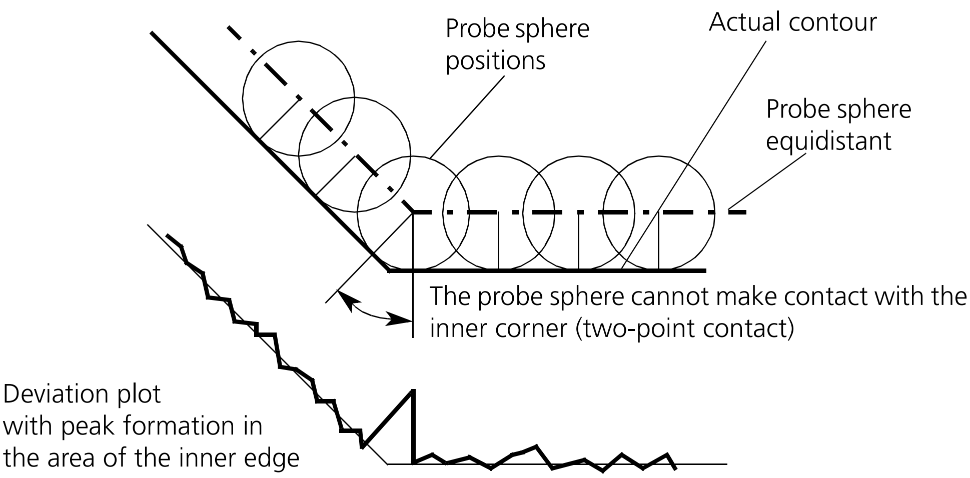
Peak formation with rounded off outer corners

If the nominal curve is angular and there are rounded off curves during the measurement, then peak representations result in the deviation plot, due to the function.



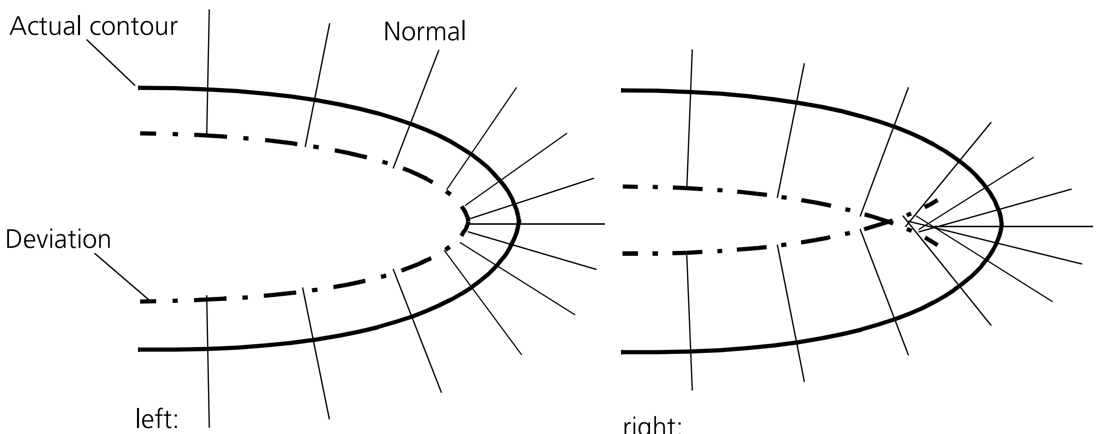
Peak formation with sharp inner corners

When measuring sharp inner corners, such or similar peaks result in the deviation plot due to the two-point contact and depending on the probe sphere radius.



Curl formation with tight curves

Curls are the result of too large a magnification of the deviation when normal directions cross. This effect can occur particularly with tight curves.

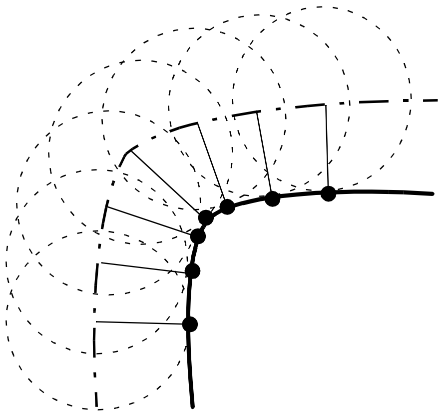


left:
Representation of a deviation with suitable magnification

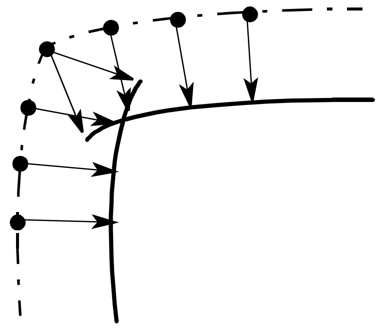
right:
Curl formation if the magnification is too large

Contour overlapping with sharp outer corners

If sharp outer corners are measured on unknown contours and then a nominal calculation is carried out, overlapping of normal directions and contours may result in the radius correction.



left:
Representation of the actual contour with the contact points of the probe sphere



right:
Measured points with the normal directions calculated and the resulting nominal contour

Plotting texts

With this command, table headings and data for assigning the plotted results can be specified. After concluding the first dialog window with **<TERMIN>**, another window is displayed, see next page.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

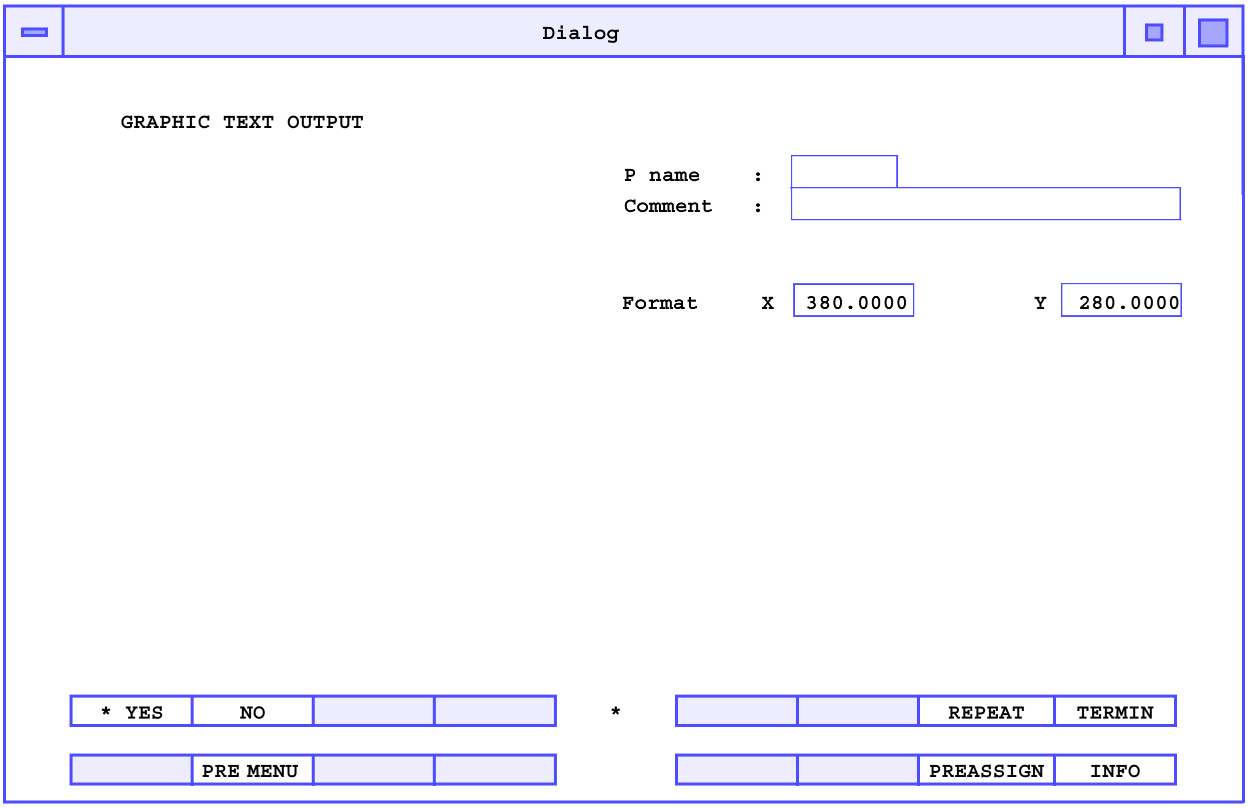
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **TXT**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **GRAPHIC TEXT OUTPUT** is displayed.



Softkey functions

INFO
YES
NO
PRE MENU
REPEAT

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

PREASSIGN

By entering a standard name, an automatic preassignment of the data boxes can be performed.

TERMIN

Change to the 2^{nd} dialog window, see next page.

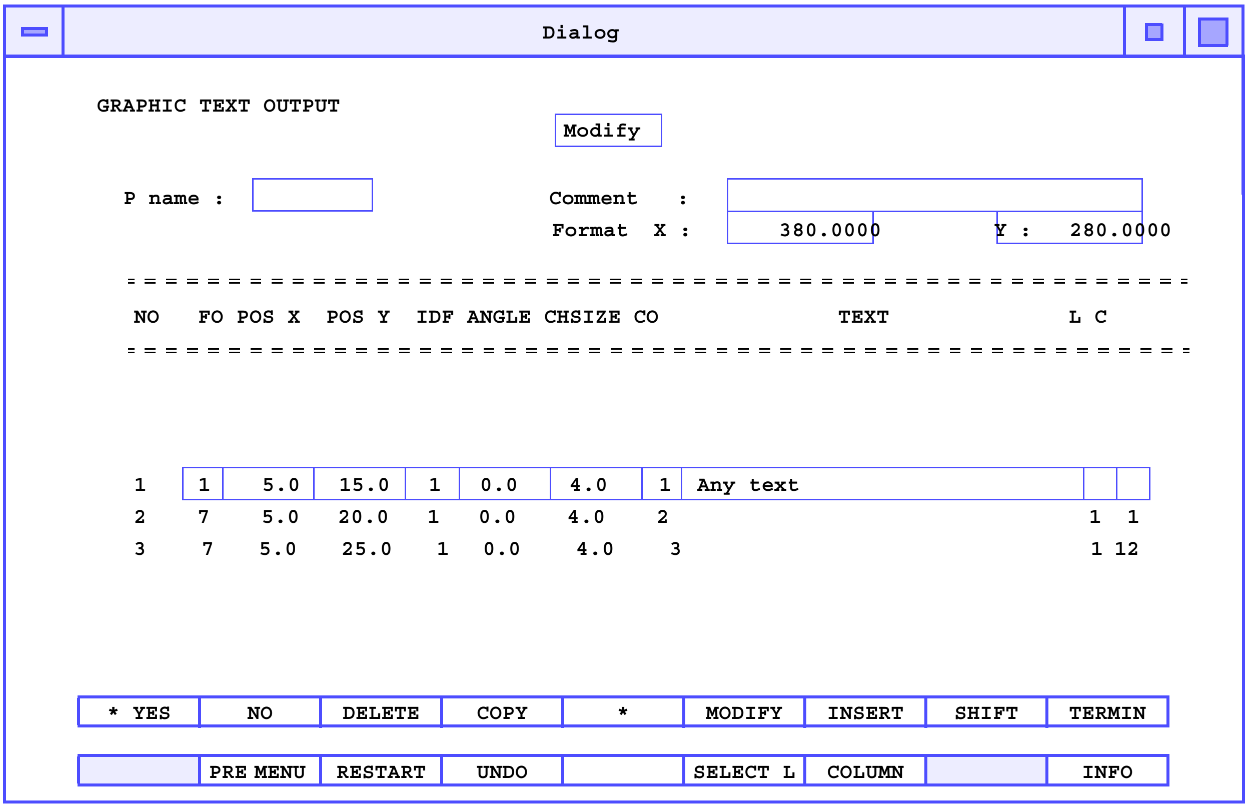
Notes on the input and display boxes

GRAPHIC TEXT OUTPUT, P name Data box for the standard name.

Comment Input of a comment text (for the documentation).

Format X Input of the page format in the X direction.

Format Y Input of the page format in the Y direction.



Softkey functions

TERMIN
INFO
YES
NO
PRE MENU

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

DELETE

To delete line(s).

COPY

To copy line(s).

MODIFY

To re-enter and/or change values.

INSERT

To insert line(s).

SHIFT To move line(s).

RESTART The value input is restarted; in this case, all previous inputs or changes are disregarded.

UNDO The last input value is deleted; the previous status is restored.

SELECT L Individual selection of a line.

COLUMN

1 Activation: To switch to column by column input

2 Activation: To switch back to line by line input.

Notes on the input and display boxes

When entering the table values, each numerical input must be concluded with **<Return>**. The cursor then jumps to the next input column. If a new line is required, this must first be created with **<SHIFT>** **<↑>**.

Meaning of the abbreviations in the table header

NO Consecutive line number.

FO Form (code number from following table)

POS X X position of the output (see drawing ➤ *page 9-66*)

POS Y Y position of the output (see drawing ➤ *page 9-66*)

IDF Code number for the reference point of the text field (see drawing ➤ *page 9-66*).

When representing number columns, make sure that these are arranged beneath one another with code 1 at the left margin and code 3 at the right margin.

ANGLE Output angle ±180° (positive angle counterclockwise)

CHSIZE Type size in mm with scale representation

CO Color of output.

TEXT Any text can be entered (max. 30 characters)

L Line number of the UMESS record header (only form 7)

C Column number of the UMESS record header (0 = all columns)

Explanation of the form parameters (FO)

1	Any text comment (max. 30 characters)
7	UMESS record head data

Headings

11	(KUM) workpiece name
12	(KUM) drawing number
13	(KUM) part name
14	(Nominal) curve name
15	(Measured data) curve name
16	Command block name
17	Standard name
18	(Current) operator
19	(Current) date

Text contents

21	(KUM) workpiece name
22	(KUM) drawing number
23	(KUM) part name
24	(Nominal) curve name
25	(Measured data) curve name
26	Command block name
27	Standard name
28	(Current) operator
29	(Current) date

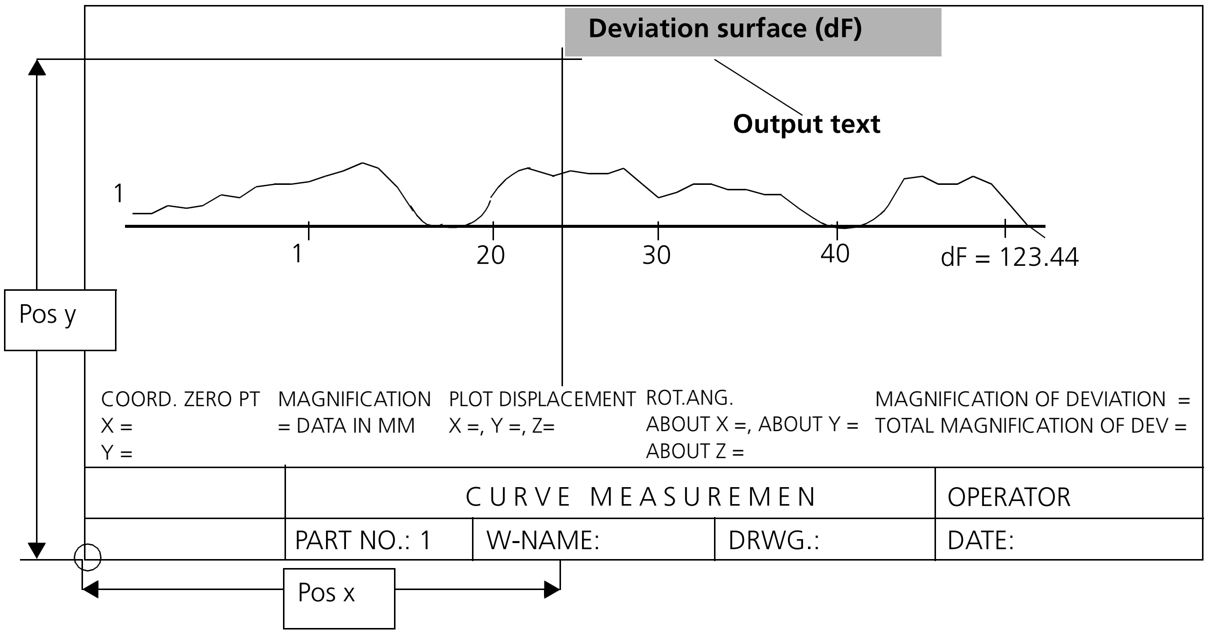
Dialog

Format X : 270.0000 Y : 190.0000

NO	FO	POS X	POS Y	IDF	ANGLE	CHSIZE	CO	TEXT	L	C
1	1	5.0	15.0	1	0.0	4.0	1	Any text		
2	7	5.0	20.0	1	0.0	4.0	2		1	1
3	7	5.0	25.0	1	0.0	4.0	3		1	2
4	7	5.0	30.0	1	0.0	4.0	4		1	3
5	7	5.0	35.0	1	0.0	4.0	5		1	4
6	7	5.0	45.0	1	0.0	4.0	7		2	1
7	7	5.0	50.0	1	0.0	4.0	1		2	2
8	7	5.0	55.0	1	0.0	4.0	2		2	3
9	17	5.0	60.0	1	0.0	4.0	3			
10	18	5.0	65.0	1	0.0	4.0	4			
11	27	20.0	60.0	1	0.0	4.0	3			
12	28	20.0	65.0	1	0.0	4.0	4			

Position of the output text (POS X, POS Y)

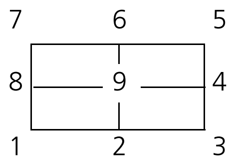
The contents of the output text is specified in the COMMENT **field** of the first dialog window. The position of the output text is defined by two inputs in the table in the second dialog window: the position point (POS X, POS Y) and the reference point (REF). In the example below, the lower left corner of the text field (1) has been selected as reference point.



Reference point for the output text (IDF)

The code number of the required corner point (1-3-5-7), a page center (2-4-6-8) or the center of the text field (9) must be specified as reference point (idf).

In this way, the position of the text field in the output plot is specified – together with the position point.



Chapter 10

VDA Interface

The VDA interface is based on the guidelines of the VDA (= Confederation of German car manufacturers) to provide a uniform interface for data exchange between different computer systems and standard DIN 66301 (= German Standardization Institute).

It enables data from other computer systems to be reformatted and transferred to the KUM curve measuring program, as well as reformatting and transferring KUM data to other systems.

In this way, for example, nominal data can be transferred to the coordinate measuring machine and further processed in KUM. The acquired measured values can then be transferred to other systems, where they can be edited as desired.

This chapter contains:

Explanation of VDA terms

Terms

All data transferred between the start code (**header**) and the end code (**trailer**) is called a **file**. The file consists of sets (lines, **records**) each with 80 characters in the **American Standard Code for Information Interchange** format (ASCII).

Characters 73-80 contain the **line number** in ascending order. The difference between the line numbers may be *greater* than 1. A step size of e.g. 10 facilitates the subsequent insertion of lines.

Components of a file

The logical components of a file are:

- Start code (header)
- Geometric elements
- Elements for structuring the geometry data
- Comments
- End code (trailer)

Data formats

Integers (integer format)

An integer constant in this application is a positive or negative integer n, whose total must be less than 2^{31}.

There is no need for a positive sign; several +/- signs are not allowed in succession.

Examples of valid integer values: 243, -1058, +53

Examples of invalid integer values: +-598, 243.8, 2147483648 (= 2^{31})

Floating decimal point numbers (real format)

A real number must be displayed in one of the following forms:

±xxxxxxx.yyyyyyyyy

±xxxxxxx.yyyyyyyyy E ± zz

| ← Mantissa → |→ Exponent

x, y, z are digits between 0 and 9; the decimal point must be included. The number of digits in the mantissa must be between 1 and 16. There is no need for a positive sign; several +/- signs are not allowed in succession.

The letter "E" in the exponential notation can be replaced by "D".

Examples of valid real values:

0., 123.079, 1.23 D-99, -.1234567890123456, 12345678901234., 10.27 E9, .7 E + 99

Examples of invalid real values:

598, + -43.78, 1234567890123456.7, 1.23 E111

Name specifications

The names of the elements consist of capital letters (A to Z) and digits (0 to 9). The first (of a maximum of 8) character must be a letter. There are no reserved character combinations. The names within a file must be unique, i.e. they are only allowed to be defined once.

Input format

The data input is *format free*, i.e. it is not tied to any one fixed format. However, the specified rules for the individual file elements must be observed. Entered blanks are ignored during interpretation, i.e. they have no influence on the contents of the file.

The following rules must be observed when entering data:

– The individual parameters must be separated from each other by a comma.

– Constants (integers, real, names, command words) must end in the line in which they begin, including separators.

- A possible continuation line must be identified as such by the last character, other than a blank, in columns 1 to 72 of the previous line being a comma.
- Comment lines must be identified as such by starting with "**$$**"; comment lines do not have continuation lines.
- The names and command words may only be written in capitals.

Notation of VDA statements

Principles

The following principles should be observed in the language structure:

- Capitals should be adopted unchanged.
  Example: POINT is the ASCII characters P, O, I, N and T.
- Lower case letters designate a variable. They must be replaced by the character string or the numeric value which results from the problem in question.
  So for example the variable **name** must be replaced by the name which is meant in the specific case, such as **SET01** or **VDA001**; the variable **xy** must be replaced by a specific numeric value, e.g. 20.0891.
- Digits must be adopted unchanged if they stand alone (e.g. -25 or 98.3512), or if several capital letters precede them (e.g. PVF 12).
- Digits (sometimes with preceding lower case letters) designate a variable, see above.
- The notation **n*[...]** means that the contents of the brackets must be repeated as often as n (n is a number in integer format).

Definition of geometric elements

Within the VDA function, the following five types of geometric elements can be defined.

The command words listed must be used in the specified form. A clockwise coordinate system in accordance with DIN 66217 must be used. Only mm (millimeters) are allowed as the unit of measurement. With all inputs, the general command structure must be observed, which applies equally for all five element types.

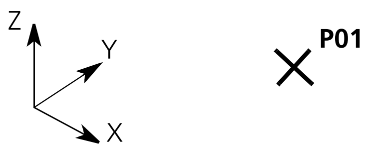
Name = command word/parameter

Elements

The five elements permitted are explained in the following chapters:

Point	POINT	➤ *Page 10-6*
Point set	PSET (Point set)	➤ *Page 10-7*
Point vector set	MDI (Master dimension)	➤ *Page 10-8*
Curve	CURVE	➤ *Page 10-8*
Surface	SURF	➤ *Page 10-9*
Specification of tolerances for a VDA element		➤ *Page 10-30*

Point (POINT)



This element is used for the transfer of information on single points to be probed, e.g. on car bodies. In this case, each point is given a name of its own.

Notation

name = POINT/x, y, z

The parameters x, y and z are the single point coordinate in real format.

3 coordinate values must always be specified, even if one or several of these values is zero.

Examples of valid elements:

P01 = POINT/10.5, -200., +.23E12

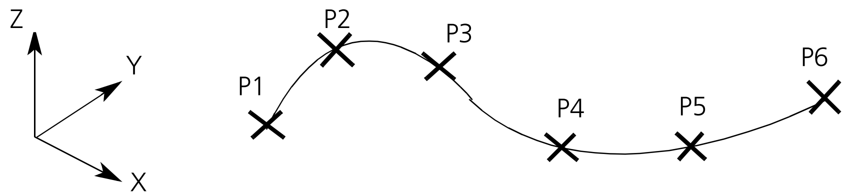
P02 = POINT/2.12, 34., -47.231

Examples of invalid elements:

P03 = POINT/12, 34.23, -85.42 (integer value as point coordinate)

P04 = POINT/-23.42, 12.53 (one coordinate missing)

Point set (PSET)



A point set is used to transfer information for a plane curve. The curve name given by the user should be used.

Notation

name = PSET/n*[x, y, z]

n is the number of points in integer format. x, y and z are point coordinates in real format. 3 coordinate values must be specified for every point on the curve, even if one or several of these values is zero.

Examples of valid elements:

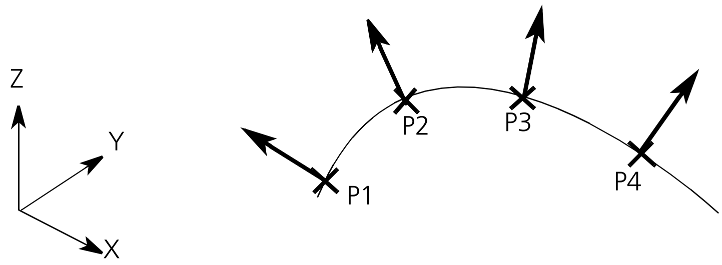
PS01 = PSET/1, 12., -12.82, .6287E-12
PS02 = PSET/2, 0., 12.5, 12.9, -3.1, 4.2, 5.1

Examples of invalid elements:

PS03 = PSET/2., 0., 12.1, 3.4, 1.9, 3.3, 5.98 (number of points is not an integer value)

PS04 = PSET/3, 0., 12.1, 3.4, 1.9, 3.3, 5.98 (the number of points specified does not coincide with the number of subsequent point coordinates)

Point vector set (MDI)



A point vector set is used to transfer information for a curve. In this case, the normal vector components are part of the information.

The curve name given by the user should be used.

Notation

name = MDI/n*[x, y, z, vx, vy, vz]

n is the number of points in integer format. x, y and z are point coordinates in real format. vx, vy, vz are the components of the normal vector in real format. 3 coordinate values and 3 vector components must be specified for every point of the curve, even if one or more of these values is zero.

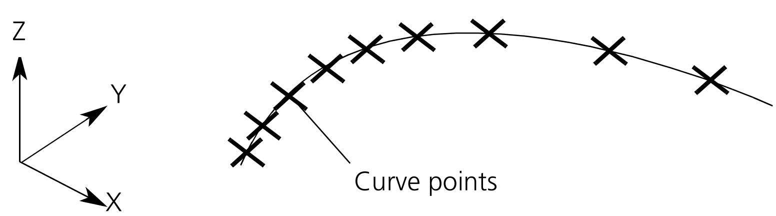
Example of a valid element:

SCHN01 = MDI/2, -11.47, 41.12, 42.67, .339, .918, .206, 1.933, 3.12, 5.34, .321, .905, .279

Example of an invalid element:

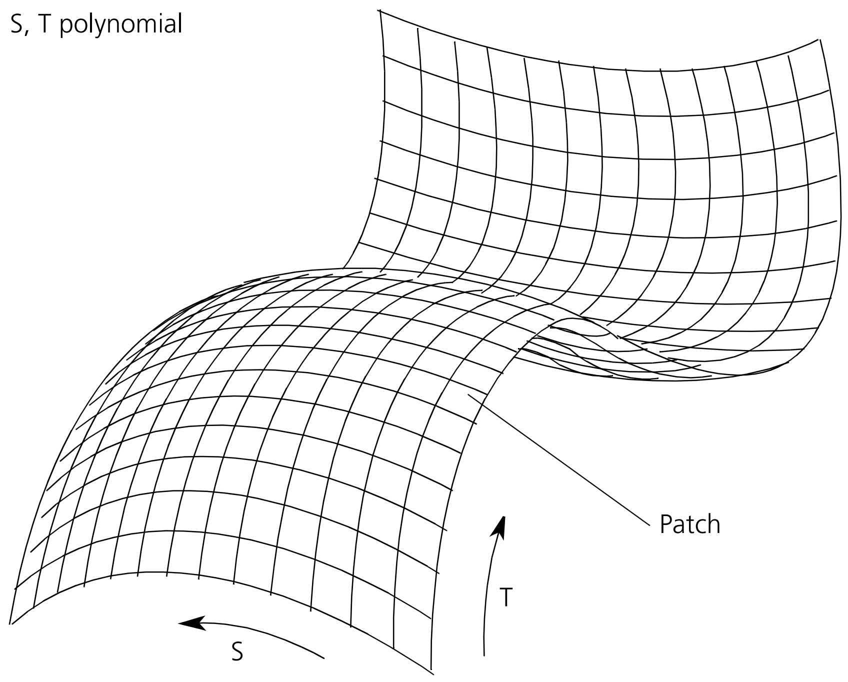
SCHN02 = MDI/1, 2.27, 48.18, 5.85, .429, .232, .873, (line ends in a comma, although there is no continuation line)

Curve (CURVE)

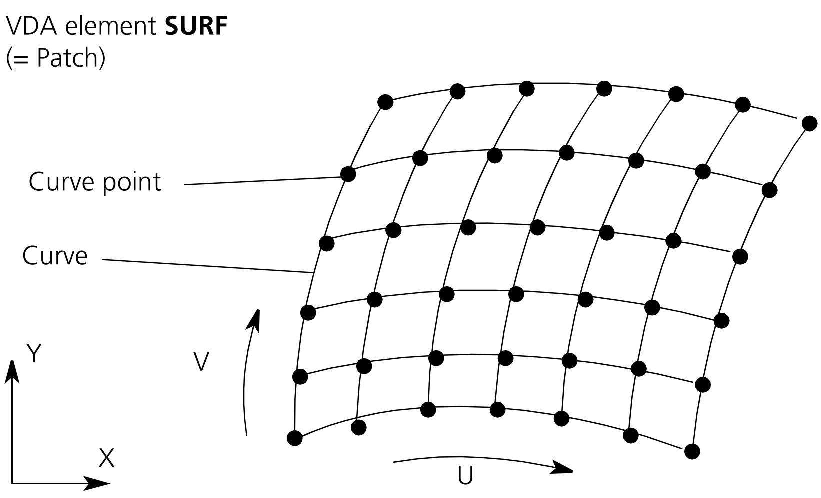


The polynomial is converted to curve points. A curve in KUM results from a CURVE VDA element.

Patch (SURF)



The S, T polynomial is divided into patches. The patches are defined in the local U, V coordinate system. For each patch curve points are calculated, which result in several curves in the U and V direction.



Non-geometric elements

The following terms are denoted as non-geometric elements:

– Start code (Header) ➤ *"Start code (Header)" on page 10-10*
– Comment ➤ *"Comment" on page 10-10*.
– Elements for structuring the geometric data ➤ *"Elements for structuring geometry data" on page 10-11*.
– End code (Trailer) ➤ *"End code (Trailer)" on page 10-11*.

Start code (Header)

The start code consists of the header line, which specifies the file name and the number of following text lines, and of the text lines themselves.

Notation

name = HEADER/n
Text line 1
…
…
…
Text line n

n (integer) is the number of lines which are contained in the start code. The following information must be given in the text lines:

– Name of sender
– Project/file name
– Date of validity
– Creation date
– Generating system
– Contact partner/address/telephone

This information is for documentation purposes only and is not evaluated by the coordinate measuring machine. For VDA-FS, Version 2.0, the following applies: machine-readable header with at least 20 lines.

Comment

Comment line

A comment line is identified by "**$$**" in the first two columns. Comment lines have no continuation lines. The text must be continued in a further comment line if necessary.

Notation

$$text

Comment lines can be inserted anywhere –even between the individual lines of a multi-line element.

The comment lines are used within the VDA function to transfer the following information to the KUM curve measuring program:

- Curve comment
- Probe sphere radius
- Plane code number
- Type of curve
- Curve number

When reading in the transfer file, the coordinate measuring machine computer checks each comment line to see whether it contains such information. If so, the corresponding information is transferred to the KUM data organization. Missing information must be manually entered in KUM.

When transferring actual data to other computer systems, the comment lines are only used for documentation.

Elements for structuring geometry data

Groups (Sets)

The data within a file is organized into groups (sets) by combining the geometric elements. Only single-stage combinations are possible.

Structuring takes place with the commands **BEGINSET** at the start and **ENDSET** at the end of an element group.

Notation

name = BEGINSET
…
name = ENDSET

The name entries for **BEGINSET** and **ENDSET** must be identical .

End code (Trailer)

The last record in a file is the trailer.

Notation

name = END

The name entries in the header and trailer must be identical.

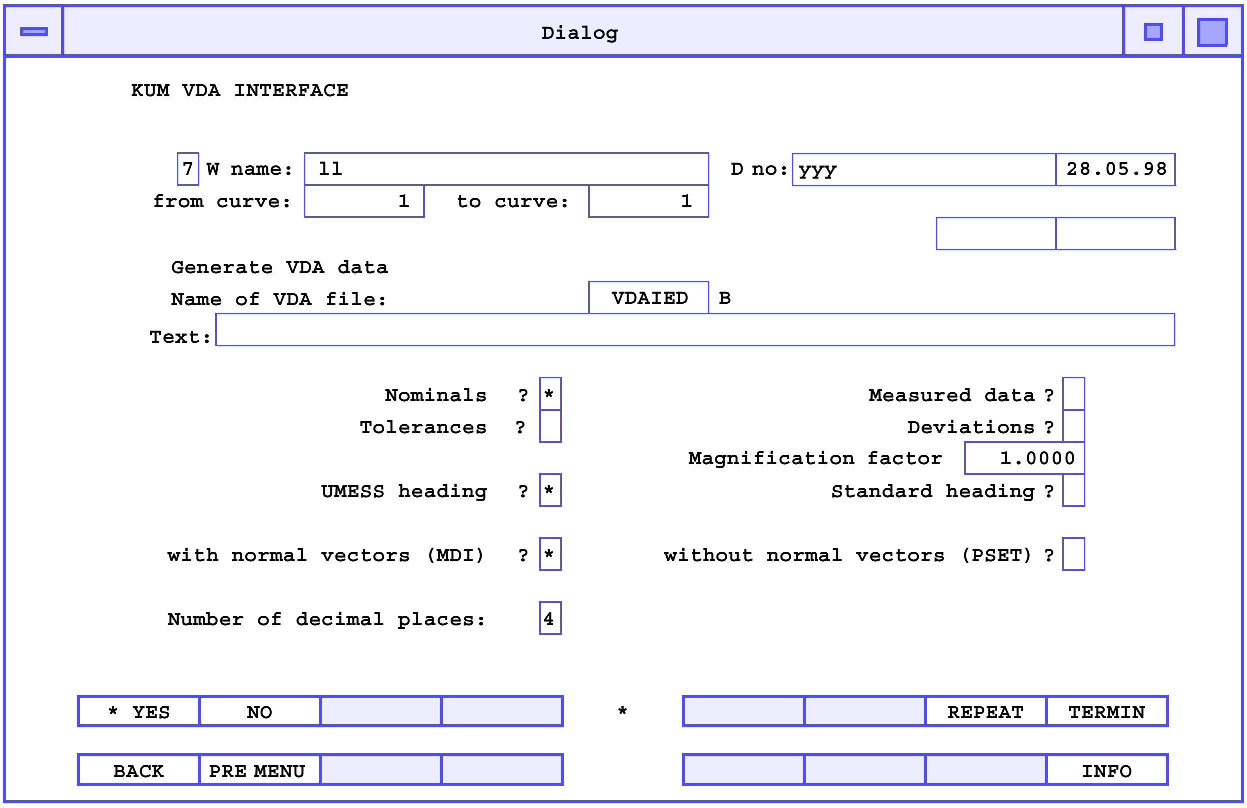
Converting KUM data to VDA format

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

KUM→VDA

Press **<KUM→VDA>**.

The dialog window with the menu title **KUM VDA INTERFACE** is displayed.



Softkey functions

INFO

YES

NO

PRE MENU

REPEAT

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

TERMIN

Execution of the data transfer and return to KUM main menu. If you select the standard heading, the dialog window with the menu title **VDA HEADER DATA FROM STANDARD FILE** is jumped to, ➤*"Standard heading" on page 10-15*.

Notes on the data boxes

Name of VDA file

A comment can be entered in the **Text** data box. The input identification (max. 8 characters without underlines) is entered in the header of the VDA file. The file name of the VDA file consists of 14 characters, the first eight of which are defined by the user. According to VDA standard (DIN 66 301), the name may only consist of upper case letters A-Z and digits 0-9; the first character in the name must be a letter. Example of a file name:

1 2 3 4 5 6 7 8 9 10 11 12 13 14

Input: **VD A T E S T 1**_ _ _ _ _ _ _ _ _ **B**

If less than eight characters are entered, no underlines may be entered, see example.

1 2 3 4 5 6 7 8 9 10 11 12 13 14

Input: **VD A**_ _ _ _ _ _ __ _ _ _ _ _ _ _ **B**

Note

The name with the underlines (14 characters) is used as the file name under which the VDA file is saved in the directory

Operating system	Directory
HP-UX 9.05	**/users/zeiss/CZ-MES-UI**
from HP-UX 10.20	**/home/zeiss/UI**

Nominals

<YES>
= Nominal data is saved to VDA file.

<NO>
= Jump to next box.

Measured data

<YES>
= Measured data is saved to VDA file.

<NO>
= Jump to next box.

Tolerances	**<YES>** Tolerances are saved to VDA file. To do this, the magnification factor must be specified. The tolerances are saved point by point or sector by sector as distances in the nominal file. They are multiplied by the magnification factor, added to the nominal points in the normal direction and saved as two point sets **PSET** in the VDA file. The first **PSET** is the upper tolerance curve, the second **PSET** the lower tolerance curve. **<NO>** Jump to next box.
Deviations	**<YES>** Deviations are saved to the VDA file. To do this, the magnification factor must be specified. The deviation vectors are multiplied by the magnification factor, added to the nominal points and saved as point set **PSET** in the VDA file. **<NO>** Jump to next box.
Magnification factor	The magnification factor must be entered for tolerances and deviations; it is not used for nominal or measured data.
UMESS heading	The current UMESS record header is used for the VDA header.
Standard heading	20 lines are requested for the VDA header via menus, according to DIN 66301.
with normal vectors (MDI)	**<YES>** Data is saved as point vector set (X, Y, Z, N_x, N_y, N_z). **<NO>** Jump to next box.
without normal vectors (PSET)	**<YES>** Data is saved as a point (X, Y, Z). **<NO>** Return to previous box.
Number of decimal places	State the number of decimal places for the coordinate values.

Standard heading

The standard heading is written in the header. The lines of the standard heading which have a “P” must be filled in according to the VDA standard (DIN 66 301).

Start menu: KUM Main Menu, ➤*“Calling the KUM Main Menu” on page 1-7*.

KUM→VDA

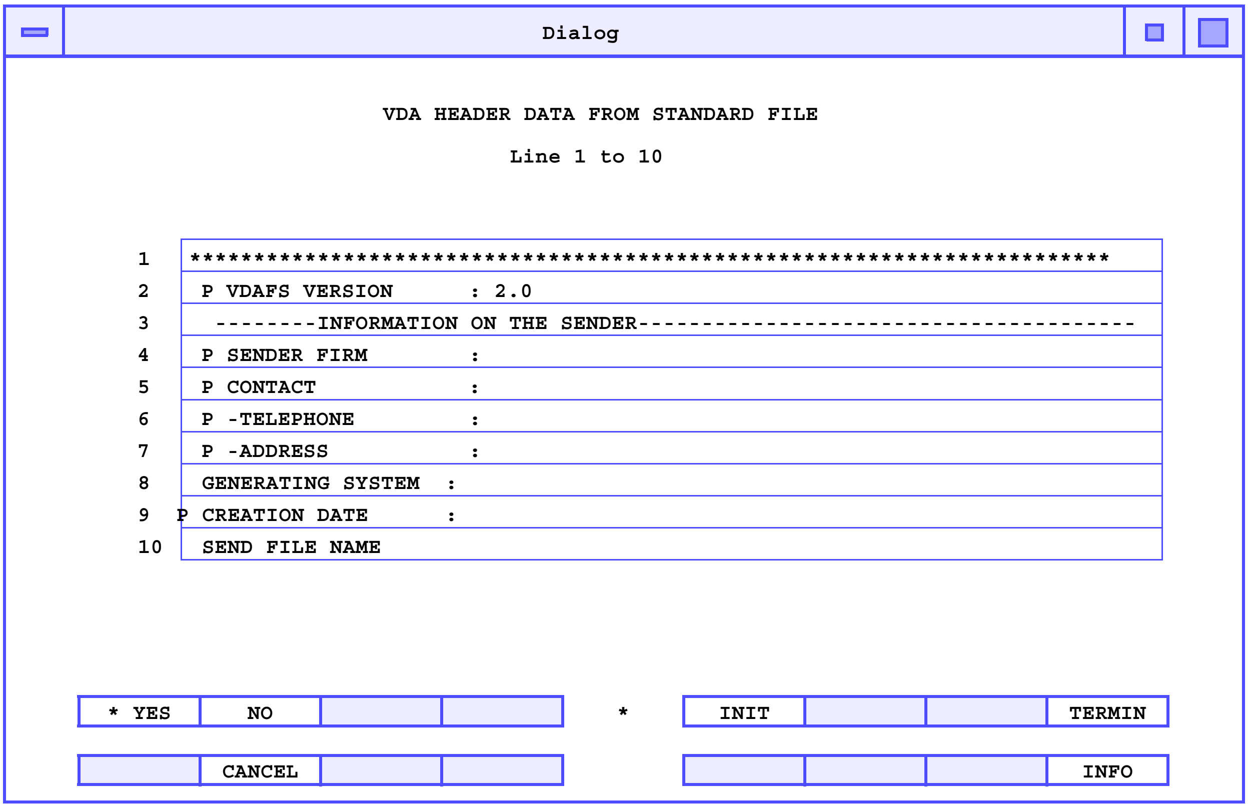
– Press **<KUM→VDA>**.
  The dialog window with the menu title **KUM VDA-INTERFACE** is displayed.

YES

– Acknowledge the Standard heading data box with **<YES>**.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **VDA HEADER DATA FROM STANDARD FILE** is displayed.



Softkey functions

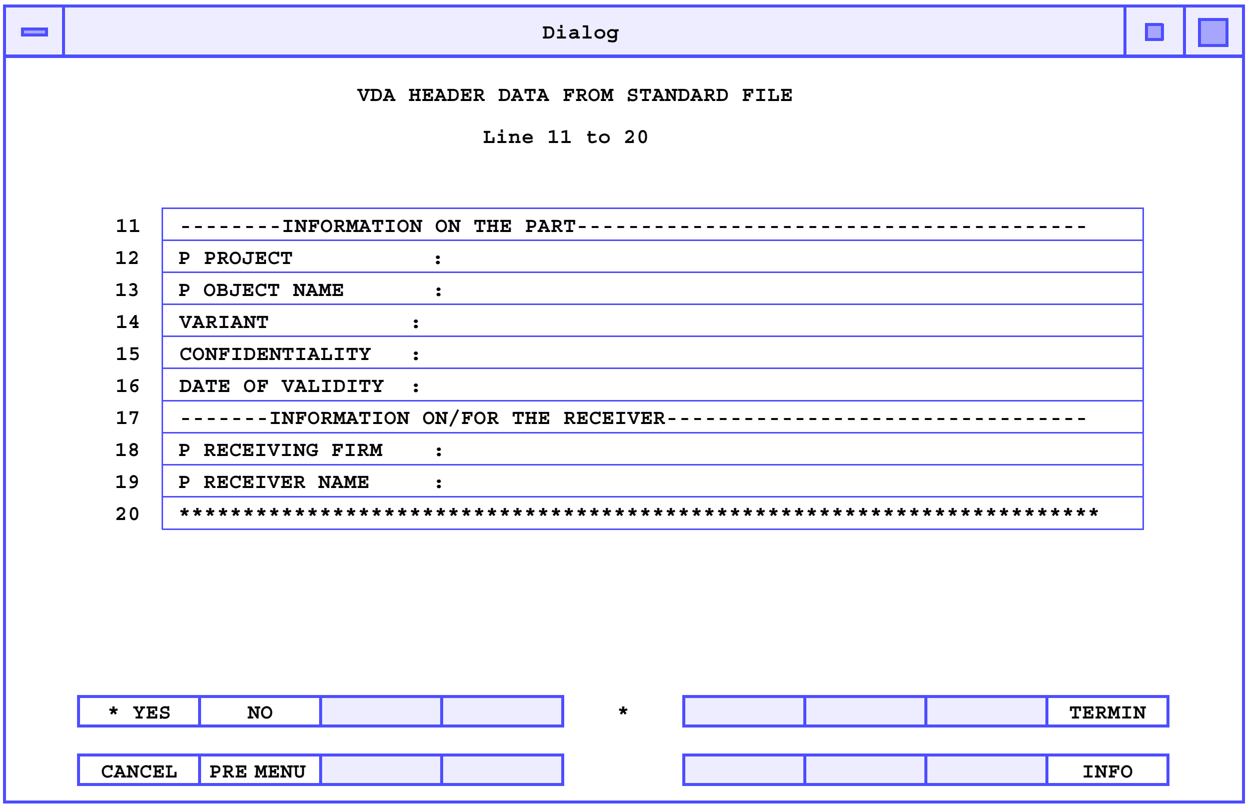
INFO **YES** **NO** — See general softkey functions, ➤*"General softkey functions" on page 1-10*.

CANCEL — Jump to KUM command input.

INIT — Preassignment of the page with the initial values.

CONT — Switch to table for displaying the next ten lines (see display from line 11 to 20 on the next page).

Display of lines 11 to 20 of the header



Comments on the two tables

NOTE

If there is a "**P**" in the table printout after the consecutive number, this means that an input must be made in this line according to the VDA standard! If this prescription is observed, the header is machine-readable.

Example of a VDA source file

```
  VDA FILE=      HEADER/20
**********************************************************************
VDAFS VERSION       : 2.0
--------INFORMATION ON THE SENDER-------------------------------------
SENDER FIRM         : . . .
CONTACT             : IP-AS
-TELEPHONE          : 07364203925
-ADDRESS            : 7082 OBERKOCHEN, POSTFACH 1369/1380
GENERATING SYSTEM   : HP-UX
CREATION DATE       : 02.10.95
SEND FILE NAME      : VDA HEADER  xxB
-------INFORMATION ON THE PART----------------------------------------
PROJECT             :
OBJECT NAME         :
VARIANT             :
CONFIDENTIALITY     :
DATE OF VALIDITY    :
-------INFORMATION ON/FOR THE RECEIVER--------------------------------
RECEIVING FIRM      :
RECEIVER NAME       :
**********************************************************************

$$PLA          =         PLANE/  3
$$TYPE         =         TYPE/    0
$$COO          =         COORD/  1
$$CUR          =         SECT/   5
SET            =         BEGINSET
POINT          =         POINT/    -11.7
                                                    12.8
                                                    10.9
SET            =         PSET/  3,
 25.11,       36.23,        0.11
 60.55,     -6555.2,       -90.1
 33.33,     -220.55,        35.0
PTVECT         =         MDI/   2,
125.36,        98.3,      -36.11,      0.315,      0.233,      0.754,
  36.3,       3.122,        32.7,       0.82,      0.298,      0.455,
SET            =         ENDSET
VDAFILE=       END
```

$$ commands

The notation of the $$ commands (➤*"Transfer of VDA data to KUM" on page 10-19*) must comply with the following specification:

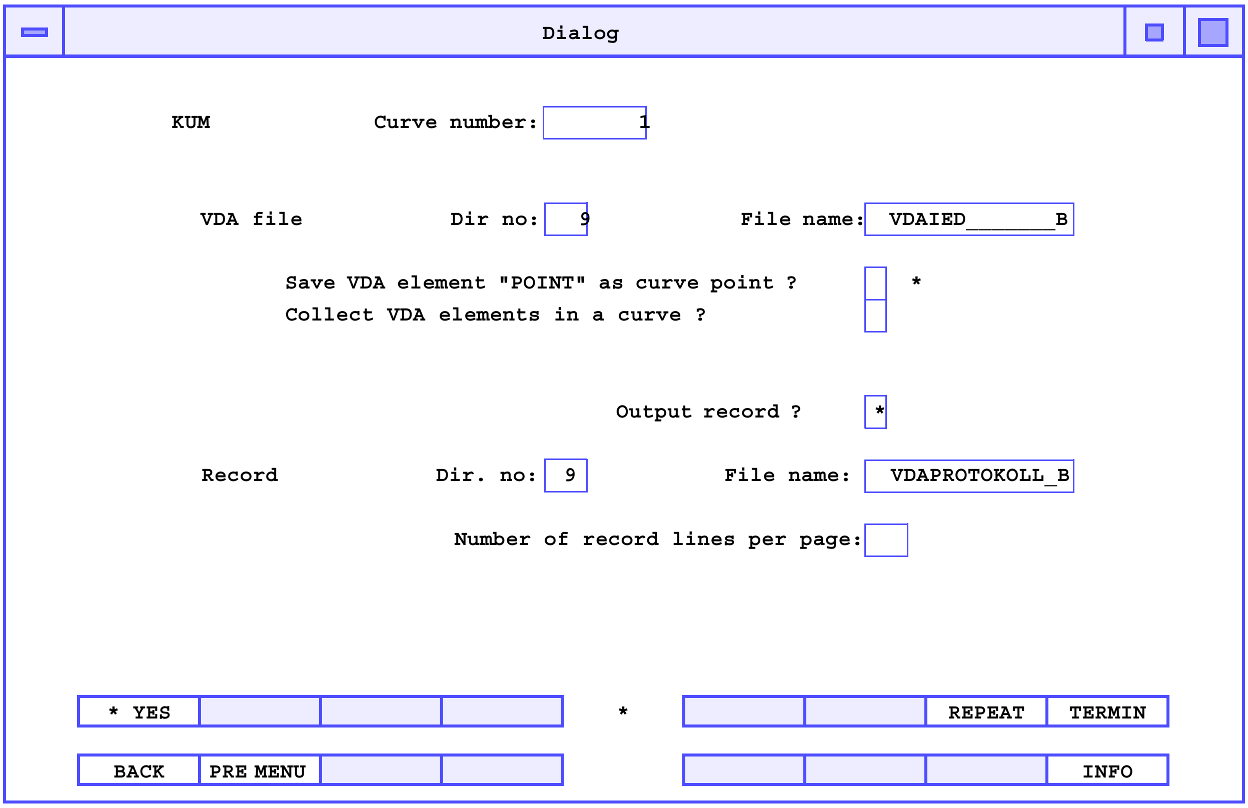
Notation	**Type of interpretation in KUM**
$$name = PLANE/n	The integer n is entered as a plane code number ($1 \leq n \leq 3$)
$$name = TYPE/n	The integer n is entered as curve type in the catalog $n = 0 \rightarrow$ open curve $n = 1 \rightarrow$ closed curve
$$name = SECT/n	The integer n is entered as curve number in the catalog ($1 \leq n \leq 999$)

Transfer of VDA data to KUM

Start menu: KUM main menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

VDA→KUM

– Press **<VDA→KUM>**.
The dialog window with the menu title **KUM VDA→KUM** is displayed.



Softkey functions

INFO
YES
NO
PRE MENU
REPEAT
BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

REPEAT

Call up of a continuation page corresponding to the input in the **File name** box, e.g.

VDACURVE_____B Description in ➤ *"Curve (CURVE)" on page 10-8*.
VDASURF______B Description in ➤ *"Patch (SURF)" on page 10-9*.

The files can come e.g. from the CAD system. They must be stored in Directory 9 (UI Directory). The first 8 places can be *freely* selected. The following places are fixed. 5 "_" follow, and lastly a "**B**". If less than 8 places are used, then the number of "_" increases.

Notes on the data boxes

KUM curve number

Display of the curve number from which the curves are stored in KUM; the curve number is entered in the KUM main menu.

VDA file dir. no.

Enter the directory number of the VDA file to be transferred.
Example: Directory no. 9 means:

Operating system	Directory
HP-UX 9.05	**/users/zeiss/CZ_MES_UI**
from HP-UX 10.20	**/home/zeiss/UI**

The exact name of the directory can be found in the **KON PAB_______B** list.

File name:
VDAIED_______B

Input of the file name.

Save VDA element "POINT" as curve point

<YES>
The VDA element **POINT** is interpreted as curve point and saved in a nominal or measured data file.

<NO>
The VDA element **POINT** is interpreted as intermediate position. If nominal data is transferred, these intermediate positions are saved as probe path in the curve-specific data; in the case of measured data, the intermediate positions are not saved.

Collect VDA elements in a curve

<YES>
All VDA elements within a **BEGINSET-ENDSET** structure are collected in a curve. An exception is formed by the **SURF** element; an additional window appears if this element occurs in the VDA file.

<NO>
Each VDA element is saved separately in a curve.

Output record

<YES>
Presetting for the record: If no inputs are made in the following boxes, the record output only appears on the screen - otherwise it appears on the screen and in the record.

<NO>
No record output, but faster program run. The record can be saved to a file by entering the directory number and a file name without special characters. The number of record characters per page must also be defined.

Record Dir. no.
Output of the directory number and the file name in the record.

File name
Enter file name of the record.

Number of record lines per page
Control of the page make-up for subsequent output of the record file on an output device.

KUM commands in the VDA file for controlling the catalog

KUM commands	Comments
$$name = **NAME**/workpiece name	no transfer to KUM
$$name = **WNO**/workpiece number	no transfer to KUM
$$name = **DATA**/code	VDA data is either saved as nominal data (code: **NOM**), measured data (**MVA**) or as deviations (**DEV**).
$$name = **TIPRAD**/probe sphere radius	If the data code is set to measured data ($$name = DATA/MEAS), then the probe sphere radius is saved for every point in KUM (probe sphere center point coord.)
$$name = **COMMENT**/curve comment	Transfer of the curve comment to KUM. The input can be checked with **DEV LIS**, if the data box **Output curve comment** is confirmed with **<YES>**.
$$name = **CURVE**/curve name	The curve name is entered in the curve catalog. To check the input: Press **<CURV ADM>** in the KUM Main Menu and in the dialog window confirm the data box **Nom curve** or **Meas curve**, as well as **Output admin catalog** with **<YES>**.
$$name = **COORD**/code number	Input of the code number (CN) in KUM as default coordinate system. Here KZ 0 = Sphere coordinates KZ 1 = Cartesian coordinates KZ 2 = Cylinder coordinates

Comment

If no error occurs when transferring the data, the KUM Main Menu is called up. If an error does occur, the VDA-KUM page appears again.

The warning **Identification has already occurred** is only for information purposes, it does not influence the transfer. In this case, the VDA-KUM page can be exited with **<PRE MENU>**.

The notation of the KUM commands ($$name = command word/parameter) must comply with certain specifications. The name specified after $$ is entered as curve name in the curve catalog.

To check all current entries, the entire curve catalog can be called up with the following input: Press **<CURV ADM>** in the KUM Main Menu; then, in the dialog window, confirm either the **Nominal curve** or **Measured curve** data box, as well as **Output admin catalog** with **<YES>**.

Input dialog for the “CURVE” VDA element

The **CURVE** VDA element is displayed as a polynomial in the VDA file. When transferred to KUM, this polynomial is converted into curve points (coordinate triple).

With a polynomial degree greater than 2, 3D normal vectors are also calculated. Information needed for this conversion which is not in the VDA file can be entered using this dialog window.

Start menu: KUM Main Menu, ➤*“Calling the KUM Main Menu” on page 1-7*.

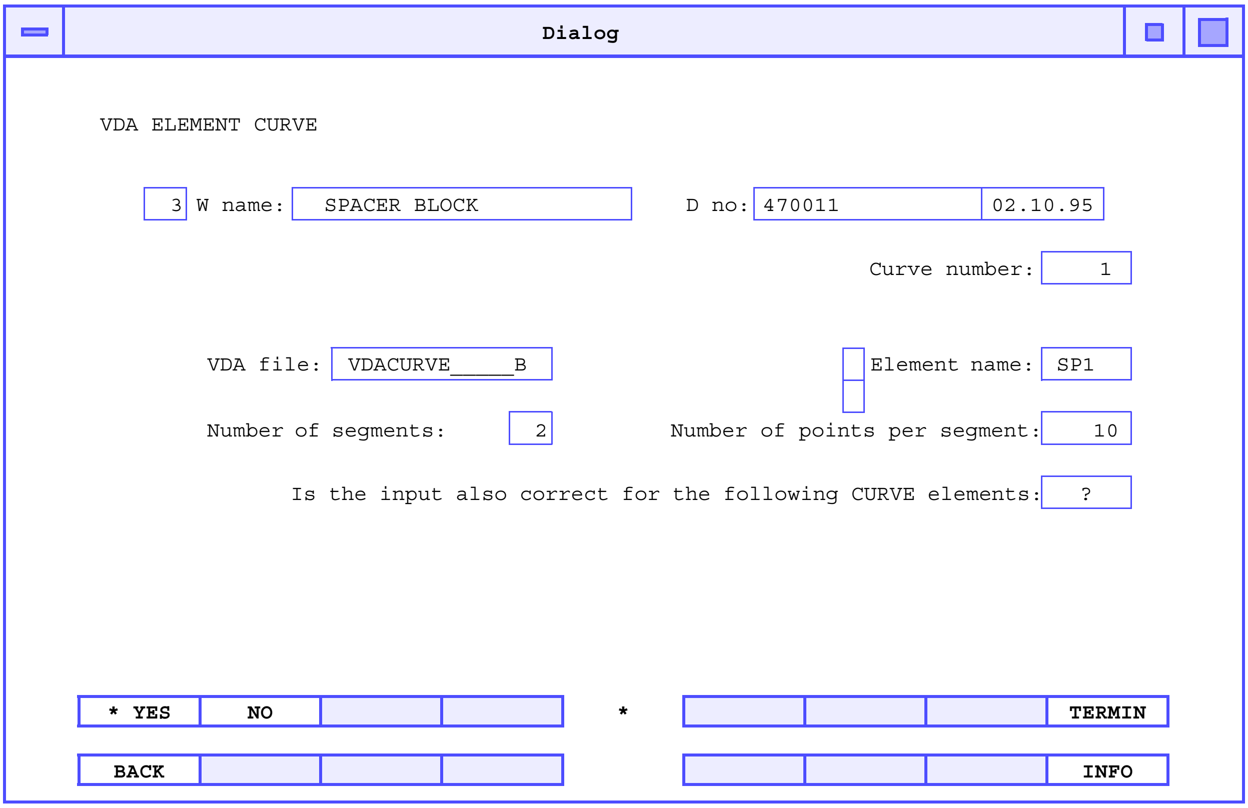
VDA→KUM

– Press **<VDA→KUM>**.
  The dialog window with the menu title **KUM VDA-KUM** is displayed.

– Enter the name in the **File name** data box.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **VDA ELEMENT CURVE** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

BACK

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the data boxes

W name
D no

Data boxes with preset header data.

Curve number

Data box with the current curve number in KUM.

VDA file

Data box with identification of the current VDA file.

The files can come from the CAD system, for example. They must be stored in Directory 9 (UI Directory). The first 8 places can be *freely* selected. The following places are fixed. 5 "_" follow and lastly a "**B**". If fewer than 8 places are used, the number of "_" increases.

Element name

Data box with the name of the current CURVE VDA element. The name of the VDA element is transferred as curve name to the KUM curve catalog.

Number of segments

Data box for specifying the number of curve segments of the VDA element.

Number of points per segment

Data box for specifying the curve points (coordinate triple) per curve segment. The following can be recommended as reference:

– with a slight curve: approx. 5 points

– with a more pronounced curve: approx. 30 points

The number of points for the entire curve results from the following relationship:

Total number of points = No. of segments * No. of points per segment + 1

Is output also correct for the following curve elements

<YES>
With the following CURVE elements, no window appears; no dialog is carried out for the CURVE elements until the end of the VDA file.

<NO>
A dialog is carried out for each CURVE element.

Checking VDA normals for the “CURVE” VDA element

With the **CURVE** VDA element, the normal vectors of the curve points are calculated with the formulas according to Frenet-Serretsch (Frenetian tripod), if the polynomial order is greater than 2.

The normal vectors of points which are in the surface grid of the **SURF** VDA element, can be determined by using the cross product of the two tangent vectors (U and V direction) of these points.

The direction of the normal vectors can be checked in this window and reversed if necessary.

Start menu: KUM Main Menu, ➤*“Calling the KUM Main Menu” on page 1-7*.

VDA→KUM

– Press **<VDA→KUM>**.
The dialog window with the menu title **KUM VDA-KUM** is displayed.

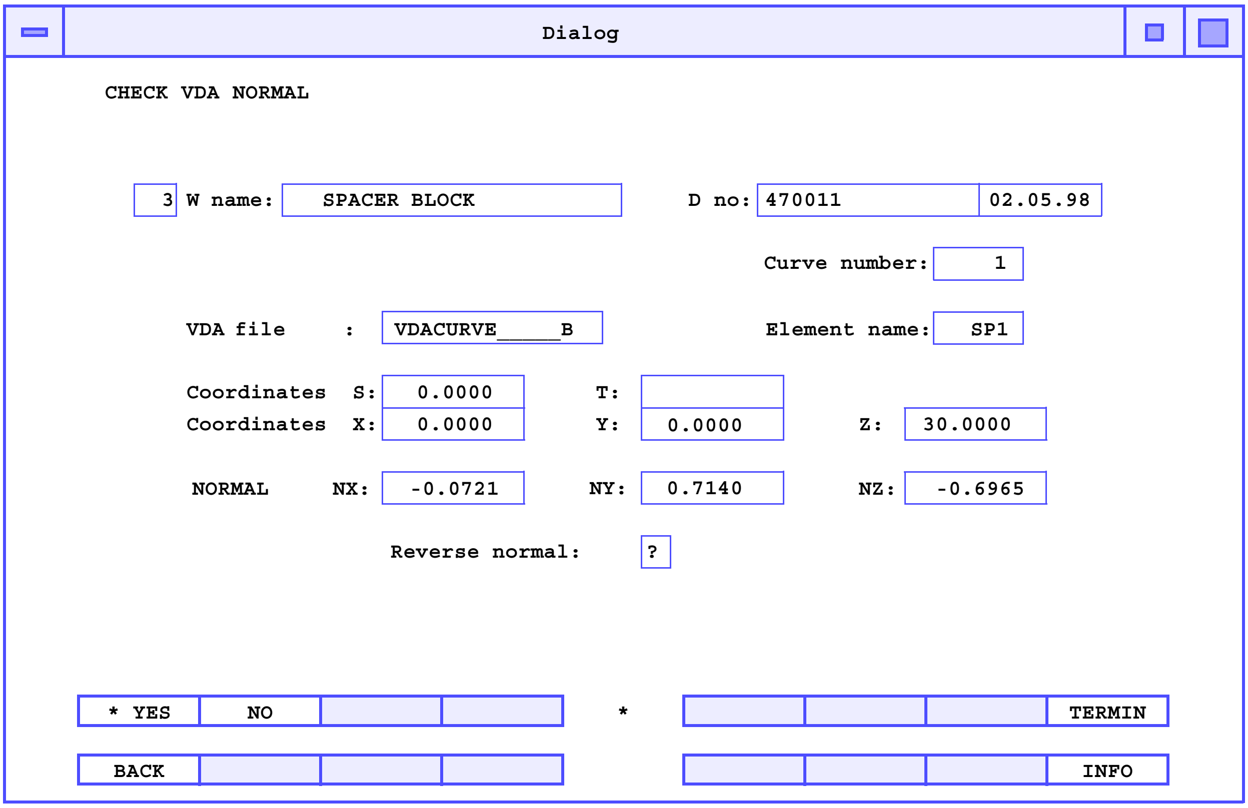
– Enter the name in the **File name** data box.

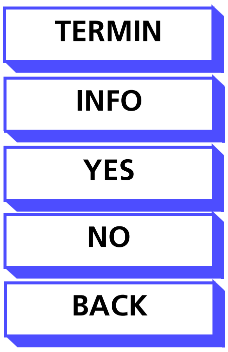
TERMIN

– Press **<TERMIN>**.
The dialog window with the menu title **CURVE VDA ELEMENT** is displayed.

TERMIN

– Press **<TERMIN>**.
The dialog window with the menu title **CHECK VDA NORMAL** is displayed.





Softkey functions

See general softkey functions, ➤*"General softkey functions" on page 1-10*.

Notes on the data boxes

W name
D no
Data boxes with preset header data.

Curve number
Data box with the current curve number in KUM.

VDA file
Data box with the designation of the current VDA file.

Element name
Data box with the name of the current CURVE VDA element. The name of the VDA element is transferred as curve name to the KUM curve catalog.

Coordinates S/T Data box with the coordinates S or T of the first point.

Coordinates X/Y/Z Data box with the XYZ coordinates of the first point.

Normal NX/NY/NZ Data box with the components of the normal vector of the first point.

Reverse normal This box must be confirmed with **<YES>** if this and all subsequent normal vectors are to be reversed.

Input dialog for "SURF" VDA element

The **SURF** VDA element is displayed in the VDA file by polynomials. These polynominals are converted to curve points (coordinate triple) and normals when the data is transferred to KUM.

The polynomials describe a surface grid in the S and T and/or in the U and V direction. S and T are global parameters, U and V are local parameters.

Information which is needed for the conversion and does not exist in the VDA file, can be entered in this dialog window.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

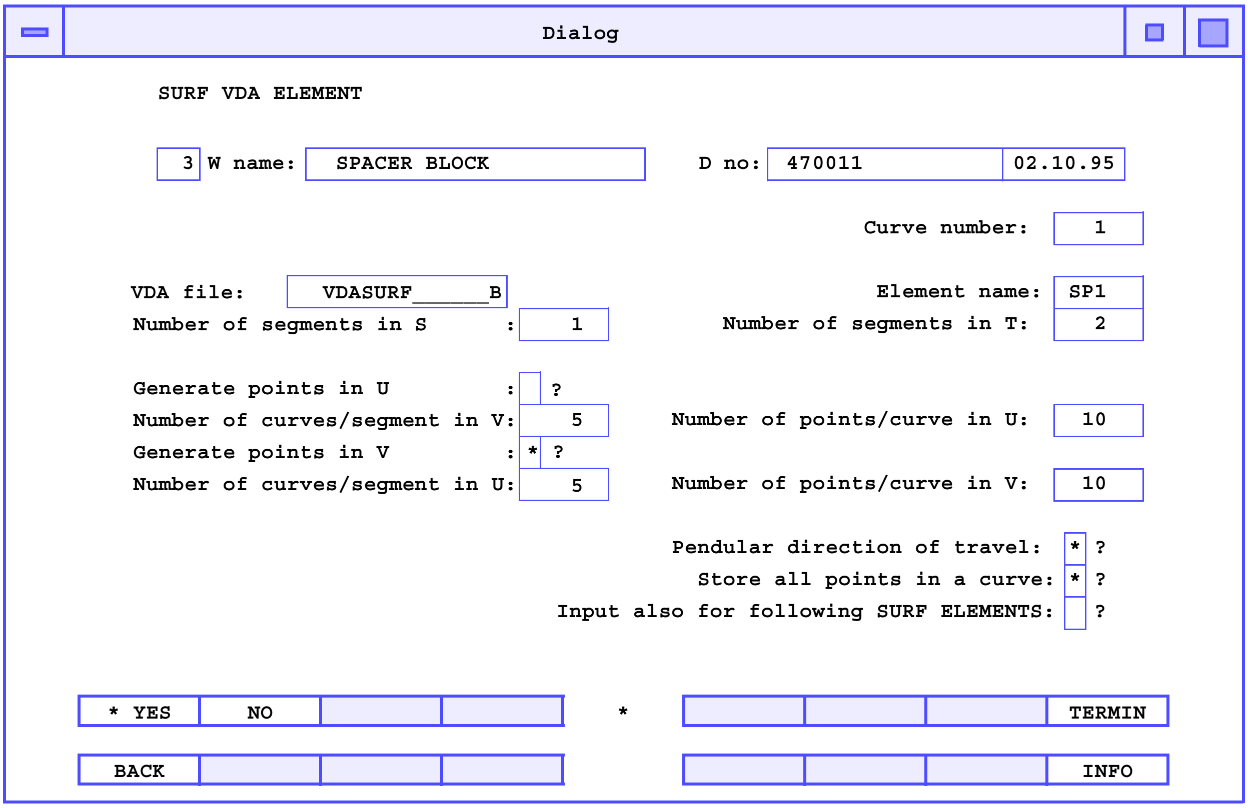
VDA→KUM

– Press **<VDA→KUM>**.
  The dialog window with the menu title **KUM VDA-KUM** is displayed.

– Enter the name in the **File name** data box.

TERMIN

– Press **<TERMIN>**.
  The dialog window with the menu title **SURF VDA ELEMENT** is displayed.



Softkey functions

TERMIN

INFO

YES

NO

BACK

See general softkey functions, ➤ *"General softkey functions" on page 1-10*.

Notes on the data boxes

W name
D no

Data boxes with preset header data.

Curve number

Data box with the current curve number in KUM.

VDA file

Data box with the designation of the current VDA file.

The files can e.g. come from the CAD system. They must be stored in Directory 9 (UI Directory). The first 8 places can be *freely* selected. The following places are fixed. 5 "_" follow and lastly a "**B**". If less than 8 places are used, the number of "_" increases.

Element name

Data box with the name of the current SURF VDA element. The name of the VDA element is transferred as curve name to the KUM curve catalog.

Number of segments in S

Data box with the number of surface segments in the S direction (a line in the surface grid). The number of surface segments for the entire surface is calculated as follows: Total number of segments = Surface segments in S * Surface segments in U.

Number of segments in T

Data box with the number of surface segments in the T direction (a column in the surface grid). The number of surface segments is calculated as follows:

Total number of segments in T = Surface segments in S * Surface segments in U

Generate points in U

This data box must be confirmed with **<YES>** if a curve is to be generated in the U direction.

Number of curves/segment in V

Input of the number of curves per surface segment in the V direction. Make sure that the last surface segments also have an additional boundary curve.

Note: With a slightly curved surface segment, 5 curves are generally sufficient, while with a more pronounced surface segment 10 curves or more may be necessary.

Number of points/ curves in U

Input of the number of points per curve in the U direction. Make sure that the curves of the last surface segments also have an additional boundary point.

Note: With a slight curve, 5 points are generally sufficient, while with a more pronounced curve, 30 points or more may be necessary.

Generate points in V

This data box must be confirmed with **<YES>** if points are to be generated which form a curve in the V direction; otherwise enter **<NO>**.

Number of curves/segment in U

Input of the number of curves per surface segment in the U direction. Make sure that the last surface segments also have an additional boundary curve.

Note: With a slightly curved surface segment, around 5 curves are generally sufficient, while with a more pronounced surface segment 10 curves or more may be necessary.

Number of points/ curves in V

Input of the number of points per curve in the V direction. Make sure that the curves of the last surface segments also have an additional boundary point.

Note: With a slight curve, 5 points are generally sufficient, while with a more pronounced curve, 30 points or more may be necessary.

Pendular direction of travel

If confirmed with **<YES>**, the direction of travel is reversed for each second curve. If, on the other hand, **<NO>** is entered, all curves have the same direction of travel.

Store all points in a curve

If all points of the entire surface grid are to be stored in a curve, this data box must be confirmed with **<YES>**. If **<NO>** is entered, each curve is saved separately.

Is input also correct for the following SURF elements

If confirmed with **<YES>**, no further dialog window appears for the following SURF elements. This means that no further dialog is carried out for SURF elements up to the end of the VDA file. If **<NO>** is entered, a new dialog is carried out for each SURF element.

Specifying tolerances for a VDA element

You can define all KUM curve tolerances with the **TOL** keyword. The data is identical to that of the KUM functions **Edit tolerances** (**TOL EDI**) and **Edit nominals** (**NOM EDI**), sector by sector tolerance input.

NOTE

Tolerances read in via the VDA interface can be edited with the **Edit nominals** KUM function, sector by sector tolerance input!
The curve dimension, shift and rotation tolerances apply for the entire curve. These tolerances are required for the curve assessment in the deviation list. If you do not use these tolerances, then simply set all values = 0.0.
The remaining tolerances up to_point_no (S), lower_tolerance (S), upper_tolerance (S), curve jump (S) and diagram position (S) are sector-dependent. Up to 25 different sectors can be defined.
If these tolerances are unchanged over the entire curve, then this is a tolerance sector (number_tolerance sectors =1).

If the number of curve points is unknown, then enter a large value (e.g. 32000) for the last tolerance sector for to_point_no**.**

Example with 2 tolerance sectors

- 1st sector to_point_no = 20
  This tolerance information applies from point number 1 to point number 20.
- 2nd sector to_point_no = 32000
  This tolerance information applies from point number 21 to point number 32000

VDA notation

$$ Name = TOL/Number_tolerance sectors,
$$ Curve dimension tolerance,
$$ Shift tolerance_X, Shift tolerance_Y,
$$ Shift tolerance_Z, Rotation tolerance_X, Rotation tolerance_Y,
$$ Rotation tolerance_Z

… from here, sector-dependent data S = 1:

$$ to_point_no (S), lower_tolerance (S),
$$ upper_tolerance(S), curve jump(S), diagram position (S),

… data for next sector S = 2.

… last sector S = number_tolerance sectors:

$$ to_point_no (S), lower_tolerance (S),
$$ upper_tolerance (S), curve jump (S), diagram position (S)

For the sector number "**S**" the following applies: S = 1,2,…, number_tolerance sectors. All lines begin with the comment character "**$$**". The VDA standard remains unimpaired–this data can be read error-free by any VDA interpreter.

Parameter types

$$:	VDA comment
Name:	Alphanumeric upper case letters, no special characters
TOL/ :	Keyword
Number_tolerance sectors:	Integer, max. 25 sectors "**S**"
Curve dimension tolerance:	Real [mm]
Shift tolerance_X:	Real [mm]
Shift tolerance_Y:	Real [mm]
Shift tolerance_Z:	Real [mm]
Rotation tolerance_X:	Real, rotation angle [degrees]
Rotation tolerance_Y:	Real, rotation angle [degrees]
Rotation tolerance_Z:	Real, rotation angle [degrees]
to_point_no (S):	Integer, function of "**S**", largest point number = 32767
Lower_tolerance (S):	Real, function of "**S**" [mm]
Upper_tolerance (S):	Real, function of "**S**" [mm]
Curve jump (S):	Real, function of "**S**" [mm]
Diagram position (S):	Real, function of "**S**" [mm]

Where are the tolerances within the VDA file?

1st case

The tolerances can be positioned directly after a VDA element (PSET,MDI).

Example

```
SET1    =  BEGINSET
MDI1    =  MDI/3,…
$$ TOL1 =  TOL/2,…
SET1    =  ENDSET
```

2nd case

You can create a VDA file which only contains tolerance information. This file can be reused for different curves.

Prerequisite in KUM

When reading in the tolerances, the relevant nominal data must be available.

Example

VDAFILE	=	HEADER/20 …
SET1	=	BEGINSET
$$		First VDA set
$$ TOL1	=	TOL/3,…
SET1	=	ENDSET
SET2	=	BEGINSET
$$		Second VDA set
$$ TOL2	=	TOL/4,…
SET2	=	ENDSET
VDAFILE	=	END

If when reading in the VDA file, the curve number **from curve** has the value 4 in the KUM main menu, then the tolerances for the first VDA set are assigned to the curve number 4. The tolerances for the second VDA set are assigned to the curve number 5.

Specifying point by point tolerances for a VDA element

You can define all KUM curve tolerances with the keyword **TOLPP** (tolerances per point). The data is identical to that of the KUM functions **Edit tolerances** (**TOL EDI**) and Edit nominals (NOM EDI), point by point tolerance input.

NOTE

Please also note the option available for sector by sector tolerance input in VDA format with the VDA keyword **TOL**.
Tolerances read in via VDA interface can be edited with the **Edit nominals** KUM function, point by point tolerance input!
The curve dimension, shift and rotation tolerances apply for the entire curve–these tolerances are required for the curve assessment in the deviation list.
If you do not use these tolerances, simply set all values = 0.0
The remaining tolerances lower_tolerance (P), upper_tolerance (P), curve jump (P) and diagram position (P) are point-dependent.

VDA notation

$$ Name = TOLPP/Number_tolerances,

$$ Curve dimension tolerance,

$$ Shift tolerance_X, Shift tolerance_Y, Shift tolerance_Z,

$$ Rotation tolerance_X, Rotation tolerance_Y, Rotation tolerance_Z,

… from here, point dependent data P = 1:

$$ Lower_tolerance (P), upper_tolerance (P), curve jump (P), diagram position (P),

… Data for next point P = 2 …

… last point P = number_tolerance points:

$$ Lower_tolerance (P), upper_tolerance (P), curve jump (P), diagram position (P)

For the point number "**P**" the following applies: P = 1,2, …, Number_tolerance points. All lines begin with the comment character "**$$**". The VDA standard remains unimpaired - this data can be read error-free by any VDA interpreter.

NOTE!
The number of tolerances **Number_tolerance points** must coincide with the number of nominal points to which they are to be saved!

Parameter types

$$:	**VDA comment**
Name:	Alphanumeric upper case letters, no special characters
TOLPP/ :	Keyword
Number_tolerance points:	Integer,function "**P**", equal to number of nominal points
Curve dimension tolerance:	Real [mm]
Shift tolerance_X:	Real [mm]
Shift tolerance_Y:	Real [mm]
Shift tolerance_Z:	Real [mm]
Rotation tolerance_X:	Real, rotation angle [degrees]
Rotation tolerance_Y:	Real, rotation angle [degrees]
Rotation tolerance_Z:	Real, rotation angle [degrees]
Lower_tolerance (P):	Real, function of "**P**" [mm]
Upper_tolerance (P):	Real, function of "**P**" [mm]
Curve jump (P):	Real, function of "**P**" [mm]
Diagram position (P):	Real, function of "**P**" [mm]

Where are the tolerances within the VDA file?

1st case

The tolerances can be positioned directly after a VDA element (PSET,MDI).

Example

SET1	=	BEGINSET
MDI1	=	MDI/3,...
$$ TOLPP1	=	TOLPP/350,...
SET1	=	ENDSET

2nd case

You can create a VDA file which only contains tolerance information. This file can be reused for different curves.

Prerequisite in KUM: When reading in the tolerances, the relevant nominal data must be available, and the following applies:
Number of tolerances = Number of nominal data.

Example

VDAFILE	=	HEADER/20 …
SET1	=	BEGINSET
$$		First VDA set
$$ TOLPP1	=	TOLPP/3,…
SET1	=	ENDSET
SET2	=	BEGINSET
$$		Second VDA set
$$ TOLPP2	=	TOLPP/4,…
SET2	=	ENDSET
VDAFILE	=	END

If when reading the VDA file the curve number **from curve** has the value 4 in the KUM Main Menu, then the tolerances for the first VDA set are assigned to curve number 4. The tolerances for the second VDA set are assigned to the following curve number 5.

Examples of tolerance input for VDA elements

Point by point tolerances

```
VDATOLP6 = HEADER/          20                                                 00000001
*********************************************************************************00000002
VDAFS VERSION       : 2.0                                                      00000003
--------INFORMATION ABOUT THE SENDER---------------------------------------------00000004
SENDER FIRM         : ZEISS                                                    00000005
Contact             :                                                          00000006
-TELEPHONE          :                                                          00000007
-ADDRESS            :                                                          00000008
GENERATING SYSTEM   :                                                          00000009
CREATION DATE       :                                                          00000010
SEND FILE NAME      :                                                          00000011
--------INFORMATION ON THE PART--------------------------------------------------00000012
PROJECT             : TOLERANCES                                               00000013
OBJECT NAME         :                                                          00000014
VARIANT             :                                                          00000015
CONFIDENTIALITY     :                                                          00000016
DATE OF VALIDITY    :                                                          00000017
---------INFORMATION ON/FOR THE RECEIVER-----------------------------------------00000018
RECEIVING FIRM      :                                                          00000019
RECEIVER NAME       :                                                          00000020
*********************************************************************************00000021
$$Points and point by point tolerances                                         00000022
SET1=BEGINSET                                                                  00000023
PSET1 = PSET/           9,                                                     00000024
     10.0000,       .0000,        .0000,                                       00000025
      7.6604,      6.4279,        .0000,                                       00000026
      1.7365,      9.8481,        .0000,                                       00000027
     -5.0000,      8.6603,        .0000,                                       00000028
     -9.3969,      3.4202,        .0000,                                       00000029
     -9.3969,     -3.4202,        .0000,                                       00000030
     -5.0000,     -8.6603,        .0000,                                       00000031
      1.7365,     -9.8481,        .0000,                                       00000032
      7.6604,      6.4279,        .0000,                                       00000033
$$ TES=TOLPP/9                                                                 00000034
 $$ 0.01,0.02,0.03,0.04,0.5,0.6,0.7,                                           00000035
$$ -0.01,0.06,0.03,0.02,                                                       00000036
$$ -0.01,0.05,0.03,0.02,                                                       00000037
$$ -0.01,0.04,0.03,0.02,                                                       00000038
$$ -0.01,0.03,0.03,0.02,                                                       00000039
$$ -0.01,0.02,0.01,0.01,                                                       00000040
$$ -0.01,0.02,0.01,0.01,                                                       00000041
 $$ 0.01,0.03,0.03,0.02,                                                       00000042
 $$ 0.01,0.04,0.03,0.02,                                                       00000043
 $$ 0.01,0.05,0.03,0.02,                                                       00000044
SET1=ENDSET                                                                    00000045
VDATOLP6 = END                                                                 00000046
```

Sector by sector tolerances

```
VDAIED = HEADER/         20                                             00000001
WORKPIECE NAME = TOLERANCES                                             00000002
DRAWING NO = sector by sector                                           00000003
ORDER NO = Example                                                      00000004
SUPPLIER/CUSTOMER = ZEISS                                               00000005
WORK CYCLE                                                              00000006
OPERATOR = Pieper                                                       00000007
DATE = 22.07.1996                                                       00000008
PART NO = 1                                                             00000009
¤¤TWO tolerance sectors                                                 00000010
SET1=BEGINSET                                                           00000011
$$ TES= TOL/2                                                           00000012
 $$ 0.01,0.02,0.03,0.04,0.5,0.6,0.7,                                    00000013
 $$ 20,-0.01,0.02,0.3,0.4                                               00000014
 $$ 32000,-0.01,0.02,0.3,0.4                                            00000015
SET1=ENDSET                                                             00000016
VDAIED = END                                                            00000017
```

Common point tolerances in a VDA file

```
VDAIED = HEADER/         8                                              00000001
WORKPIECE NAME = TOLERANCES                                             00000002
DRAWING NO = point by point                                             00000003
ORDER NO = Example                                                      00000004
SUPPLIER/CUSTOMER = ZEISS                                               00000005
WORK CYCLE 0 Test                                                       00000006
OPERATOR =                                                              00000007
DATE = 22.07.1996                                                       00000008
PART NO = 1                                                             00000009
¤¤Point by point tolerances                                             00000010
SET1=BEGINSET                                                           00000011
$$ TES= TOLPP/9                                                         00000012
 $$ 0.01,0.02,0.03,0.04,0.5,0.6,0.7,                                    00000013
 $$ -0.01,0.06,0.03,0.02,                                               00000014
 $$ -0.01,0.05,0.03,0.02,                                               00000015
 $$ -0.01,0.04,0.03,0.02,                                               00000016
 $$ -0.01,0.03,0.03,0.02,                                               00000017
 $$ -0.01,0.02,0.01,0.01,                                               00000018
 $$ -0.01,0.02,0.01,0.01,                                               00000019
 $$ -0.01,0.03,0.03,0.02,                                               00000020
 $$ -0.01,0.04,0.03,0.02,                                               00000021
 $$ -0.01,0.05,0.03,0.02,                                               00000022
SET1=ENDSET                                                             00000023
VDAIED = END                                                            00000024
```

DXF interface

Read DXF format (DXF READ)

The Read DXF format function interprets the content of a dxf file, Release 12. The following dxf elements (entities) are saved as KUM nominals: **POINT**, **LINE**, **ARC**, **CIRCLE**, **SOLID** and **POLYLINE** (**VERTEX**).

Dimensioning and labeling are not transferred to KUM, i.e. only the elements from the **ENTITIES** are of a dxf file are interpreted. Apart from the world coordinate system, no further coordinate systems are taken into consideration.

Several **VERTEX** elements form a **POLYLINE** element. They are transferred to KUM as single points and collected in a curve. In normal cases two single points are connected together by a straight line.

In the event of an indentation, an arc is calculated between two single points.

Curvature-dependent point generation

The number of points per element (resolution can be controlled in the window by entering the minimum and maximum distance between points, as well as the angle of the permissible change in tangent direction).

NOTE

If the minimum distance between points is less than the CMM resolution/100, identical points can be generated. These can subsequently be removed again with the **Correct nominals** KUM function (**NOM COR**).

The change in tangent direction is a dimension for the curve curvature. Specify the permissible angle between the two tangents of two consecutive curve points here. The smaller this angle, the more points you will obtain for the elements circle, circular section and polyline with indentation. The minimum and maximum distance between points is taken into consideration as radian measure.

Using the relevant data box, you can collect all points which belong to a dxf layer into a curve, if required.

Please note the following limit values: The maximum number of curves per workpiece is 999. A maximum of 32000 points can be saved for each curve.

In the following cases, the preset limit values are replaced by sensible values:

– the length of a line is less than the minimum distance between points
– an arc is shorter than the minimum distance between points.

Data backup with DI 3500-SKUMS

All workpiece-independent KUM data can be saved and restored using direct inputs **DI 3510** and **3511**.

When saving or restoring **DI 3500** a KUM workpiece or a CNC run which contains a KUM workpiece, the relevant workpiece-independent standards (and standard data) are also taken into account.

Our data backup Via the CZ service, the user data can be saved to DAT tape (DDS).

Full backup The entire hard disk can be saved to DAT tape (DDS) via the UNIX system with SAM.

Network A data backup can be automated by your system administrator via network.

Reconstruction

To enable a reconstruction with minimum data loss, we recommend the following backup procedure:

Full backup and user data backup

- Total data stock to DAT tape (DDS):
  Once a week to once a month, depending on the quantity of modified or new data = > via CZ service.
  To do this, use at least two different DAT tapes in alternation.

<DI 3500>

- Control data and KUM workpieces:
  On the date of creation or modification = > via **<DI 3500>** (➤*"Administration" on page 4-15*).
  Once again, you should use several different diskettes.

before update

- A backup of important UMESS data is strongly recommended before any new installation and each measuring software update!

Saving or restoring CNC progams <DI 3500>

Intermediate memory

Application This function allows you to copy UMESS and KUM workpieces from the workpiece catalog via an intermediate memory onto a backup medium and back again. This function also ensures that you can use workpieces from other systems, e.g. UMESS 1000, in UMESS.

KUM data KUM command blocks can be copied to the intermediate memory

with **<DI 3510>** and back again with **<DI 3511>**.

Application examples

Backup

– It is best to back up new or modified measuring runs daily and in duplicate. This means that you also save workpieces which have been added since the last complete data backup or which have been modified.

Transferring into storage

– When the workpiece catalog is full, transfer CNC programs which you no longer need or which you do not need all the time, or retrieve transferred workpieces.

Transfer

– Send or transfer CNC programs or load runs to and from the backup medium.

Miscellaneous

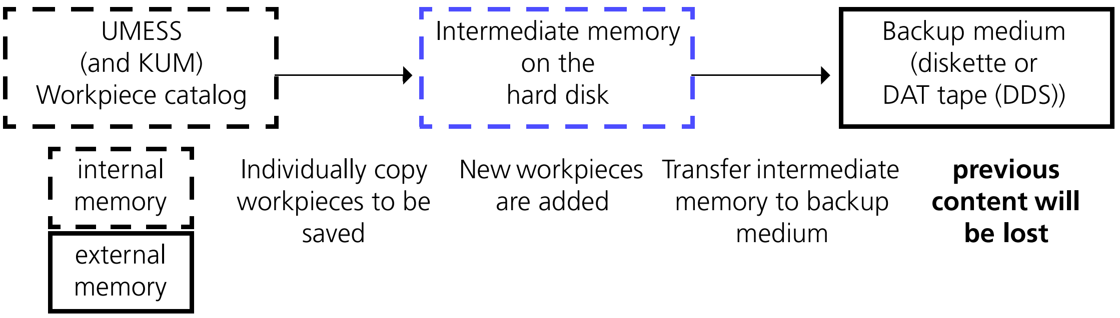
You can also copy workpiece files and other files outside UMESS by UNIX command to and from backup medium.

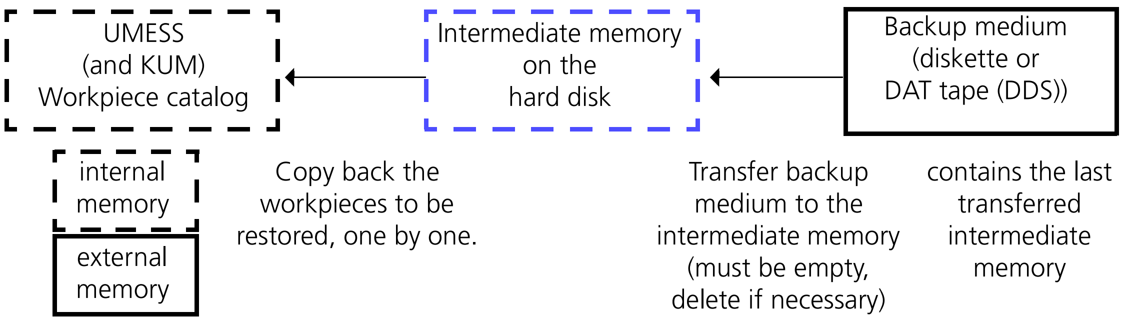
Directory

The directory **/var/opt/zeiss/CZ_BACKUP_SCR** is used as intermediate memory on the hard disk.

Principle of transferring into storage with **<DI 3500>** (backup):

Principle of restoring with **<DI 3500>**:

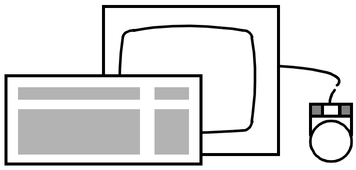


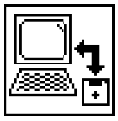


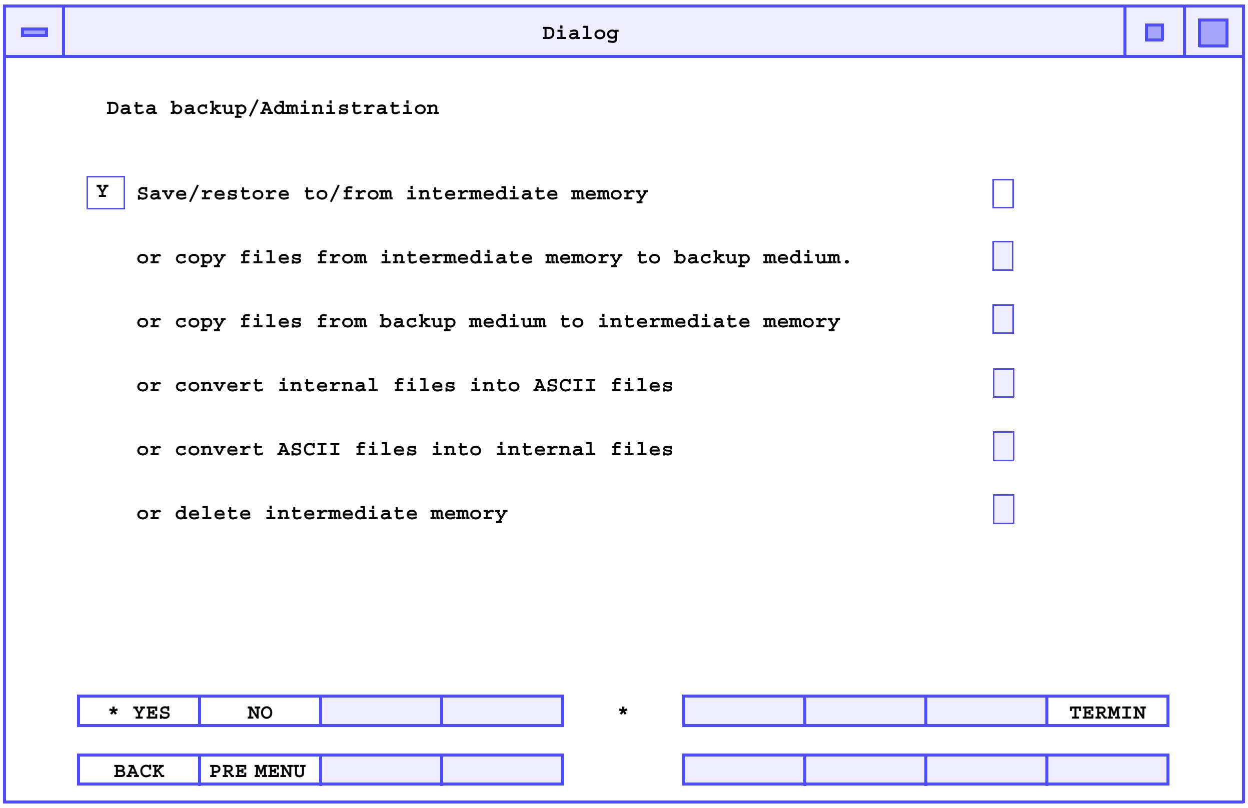
Dialog window for data backup

Function call

You must always start all operations for transferring and retrieving workpieces as well as, if applicable, conversion between internal and ASCII format, via the **<Data backup/Administration>** dialog window.



DI	Pull-Down-Menu	Pictogram
3500	Service Data backup...	



Function selection

Function selection cannot occur with the mouse, but is executed via the keyboard. Only the softkeys in the dialog window can be operated with the mouse.

SOFTKEY

* YES
NO

Select the relevant function via the softkeys.

(**<YES>** = Entry of *)

Selection of individual fields is also possible with the ∨ and ∧ cursor keys.

REPEAT

Selected function must be confirmed for execution.

PRE MENU
BACK

When all copying tasks are complete, exit the dialog window with one of the two keys.

Delete intermediate memory

Application

The intermediate memory must be deleted,

– if you wish to create a new backup or
– as preparation for reloading from the backup medium.

Function call

Select function with the **<YES/NO>** softkeys and confirm with **<TERMIN>**.

Save/Restore to/from intermediate memory

Application

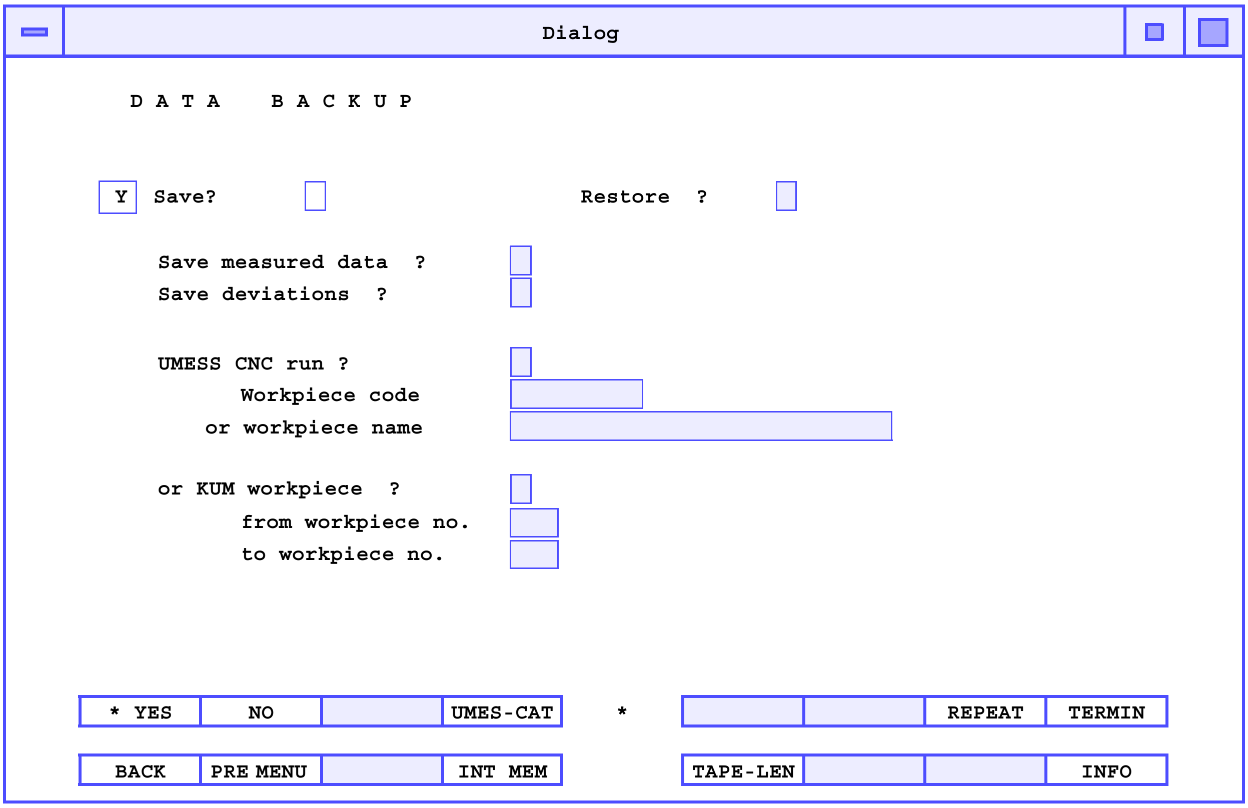
Using the procedure described below, you can

– copy the CNC runs specified for backup and/or KUM workpieces to the intermediate memory,
– copy workpieces from the intermediate memory to the workpiece catalog,
– define the size of the intermediate memory (according to the backup medium used),
– and list the content of the intermediate memory.

Softkeys

Please note

The intermediate memory will hold the same number of workpieces as can be stored on a backup medium of the specified size. If the capacity is exceeded, a corresponding message will appear, that *The workpiece in question cannot be transferred to the intermediate memory*. In this case, empty the intermediate memory by transferring to backup medium or by function call (➤*"Administration of standard command blocks" on page 4-24*).



Data boxes

Save? Copy from workpiece catalog into intermediate memory.

Restore? Copy into workpiece catalog from the intermediate memory.

Save measured data? Refers to KUM, cf. relevant operating manual. Input not required for Restore.

Save deviations? Refers to KUM, cf. relevant operating manual. Input not required for **Restore**.

*** YES** / **NO** Task selection (**<* YES>** = Entry of *).

UMES-CAT Output of workpiece catalog on the screen (see also Chapter 17).

REPEAT Add missing entries (e.g. workpiece name).

TERMIN Close dialog window, entered workpiece is copied according to the specified direction. The dialog window then reappears.

If with **Restore = *** the specified workpiece already or still exists in the workpiece catalog, the program asks for a new workpiece name. This gives you the option of duplicating UMESS workpieces in the workpiece catalog.

BACK

PRE MENU

Return to **<Data backup / Administration>** dialog window.

INT MEM

List current content of the intermediate memory on the screen, specifying workpiece number, name, file name, backup date and data type.

The following designations are available for the data type:

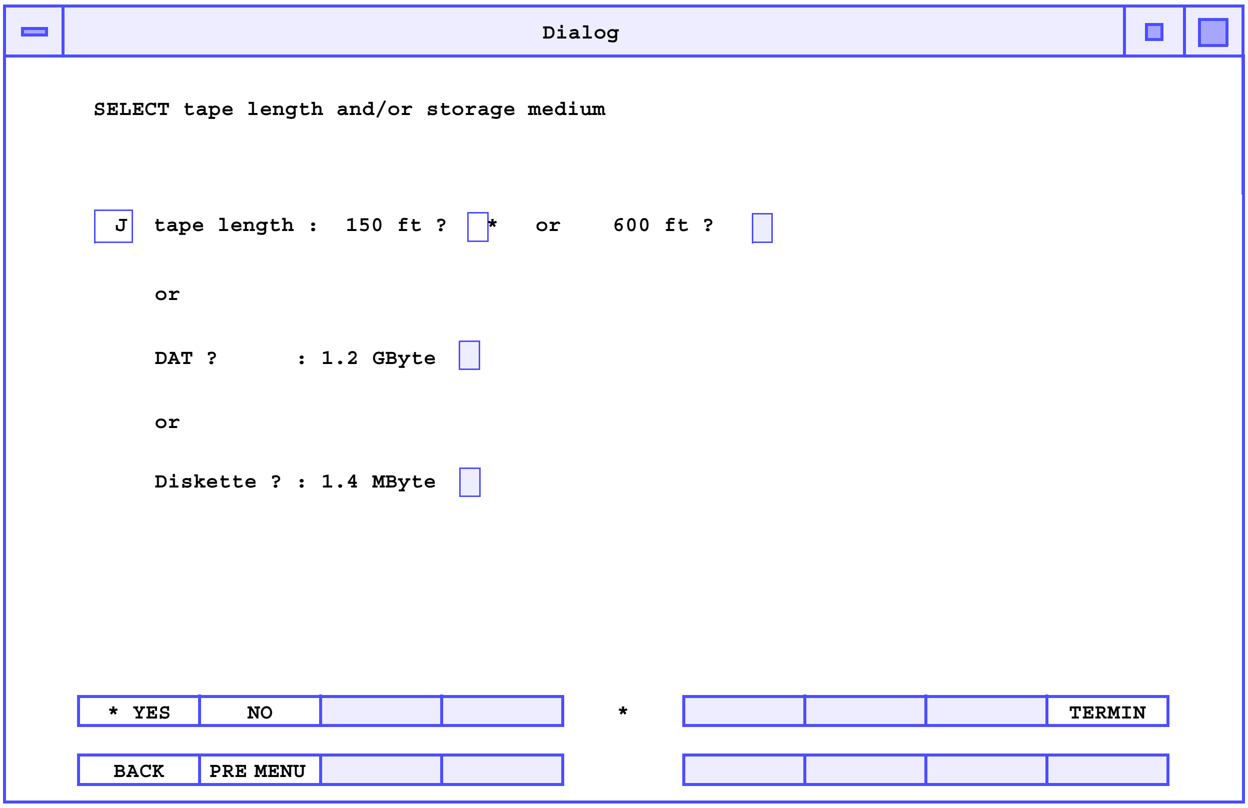
A ASCII format.

B Internal format.

U Conversion defective (e.g. intermediate memory capacity insufficient).

TAPE-LEN

Specify length or type of backup medium used in the dialog window **<SELECT tape length and/or storage medium>**
(via **<* YES>/<NO>**, accept with **<TERMIN>**). The program uses this information to calculate the size of the intermediate memory.



UMESS CNC run?

Copy CNC programs. The workpieces to be copied must be specified using workpiece name or number (as is usual for the workpiece catalog). If a CNC program contains KUM calls, the workpiece-dependent KUM data is also saved.

KUM workpiece?

Copy KUM programs The workpieces to be copied must be specified by their numbers (cf. KUM operating manual).

Procedure

Tape length

If you are working with different backup media or creating the intermediate memory for the first time: Specify tape length (**<TAPE-LEN>** softkey).

Copying direction

Select required copying direction:

- From workpiece catalog to intermediate memory: **Save = ***.
- From intermediate memory to workpiece catalog: **Restore = ***.

KUM data

KUM user: specify other data to be saved, if applicable (measured data, deviations).

Workpiece code

Specify workpieces to be copied. Initialize copying procedure with **<TERMIN>**. With KUM, several workpieces can be copied if they have consecutive numbers. With UMESS this also applies if you make the entry in the form e.g. **1-2** or **110-119** (i.e. number of the first and last workpiece, separated by a hyphen, without a space).

List intermediate memory

If required, list the content of the intermediate memory with **<INT MEM>**.

NOTE

The intermediate memory is located on the hard disk in the directory **/var/opt/zeiss/CZ_BACKUP_SCR**.
In the event of a serious fault (disk crash), the memory is in danger of being destroyed like the other UMESS and KUM control data. You only have a true backup if you have transferred the intermediate memory onto a backup medium.
Only backup of the entire data stock (full backup) also includes the intermediate memory.

Copying the intermediate memory onto a backup medium

Application

Using the dialog window described below, you can copy the entire content of the intermediate memory onto a backup medium.

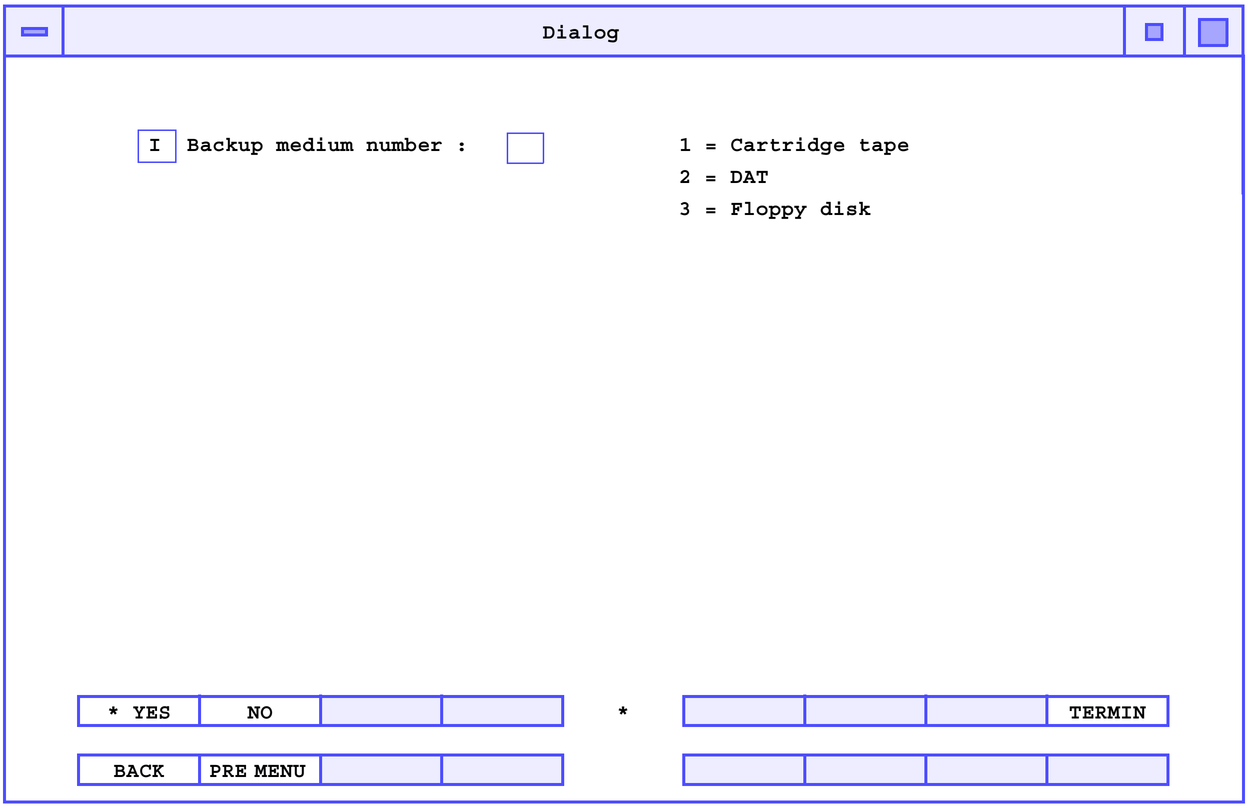
Procedure

Backup medium

Insert the backup medium of the size which you have specified with **<TAPE-LEN>** (➤*"Standard command block/Parameters" on page 4-27*), into the drive.

Select function

Call up dialog window (➤*"Command block/Parameter" on page 4-21*) and select **<Copy files from intermediate memory onto backup medium>**.



Code number

Enter the relevant code number for your backup medium and confirm input with **<TERMIN>**.

NOTE

The following warning appears:
The data on the tape/floppy disk will be overwritten!

Confirmation query

Is tape/floppy disk inserted and write protection removed?

Confirm with **<YES>** or cancel with **<NO>**.

Background processes

The following functions now run automatically:

– The content of the intermediate memory is transferred to the backup medium in **tar**-format.
  All transferred UMESS and KUM data are displayed in the background of the UMESS dialog window. A catalog file called **SAVE_INFO____K** is also copied.

– The previous content of the backup medium will be lost!

– If an error occurs during the copying procedure, it will be documented accordingly in the UMESS dialog window.

– The intermediate memory will be automatically deleted!

– The following dialog window then appears:
  <Data backup/Administration>.

Check

If necessary List content of the backup medium outside UMESS using UNIX command (**tar tvf/dev/dat** or **tar tvf/dev/rdsk/floppy** depending on the medium).

Copy backup medium to intermediate memory

Application

The procedure described below transfers the entire content of a backup medium into the empty intermediate memory.

Prerequisite

The function is only applicable for backup media which you have pre-recorded with **<DI 3500>** or with the earlier KUM backup program (SKUMS). The data on the backup medium may also be available in ASCII format, e.g. data which originate from UMESS 100.

Procedure

Prerequisite

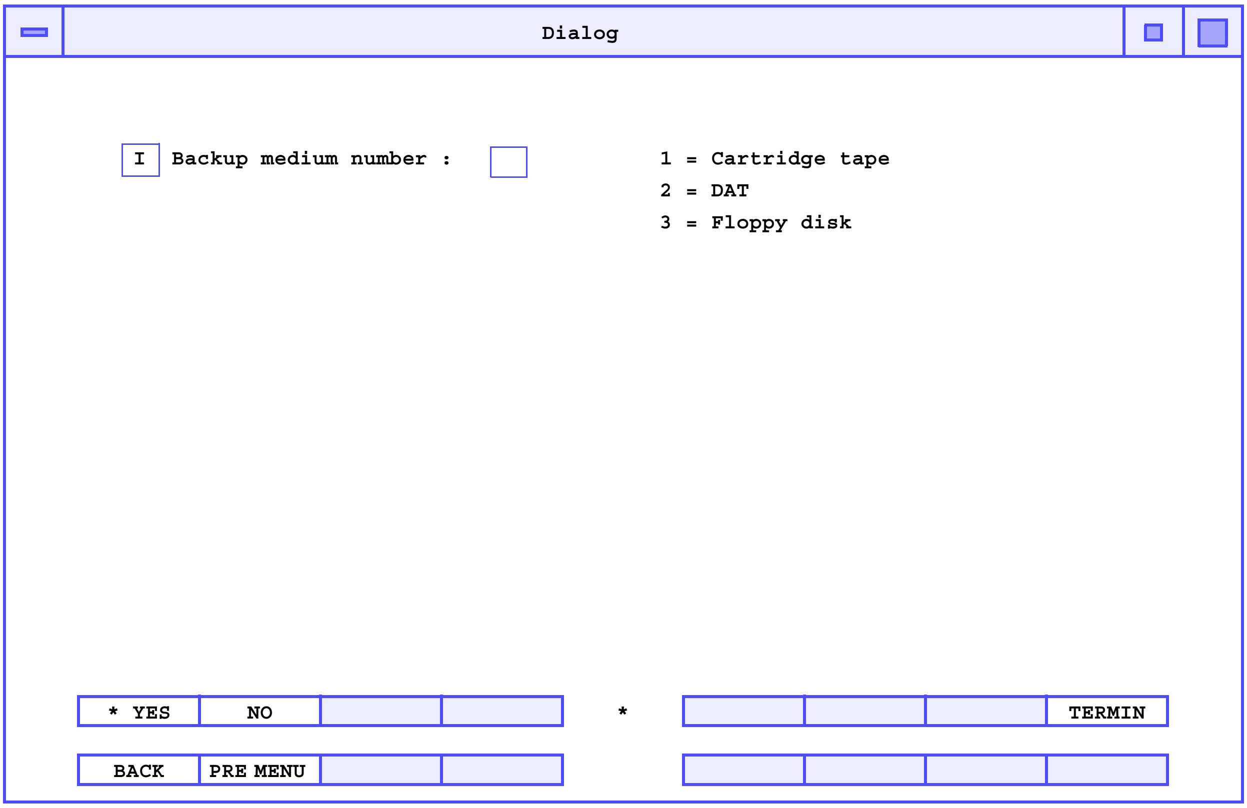
Delete intermediate memory (➤*"Administration of standard command blocks" on page 4-24*).

Backup medium

Insert backup medium into drive.

Select function

Call up dialog window (➤*"Command block/Parameter" on page 4-21*) and mark **<Copy files from backup medium to intermediate memory>**.



Note

You do not need to enter the tape length.

Code number

Enter relevant code number for your backup medium and confirm input with **<TERMIN>**.

NOTE

The following message appears:
Copy from tape/floppy disk to intermediate memory!

Confirmation query

Is tape/floppy disk inserted?

Confirm with **<YES>** or cancel with **<NO>**.

Background processes

The following functions now run automatically:

- All transferred UMESS and KUM data are now displayed in the background of the UMESS dialog window..
- If an error occurs during the copying process, it is documented accordingly in the UMESS dialog window.
- The **<Data backup/Administration>** dialog window then appears.

Restore

You can now copy the workpieces from the intermediate memory into the workpiece catalog (➤*"Standard command block/Parameters" on page 4-27*);

Convert ASCII data into the internal format beforehand.

Convert control data into ASCII format or into internal format

Prerequisites

On principle you can also use workpieces in UMESS/KUM which you have generated with a compatible system, e.g. UMESS/KUM 1000, and vice-versa.

Please note

- The conversion takes a lot of time. Therefore, only start this process if you actually need data for the other system.
- ASCII data need around twice as much storage space as data in internal format. The storage space in the intermediate memory may not therefore be sufficient. Two options:

1. Start conversion as described below and wait for the **Disk full** screen message. Use **<INT MEM>** to check which data have been recorded and which have not (➤*"Standard command block/Parameters" on page 4-27*). Then repeat conversion for workpieces of data type "**B**" and "**U**".
2. Always only convert and transfer a few workpieces, as described below.

Procedure

In system A (e.g. UMESS 1000):

Intermediate memory

Delete the intermediate memory if necessary: (➤*"Administration of standard command blocks" on page 4-24*).

Copy workpieces

Copy workpiece(s) into the intermediate memory: (➤*"Standard command block/Parameters" on page 4-27*).

Change format

Convert workpiece files from internal format into ASCII format:

Conversion affects all workpieces in the intermediate memory.

Backup medium

Transfer intermediate memory with ASCII data to backup medium: (➤*"Standard administration" on page 4-30*) If necessary, refer to the system-relevant operating manual for operation and input.

In system B (e.g. UMESS):

Backup medium

Transfer content of the backup medium to the intermediate memory. (➤*"Standard" on page 4-33*)

Change format

Convert workpiece files from ASCII format to internal format.

Conversion affects all workpieces in the intermediate memory.

Copy workpieces

Transfer workpieces from the intermediate memory to the workpiece catalog: (➤*"Standard command block/Parameters" on page 4-27*)

Make further adjustments if necessary.

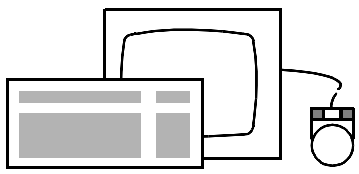
Save and restore all workpiece-independent KUM data with <DI 3510> and <DI 3511>

Application

CNC runs and the associated KUM data are saved with **<DI 3500>**. The workpiece-independent standards and standard command blocks can be copied into the intermediate memory and converted to ASCII with **<DI 3510>**.

<DI 3510>

Save to intermediate memory

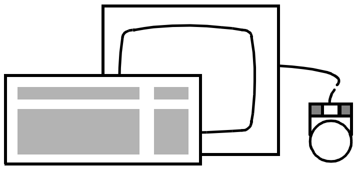


DI	Pull-Down-Menu	Pictogram
3510		

When saving, all relevant standards and standard command blocks are automatically taken into account and converted to ASCII. The saved files are documented in the listing and message window.

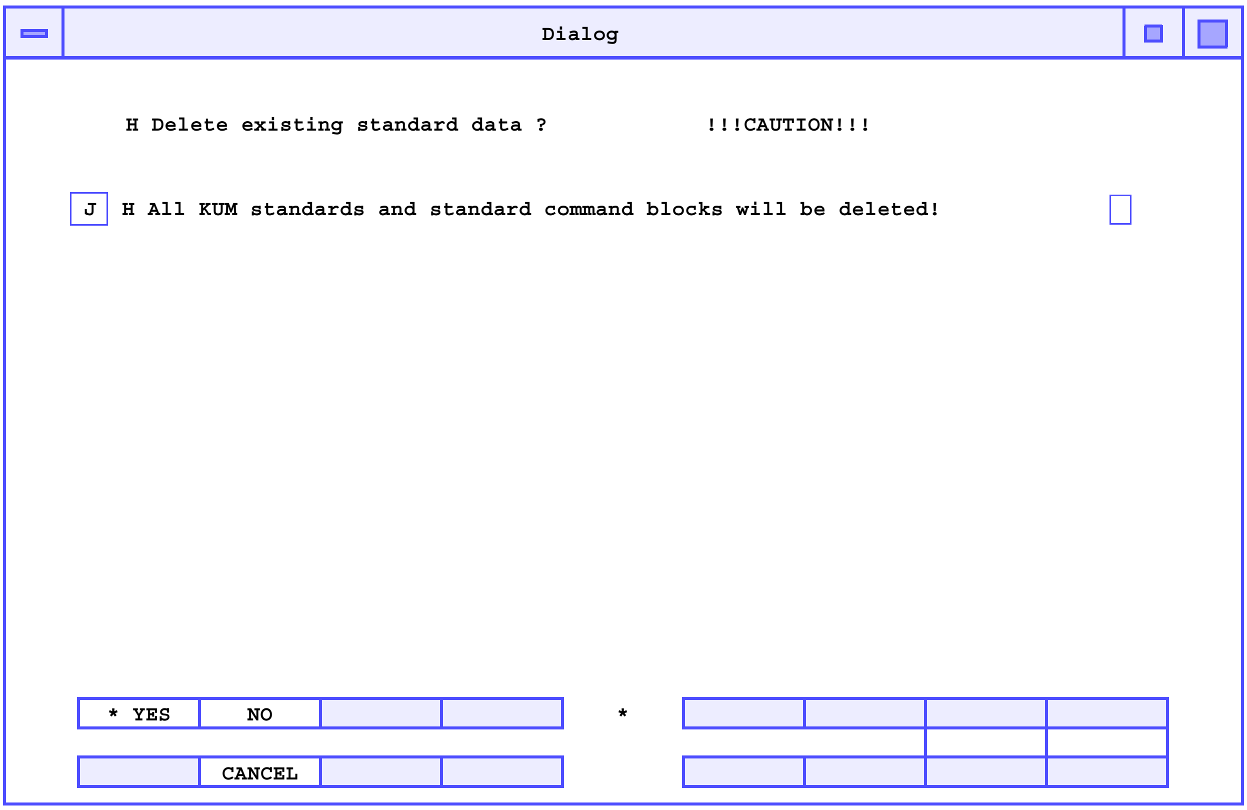
<DI 3511>

Restore from intermediate memory



DI	Pull-Down-Menu	Pictogram
3511		

Several KUM workpieces with associated standard data can be located in the intermediate memory. When restoring, it is established whether standard data is located in the intermediate memory. You can decide in a dialog window whether or not you wish to restore the existing standard data.



Operating mode “Save to intermediate memory”

All associated standards and standard command blocks are automatically taken into account when saving.

Operating mode "Restore from intermediate memory"

Several KUM workpieces with associated standard data can be located in the intermediate memory. When restoring, it is established whether or not standard data is located in the intermediate memory. You can decide in a dialog window whether or not you wish to restore the existing standard data.

Operating mode "Data conversion ASCII/Binary and Binary/ASCII"

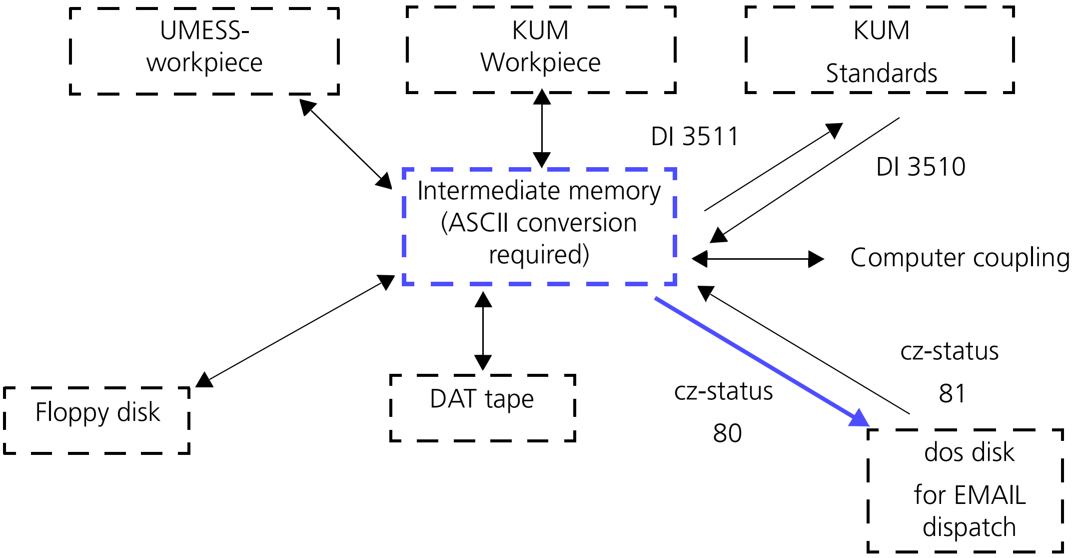
NOTE!
If you decide to restore the standard data, then all standard data present in the intermediate memory will be restored. Any standard data present on your computer will be overwritten!
All standard data located in the intermediate memory will then be deleted. This ensures that a restored standard–which can be used any number of times–does not have to be repeatedly restored. In addition to any existing CNC runs, only workpiece-dependent KUM data are now still present in the intermediate memory.
The relevant standards are now located on your computer - even for KUM workpieces that have not yet been restored.

All data present in the intermediate memory, including standard data, is converted into the relevant data format.

Compatibility

All data formats are unchanged; compatibility with older software revisions is guaranteed.

Schematic representation
<DI 3500> and <DI 3510>



Chapter 11

Camshaft Measurement

This chapter contains:

General information on camshaft measurement

Measuring cams

You can measure cams fully-automatically or manually with the KUM functions for **Camshaft measurement**.

Contour measurement

You can determine the shape of individual cams with a **contour measurement**. Probe spheres are used for contour measurement. Scanning- methods are used for measuring.

Lift curves

You can calculate lift curves.

You can output the **lift curve** and the **contour** numerically and graphically, and define a tolerance band with selectable tolerance and selectable magnification of the deviations.

Rotational best fit

You can view the form and position deviations by subsequently calculating the deviation with the help of the **rotational best fit** of lift curve or contour.

Deviations

You can display the **deviations** as a linear plot; the deviations are output corrected by the radius offset in the tolerance band.

Curve jump

You can output the **curve jump** as a list.

With the KUM functions for **Camshaft measurement** you can display the deviations as a linear plot and the derivations from the cam shape (lift curve, speed path and acceleration path) in a graph as a polar plot.

The commands for camshaft measurement

Object	Action	Explanation
RAV	**CAL**	Calculate radial vectors
NOM	**CON**	Convert nominal value
MVA	**CON**	Probe sphere correction in the normal direction
LDE	**PLO**	Linear plot, polar
LIF	**PLO**	Plot lift curve, polar
SPE	**PLO**	Speed plot, polar
ACC	**PLO**	Acceleration plot, polar
RAV **MVA**	**CAL** **CON**	Convert measured values in radial direction
MVA	**TRA**	Transform measured values, add or subtract equidistants
DEV	**LIS**	List deviations with curve jump
OFS	**CAL**	Calculate offset

Procedure for camshaft measurement

Preparing the CMM

Clamp camshaft

Insert probe configuration

UMESS

Define probes

Define workpiece coordinate system (measure bearings and alignment slot) Store W position

KUM

Preparing nominals

Duplicate nominals acc. to the number of cams: **NOM COP**

Transform nominals: With the functions Calculate radial vectors **RAV CAL**, **Convert nominals (NOM CON)** and **Transform nominals (NOM TRA)** Add or subtract equidistants you can make cams larger or smaller in the radial direction **NOM TRA**

If necessary, edit nominals **NOM EDI**

Convert nominals (Calculate normals): **NOM CON**

Measure camshafts according to nominals in the normal direction

Measure manually or in CNC mode

Calculate deviations,
best fit with nominals in normal direction

Convert measured values for probe sphere correction: **MVA CON**

Calculation of deviations in the radial direction: **RAV CAL DEV CAL**

OR

Calculate deviations in radial direction: **RAV CAL**

Fit measured values : **MVA BFT**

Curve can be smoothed: **DEV FIL**

Calculate offset: **OFS CAL**

Outputting results

List deviations: **DEV LIS**

Plot lift curve: **LIF PLO**

Output linear plot: **LDE PLO**

Output speed plot: **SPE PLO**

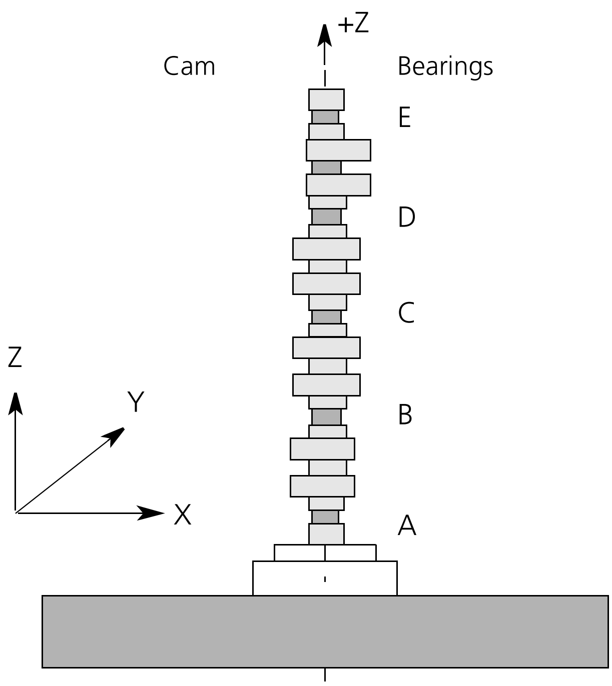
Output acceleration plot: **ACC PLO**

Preparations

Measurement assembly

Clamp the camshaft on the coordinate measuring machine. The camshaft will have no sag with a stationary, vertical arrangement. With a horizontal arrangement, you may be able to avoid sag by using a backrest.

Vertical assembly



Nominals

Generating nominals

If you do not have any nominals available, you can measure (digitize) the cams of a master piece as an unknown contour.

Nominals from CAD system

You can transfer nominals to KUM via the VDA interface and then carry out the measurement using the **Scanning according to nominals** method (known contour).

Entering nominals

You can enter data manually using the **Edit nominals** function, for example by copying from a data sheet.

Displacing the nominals or zero points

If several cams of a camshaft have the same shape and you only have the nominals for one cam, you can duplicate the nominals according to the number of cams.

Displacing the zero point

With vertical camshafts (spatial axis = camshaft axis) if you always place the zero point (Z = 0) in the center of the respective cam, then you will obtain comparable curves for the evaluation, which, for example with a linear plot, lie roughly symmetrical to the Z- axis.

You can displace the zero point with the UMESS function **<DI 1723> Zero point displacement**, UMESS operating manual. As the cams are situated at different angles, you must rotate the angle for each cam with the function **<DI 1709>**, UMESS operating manual.

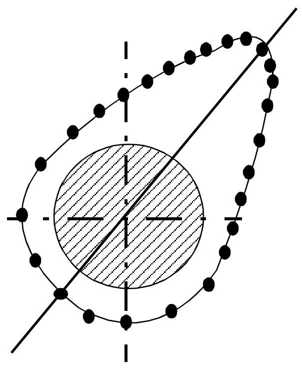
Displacing nominals

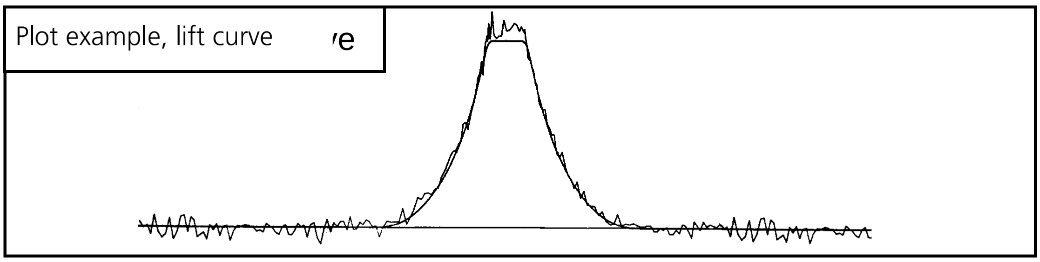
Another possibility is to duplicate the nominals and transform them according to the arrangement of the cams (displacement, rotation).

Start of curve

Usually the measurement is started at the point which lies opposite the largest lift of the cam. This means that during the evaluation, the most important part of the cam curve, the largest lift, is positioned in the center of the page. In order to achieve this, you may have to prepare the nominals accordingly.

Start of curve





Optimizing the measuring run

To measure a cam completely over 360°, the probe may have to be changed several times during the measurement. Probing routes must also be covered for each probe change.

With the **NOM SHI** or **MVA SHI** command, you can optimize the measuring run by positioning the start of the curve so that only one probe change is required during a cam measurement. You can achieve this if you take the nominal point as point 1 of the measurement, which can be probed in an axis of the control coordinate system, i.e. whose normal lies parallel to an axis of the control coordinate system.

For further explanations on the commands **NOM SHI** or **MVA SHI**
➤ *"Optimizing the measuring run" on page 7-100*.

Measuring

Principle of measurement

Each cam is treated individually with the camshaft measuring program.

Transformation

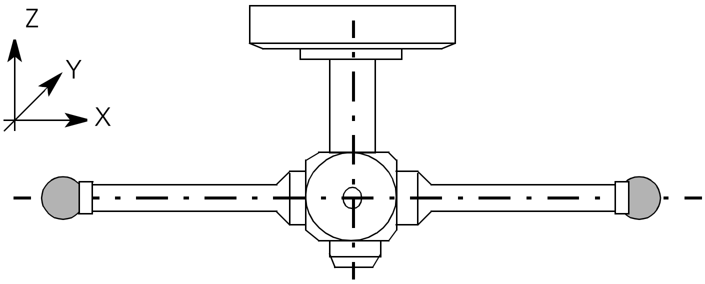
As no sag is taken into consideration, it may be necessary to always carry out the 3D transformation with the bearings between which the cam to be measured is situated. The 2D transformation is always carried out with the same alignment element.

You can determine the displacement of the workpiece coordinate system from cam to cam using the translational best fit.

When measuring according to nominals (scanning), you must probe according to nominals with normal vectors, not according to nominals with radial vectors.

Probe calibration

Cluster with two probes



Two probes

In order to be able to measure a cam, you need a probe cluster with at least two probes. Defining the probes is part of the basic UMESS program, see UMESS operating manual.

Workpiece coordinate system and W position

In order to determine the workpiece coordinate system of the camshaft, you must measure at least two bearings and the alignment element (slot or borehole).

Procedure

Measure 2 bearings	Circle
	Circle
	3D transformation
	Zero point
Measure alignment element (for example: slot)	Point
	Point
	Symmetry
	2D transformation
	Zero point
	W-position

For further explanations on the workpiece coordinate system and W-position, see UMESS operating manual.

Measuring programs

You can measure the cams individually with the scanning measuring programs, see UMESS operating manual.

Measuring probe head

For coordinate measuring machines with measuring probe head:

– Scanning unknown contours, scanning in the plane of the workpiece coordinate system, see UMESS operating manual

– Scanning known contours, scanning according to nominals, see UMESS operating manual

Trigger probe head

For coordinate measuring machines with trigger probe head:

– Scanning unknown contours, clamped in the **computer-controlled** operating mode and

Path mode:	Plane in the WP system
or	Circular path
or	Measurement according to nominals
or	Scanning according to nominals
or	Fast laser scanning

UMESS operating manual

Calculation

Converting measured values to the probe sphere correction

During the measured value conversion (**MVA CON**) the existing probe center point data is corrected by the probe sphere radius in the normal direction. The original measured values are overwritten.

For further explanations on the **MVA CON** command, ➤*"Conversion main menu" on page 7-2*.

Setting the mode for calculating radial vectors

The **RAV CAL** command sets the **Calculate radial vectors** mode. This mode is effective for the following functions:

NOM CON, **NOM CAL**, **MVA CON**, **MVA BFT**, **DEV CAL**, **DEV PLO**, **LIF PLO**.

The mode is only effective for the command block in which the **RAV CAL** command occurs and from the line which follows the command. With the **DEV LIS** function, a note is printed out in the record header if radial deviations exist.

Calculating the deviations in the radial direction

With the deviation calculation (**RAV CAL**, **DEV CAL**) you must take nominals with normal vectors, not nominals with radial vectors. Further explanations ➤*"Deviations - Main menu" on page 7-16*.

1. Presetting: **RAV CAL**
2. Calculation: **DEV CAL**, Calculate deviations

OR

1. Presetting: **RAV CAL**
2. Calculation: **MVA BFT**, Best fit measured values

For explanations on **Best fit measured values**, ➤*"Best fit of measured values" on page 7-44*.

Curve can be smoothed

You can use the **DEV FIL** function to filter curves in accordance with DIN ISO TC 57/SC1 WG1.

The **DEV FIL** function mathematically smooths short-waved parts of the curve shape which usually superimpose the pure form deviation as a quite distinctive peak and trough line.

For further explanations on the **DEV FIL** command, ➤ *"Smoothing a curve" on page 7-25*.

Deviations–eliminating outliers

The **DEV ELO** function allows you to delete deviations whose distance is greater than the delta value entered.

For further explanations on the **DEV ELO** command, ➤ *"Deviations–eliminating outliers" on page 7-27*.

Calculating the lift data

Data

With a camshaft measurement, the nominals are usually available as lift data. If the cam is not measured with a cutting edge or a cylinder shaft (lift measurement), but with a probe sphere (contour measurement), the measured data is available as contour data.

Advantages

A contour measurement has the advantage that *a rotary table* is not required for the measurement. Also, *no special probe calibration* is necessary, as is the case for example when measuring with an edge or a cylinder shaft.

However, a nominal-actual comparison between lift and contour data is not allowed!

A correct deviation calculation or best fit is only possible after the contour data has been converted to lift data with the **Calculate lift data (MVA CST)** program.

Prerequisite

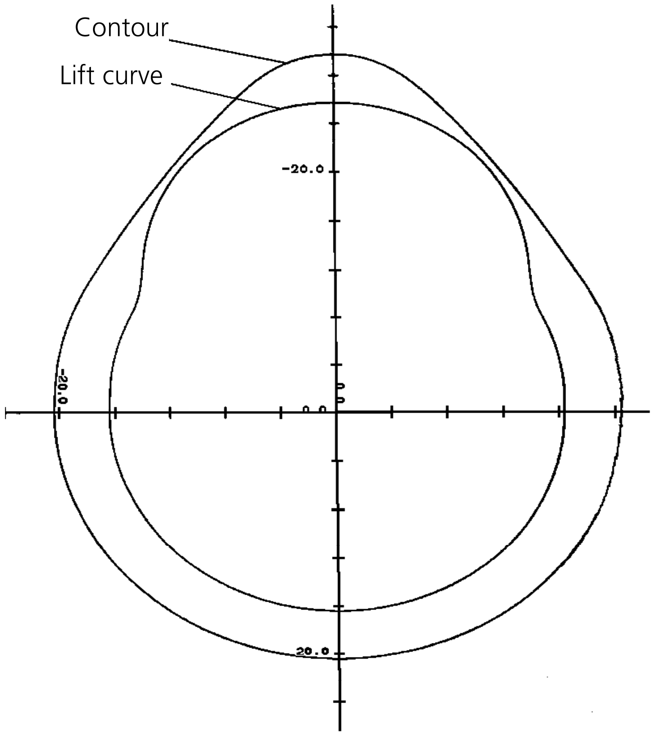
Prerequisite for use of the program is that for the contour measurement, the workpiece zero point is located in the center of the camshaft axis. The measured curve is treated as a closed curve.

NOTE

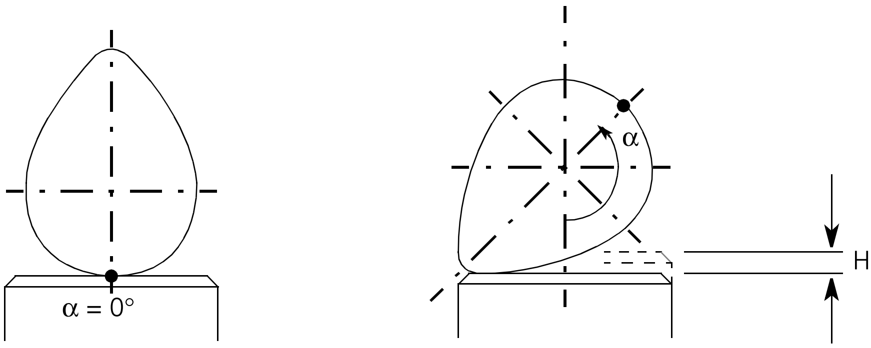
The **Calculate lift measured values** program can only be used once; otherwise an error message is output. Lift data cannot be reconverted to contour data.

A measured value conversion or a probe sphere radius correction is carried out automatically. If a measured value conversion has already been carried out, the **Calculate lift data** function can still be executed.

Equidistants (probe sphere radii) and probing vectors are transferred from the contour data to the lift data.



Angle of rotation (α) and lift (H)



Input

The following procedure is recommended for entering the lift data:

1. Generate a circle with a base circle radius; one point is generated per degree for an angle range of 360 degrees and 360 + 1 points.
2. Enter the lift as equidistant for each point; **Edit nominals** function.
3. Nominal value conversion with calculation of the normals.
4. Add the equidistants in the normal direction; **Transform nominals** function.
5. Nominal value conversion with the transformed data.

Output of results

Listing deviations

Further explanations, ➤"Deviation record" on page 8-18.

```
                                ZEISS  KUM

Cylinder coordinates                     MANUAL MEASUREMENT

DRAWING NO.            | ORDER NO         | SUPPLIER/CUSTOMER  |  WORK CYCLE
Camshaft                                                       |Plot

OPERATOR               | DATE         | PART NO
I-SP1/Pir              | 02.10.95     | 4
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
PTNO|  RADIUS   |  ROT ANG  |  HEIGHT   |     EN    |CJP| DIAGRAM OF EN |
= = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = = =
TEXT:
 Type        |Curve|   Name    | Creation date| Modification|No. of points|
Deviation:   2                  08.11.1993   08.11.1993     357
Radial deviations
Offset=      .0101
Nominals: 2   PF2               22.04.1993   10.11.1993     357
Measured values :               08.11.1993   08.11.1993     700

Surface points
    1    14.4998   312.0145   304.5000     .0030   |        *-       |
    2    14.5001   313.0158   304.5000    -.0003   |        *        |
    3    14.5000   314.0136   304.5000     .0009   |        *        |
    4    14.4999   315.0168   304.5000     .0011   |        *        |
    5    14.5001   316.0143   304.5000     .0008   |        *        |
    6    14.4997   317.0150   304.5000     .0013   |        *        |
    7    14.5002   318.0134   304.5000     .0000   |        *        |
    8    14.5002   319.0155   304.5000     .0004   |        *        |
    9    14.5002   320.0133   304.5000     .0002   |        *        |
   10    14.4999   321.0156   304.5000     .0018   |        *        |

   81    14.5002    32.0142   304.5000    -.0058   |      --*        |
   82    14.5000    33.0128   304.5000    -.0054   |      --*        |
   83    14.4998    34.0134   304.5000    -.0053   |      --*        |
   84    14.5004    35.0140   304.5000    -.0057   |      --*        |
   85    14.5004    36.0140   304.5000    -.0057   |      --*        |
   86    14.4998    37.0137   304.5000    -.0054   |      --*        |
   87    14.5001    38.0143   304.5000    -.0057   |      --*        |
   88    14.4998    39.0153   304.5000    -.0051   |      --*        |
   89    14.4996    40.0145   304.5000    -.0045   |      --*        |
   90    14.5003    41.0153   304.5000    -.0013   |        *        |
 Sector evaluation
  Tolerance sector no =  1 | Nominal |  Actual  | Tol. exc.| at point |
 Curve form below    CFB :   -.0060    -.0058     .0000      81
 Curve form above    CFA :    .0060     .0030     .0000       1
 Total curve tol.     TCT:              .0088
 Curve jump tol.     CJP :    .0200     .0033     .0000       2
 Diagram position        :    .0020
  91    14.4998    42.0145   304.5000    -.0039   |      --*        |
```

```
8351     14.5002   302.0142   304.5000      .0003   |        *     |
352     14.5000   303.0128   304.5000     .0010   |        *     |
353     14.4998   304.0134   304.5000     .0008   |        *     |
354     14.5004   305.0140   304.5000     .0000   |        *     |
355     14.5004   306.0140   304.5000     .0000   |        *     |
356     14.4998   307.0137   304.5000     .0006   |        *     |
357     14.5001   308.0143   304.5000     .0008   |        *     |

Sector evaluation
 Tolerance sector no.= 3 |    Nom    |    Act    | Tol. exc.| at point|

Curve form below     CFB :    -.0060     -.0069     -.0009     271
Curve form above     CFA :     .0060      .0044      .0000     325
Total curve tol.     TCT :                .0113
Curve jump tol.      CJP :     .0200      .0033      .0000     327
Diagram position         :     .0020

Curve evaluation         |    Nom    |    Act    | Tol. exc.| at point|

Curve form below     CFB :               -.0089                261
Curve form above     CFA :                .0073                221
Total curve tol.     TCT :     .0100      .0162      .0062
Curve jump tol.      CJT :                .0040                104

Best fit data            |    Nom    |    Act    | Tol. exc.|

Curve displ. in X        :     .0100     -.0117     -.0017
Curve displ. in Y        :     .0100      .0003      .0000
Curve displ. in Z        :     .0100      .0068      .0000
Curve rotation about X   :     .1000      .0000      .0000
Curve rotation about Y   :     .1000      .0472      .0000
Curve rotation about Z   :     .1000      .0000      .0000
```

Polar plot

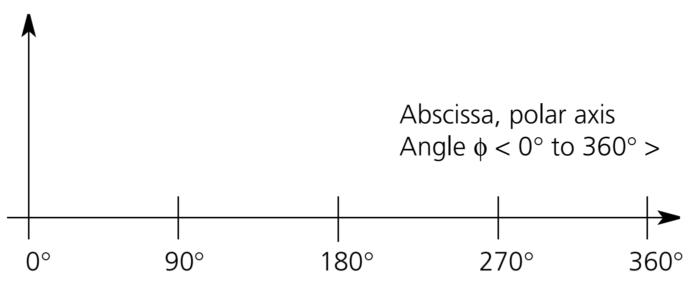
Results

As the results of the camshaft measurement, you can display the deviations as a linear plot and the derivations from the cam shape (lift curve, speed and acceleration path) graphically, as a polar plot.

Coordinate axes of the polar plot

Ordinate:

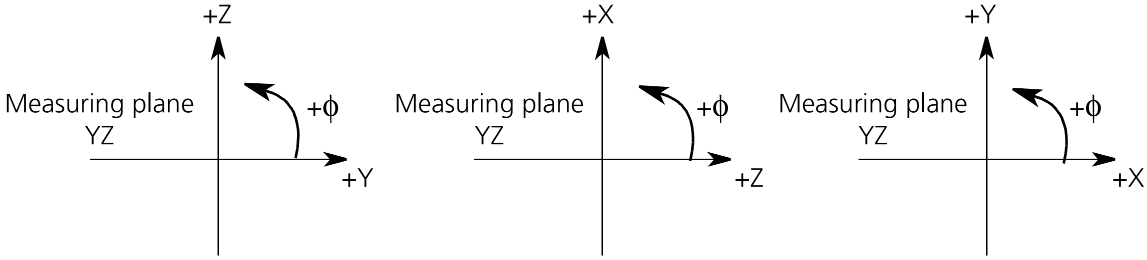
Lift **<mm>** or
Linear deviation **<mm>**
Speed **<mm/s>**
Acceleration **<mm/s^2>**



Angle ϕ

The angle ϕ has a value range from ϕ = 0° to ϕ = 360°. The angle ϕ is defined as follows, in relation to the respective measuring plane in which measurement is being performed:

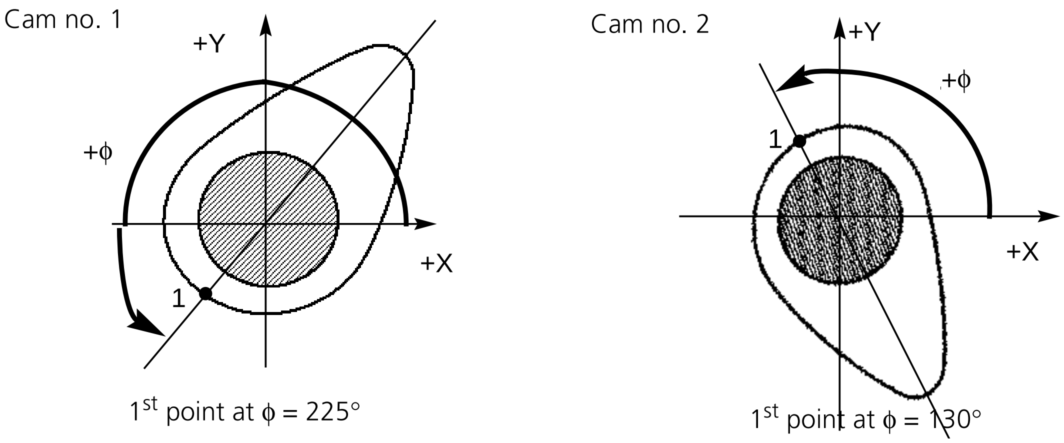
Angle ϕ in the cartesian 2D coordinate system

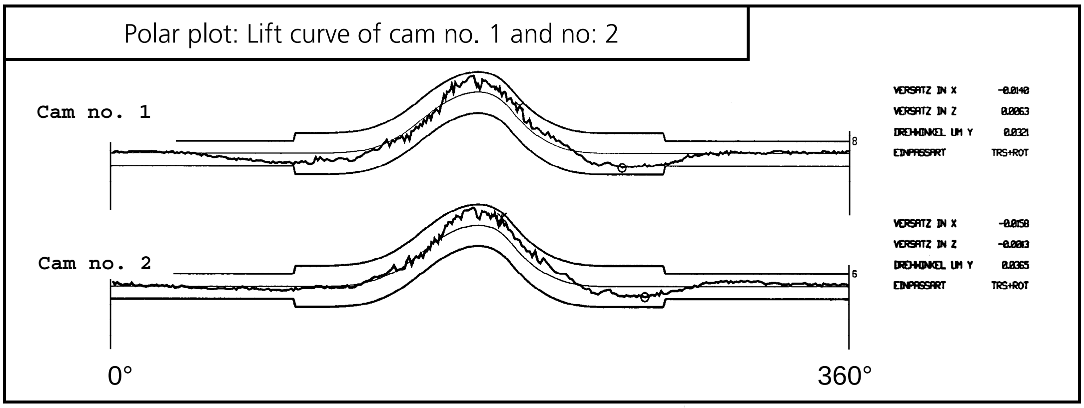


Output

When outputting the results of the camshaft measurement, the start point of a cam is shifted to the angle $\phi = 0°$ for the polar plot. When editing and listing, however, the real angle values are displayed.

Example: Polar display of 2 cams





Start menu: ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **LIF** *or* **LDE** *or* **SPE** *or* **ACC**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM POLAR PLOT-MAIN MENU** is displayed.

Plotting several curves on a page

Plotting

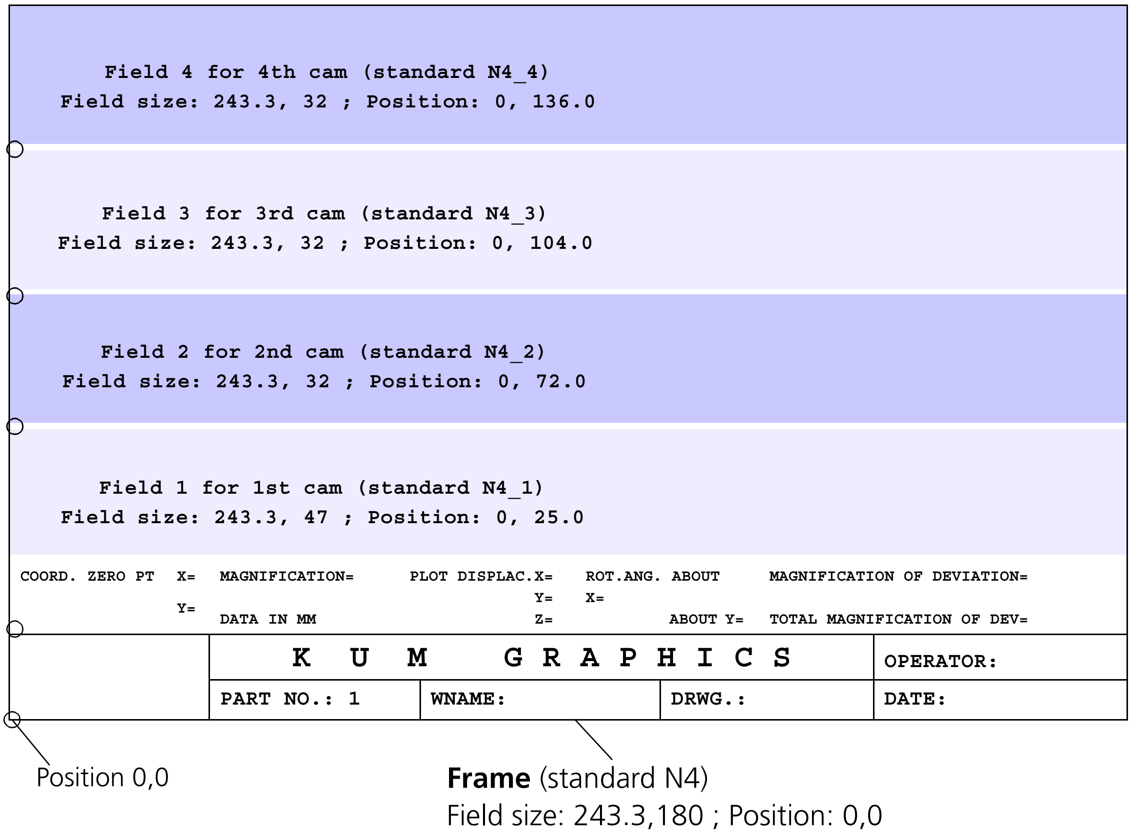
In order to fully document the result of your camshaft measurement, you can plot the lift curves, linear deviations, speed curves or acceleration curves for all cams of a camshaft on one page. Divide the page with the **PLT INI Initialize plotter** function, by defining several fields in different places on the page.

Store these fields as standards and link them to standard command blocks; then, with the help of these standard command blocks, you can plot the lift curves, linear deviations, speed curves and acceleration curves on one page.

Example: Plotting 4 curves on a DIN A4 page

When dividing the page, field no. 1 is larger than the other fields. As a result, you still have room for additional information between the first curve and the record header.

In this application example, the standards are identified with **N4** and **N4_1** to **N4_4** and the standard command blocks with **NOM4_1** to **NOM4_4** and with **HUB4_1** and **HUB4_2**.



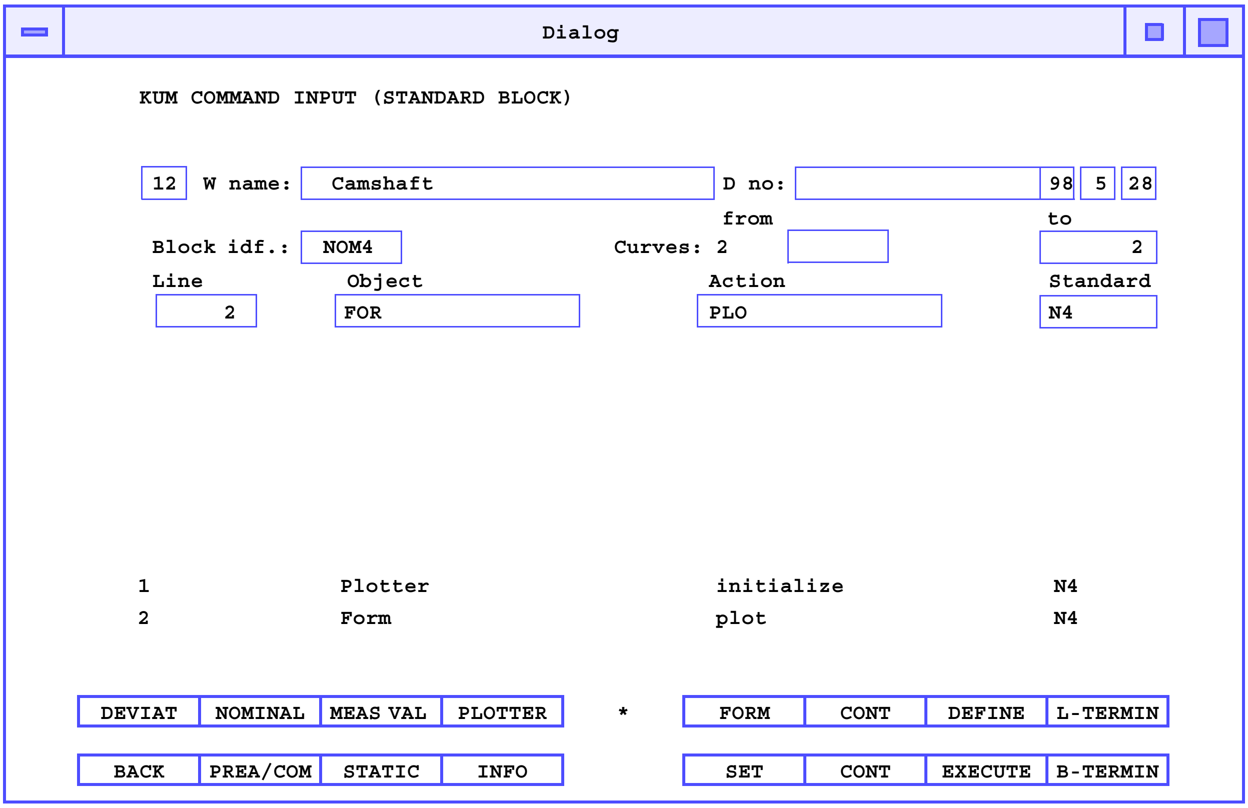
1 Define a standard command block for plotting the outer frame and the form (in this example, standard command block **NOM4**).

2 Define a standard command block for each of the four fields (in this example, standard command block **NOM4** to **NOM4_4**).

3 Define two standard command blocks, for example for four lift curves (in this example, standard command block **HUB4_1** and **HUB4_2**).

4 Include all standard command blocks in a CNC run.

Defining a standard command block for outer frame and form



Dialog

PLOT INIT MAIN MENU STANDARD NAME

DRAWING FIELD for frame

	X	Y
Field size:	243.0000	47.0000

DEVICE SETTING

Frame size from long term file ?

Frame size as preset ? *

Position of frame Field ref: 1

	X	Y
Position:	0.0000	25.0000

Limit frame size ?

	X	Y
max. frame size:	243,3000	47,0000

* YES	NO	TYP FACE	IMAGINFO	*	CURVINFO	PAGE ARR	REPEAT	TERMIN
BACK	PRE MENU		SCALE		PREA/COM			INFO

Dialog

KUM COMMAND INPUT (STANDARD BLOCK)

12 W name: Camshaft D no: 98 5 28

Block idf. : NOM4_1 Curves: 2 from to

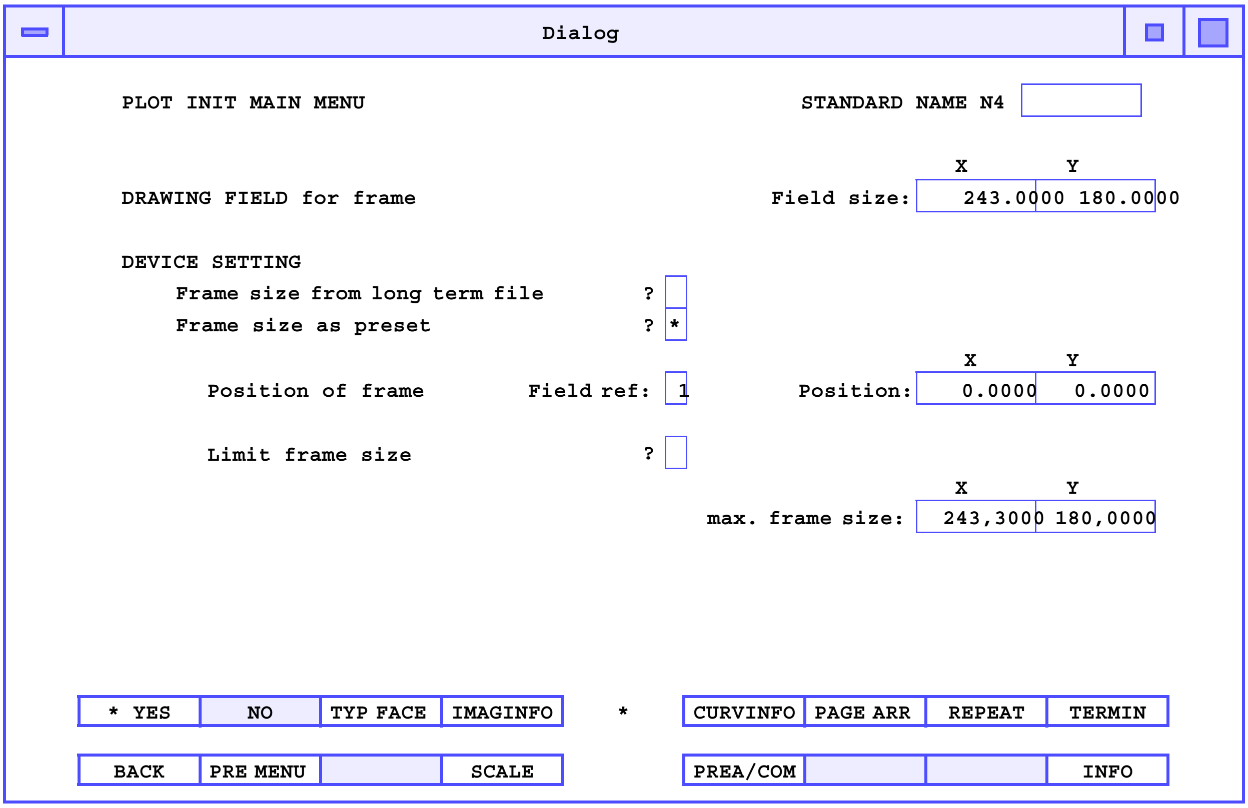
Line	Object	Action	Standard
2	TXT	PLO	N4_1

1	Plotter	initialize	N4_1
2	Form	plot	N4_1
3	Text	plot	N4_1

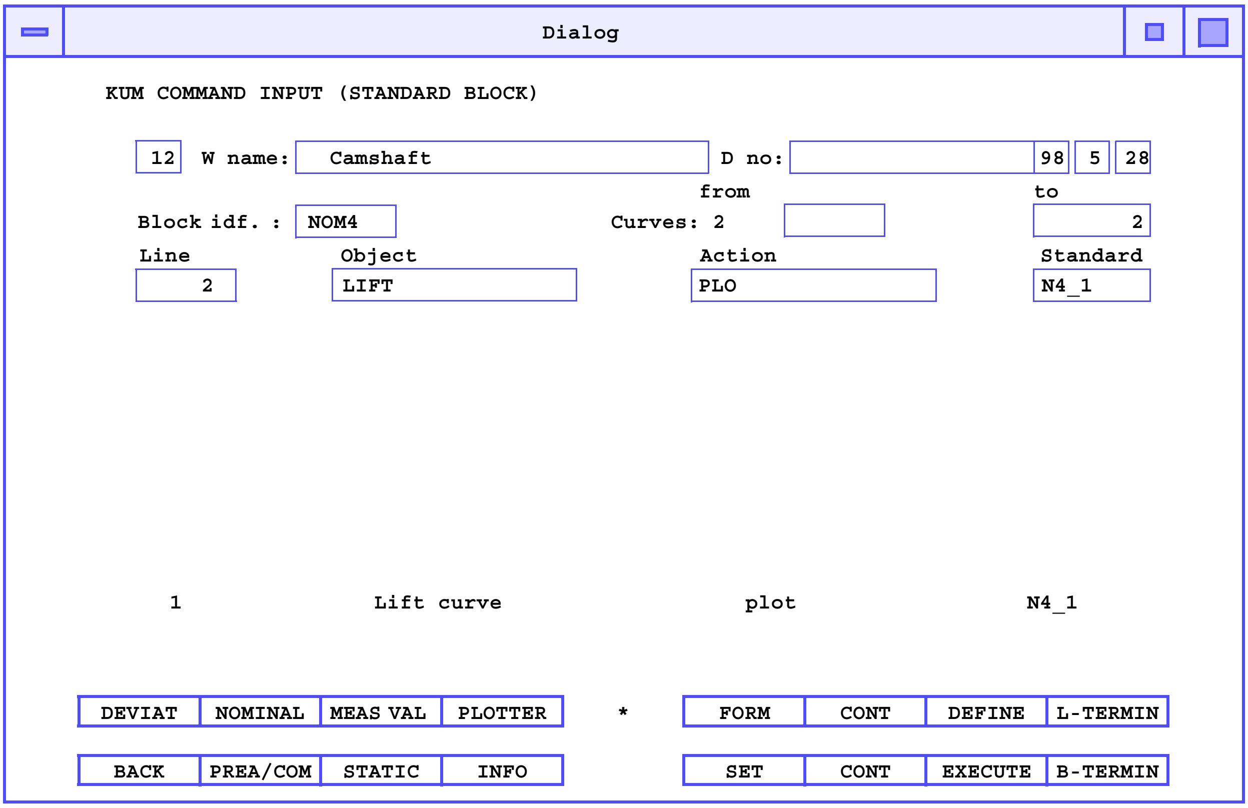
DEVIAT	NOMINAL	MEAS VAL	PLOTTER	*	FORM	CONT	DEFINE	L-TERMIN
BACK	PREA/COM	STATIC	INFO		SET	CONT	EXECUTE	B-TERMIN

Additional texts plot

With the **TXT PLO** function you can plot additional texts and data from the extended record head **<DI 1611>**. For further explanation, ➤*“Plotting texts” on page 9-61*.



Define standard command block for plotting lift curve no. 1



CNC run

CNC run for plotting four lift curves on one page:

The standard command blocks mentioned above are used in this CNC run.

Instead of plotting four lift curves, in the same way you can also include standard command blocks for plotting the linear deviations, speed curves or acceleration curves in this CNC run. Simply exchange command blocks **HUB4_1 and HUB4_2** for the command blocks from the other curves.

NOTE

In this example, the command block **HUB4_2** is used several times.

```
                                   ZEISS   UMESS

      WORKPIECE NAME         4 cams

      FILE NAME: CNC_________1B
      CONTROL DATA LINES: 23                   NOMINAL VALUE LINES:     0

           |     X     |     Y     |     Z     |            |      |      |      |      |
      NO   |-------------------------------|   Function  | SCN  | ACN  | PCN  | CCN  | ADR
           |              Dialog             |            |      |      |      |      |
        Snr  | Set type                        | Idf    |Sy    |Nom dim   | U. tol   | L. tol
        Snr  |                   |MEadr|    | Idf.    Sy   |    t      |(M)|    A    |(M)

        1 Lift curve                          RECORD HEAD      0      8  1610  1650
        2 Camshaft                             DL  R HEAD      0      0  9911     0
        3                                      DL  R HEAD      0      0  9911     0
        4                                      DL  R HEAD      0      0  9911     0
        5 Plot                                 DL  R HEAD      0      0  9911     0
        6                                      DL  R HEAD      0      0  9911     0
        7                                     LDL  R HEAD      0      0  9919     0
        8                                     KUM-START        0      1  2700     0
        9 CAMSHAFT                            W-NAME           0      4  2711     0
       10                                      DL   W-NAME     0      0  9911     0
       11                                     L-NUMBER         0      0  9911     0
       12          3                          WPC-NUMBER       0      0  9919     0
       13     2    2  NOM4                    KUM-STABLOCK     0      1  2781     0
       14     2    2  NOM4_1                  KUM-STABLOCK     0      1  2781     0
       15     2    2  HUB4_1                  KUM-STABLOCK     0      1  2781     0
       16     4    4  NOM4_2                  KUM-STABLOCK     0      1  2781     0
       17     4    4  HUB4_2                  KUM-STABLOCK     0      1  2781     0
       18     6    6  NOM4_3                  KUM-STABLOCK     0      1  2781     0
       19     6    6  HUB4_2                  KUM-STABLOCK     0      1  2781     0
       20     8    8  NOM4_4                  KUM-STABLOCK     0      1  2781     0
       21     8    8  HUB4_2                  KUM-STABLOCK     0      1  2781     0
       22                                     KUM-END          0      1  2788     0
      23                                     P-END            0      0  9999  1999
```

End

End of application example!

Plotting lift curves

Example

This is an example of the polar representation of the lift curves of four cams. The nominal lift curve is displayed with three different tolerances and the deviation curve. Toleance band and deviation curve are displayed magnified.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.

The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

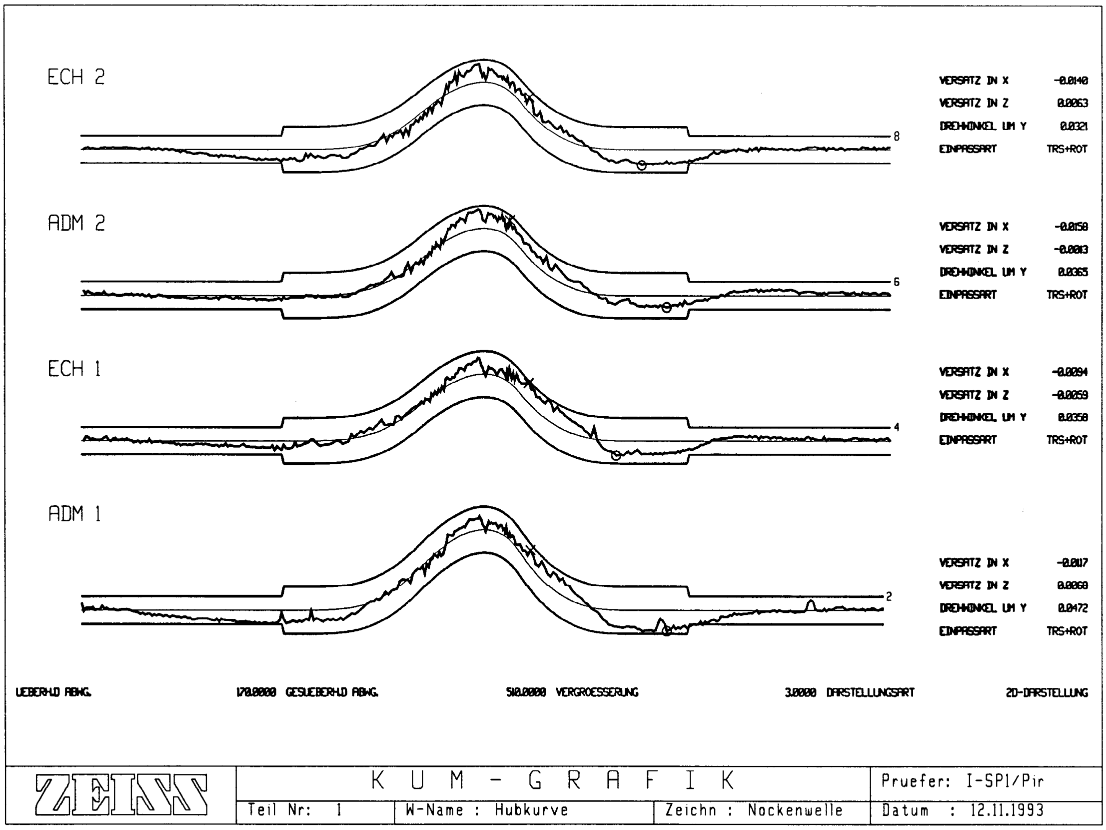
ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **LIFT**
  Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM POLAR PLOT- MAIN MENU** is displayed.



Output of the linear plot of the deviations

Example

This is an example of the polar representation of the linear deviations of four cams.

In the linear plot, the nominals are displayed as a line. The tolerance band and the deviations are displayed magnified .

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

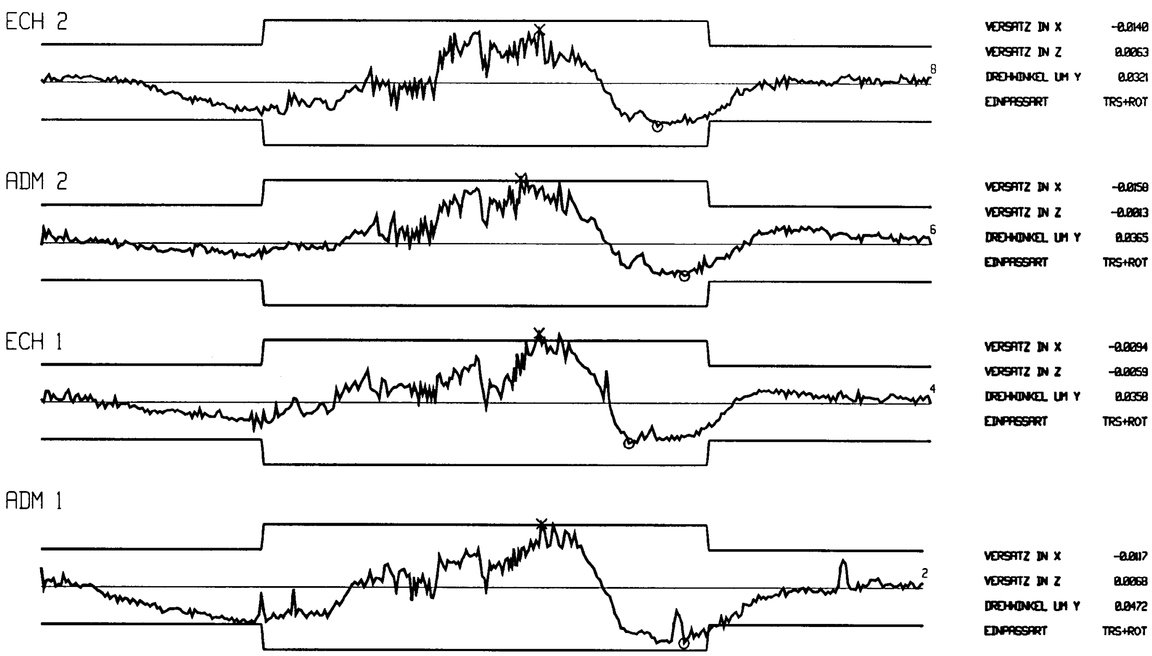
ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.

– Enter the KUM command in the data boxes.
  Object: **LDE**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM LINEAR PLOT - MAIN MENU** is displayed.



Plotting a mean value line

The **Plot mean value line** function contains the function **Plot linear deviation** (**LDE PLO**) and draws a mean value line in addition.

NOTE!
The mean value line is calculated from the deviation curve with the **Calculate pitch** function (➤*"Calculating the offset" on page 7-30*). Therefore, the **Plot mean value line** function may only be used after the **Calculate pitch** function.

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **ASG**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM LINEAR PLOT - MAIN MENU** is displayed.

Deviation

The minimum deviation (E_{min}) and the maximum deviation (E_{max}) are marked from the mean value line.

Using the **Initialize plotter** function, you can output the corresponding values of the minimum and maximum deviation, the nominal pitch, the pitch error as well as the total deviation (➤*"Plot Init Main Menu" on page 9-6*).

Polar angle 0 degrees

The representation of the linear deviations always starts in the coordinate origin, i.e. the first nominal point always has the polar angle **0 degrees** and the corresponding deviation 0 mm. This has the advantage that all curves are plotted in the same way, regardless of the start angle of the different measurements.

Example

1 Measurement: Start angle 10 degrees, angle range 180 degrees

2 Measurement: Start angle 50 degrees, angle range 180 degrees

Plot mean value line:

In both cases the representation starts at 0 degrees. The curves can therefore be compared directly with one another.

Example

For the minimum and maximum deviations, the location at which these values occur is always specified in brackets after the respective text E_{min} or E_{max} ;

E_{MIN} (120) = -0.322, E_{MAX} (150) = 0.7343

NOTE

E_{MIN} and E_{MAX} are the min/max values of the deviation in relation to the mean value line.
The **total deviation** is the difference E_{max} - E_{min}.

The direction of travel influences the abscissa polar. The plot output for angle refers to the zero axis. The numerical value inside the round brackets, in the case of a polar representation, is the polar angle of the representation moved to the coordinate origin. In the case of a cartesian coordinate system, the point number of the deviation is output.

Data output during plotting: Nominal pitch, pitch error, $E_{MIN,}$ E_{MAX}, as well as the total deviation are plotted as curve information if the relevant boxes have been filled in for the **PLT INI**, **FOR PLO** and **ASG PLO** functions.

Output of speed plot

This is an example of the polar representation of the speed curves of four cams. The nominal speed and actual speed, magnified, are displayed.

Masked positions

NOTE

For the speed plot, the last and first valid point are linked in a masked position (no gaps).

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

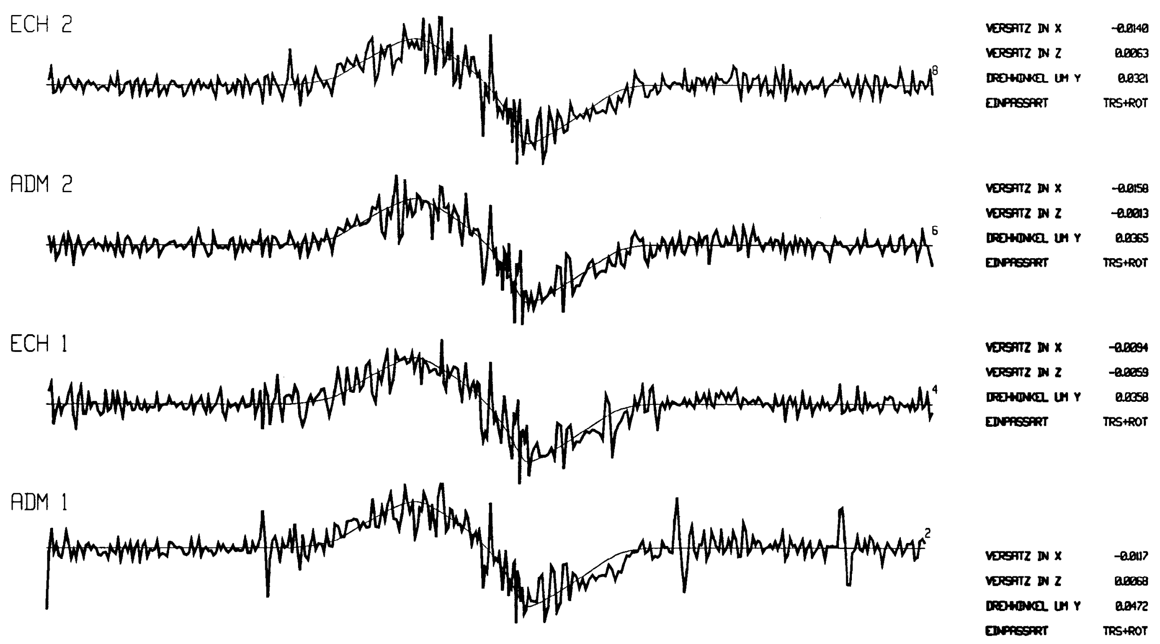
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **SPE**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM POLAR PLOT - MAIN MENU** is displayed.



Output of acceleration plot

This is an example of the polar representation of the acceleration curves of four cams.

The nominal acceleration and the actual acceleration, magnified, are displayed.

Masked positions

NOTE

For the acceleration plot, the last and first valid point are linked together in a masked position (no gaps).

Start menu: KUM Main Menu, ➤*"Calling the KUM Main Menu" on page 1-7*.

DEFINE

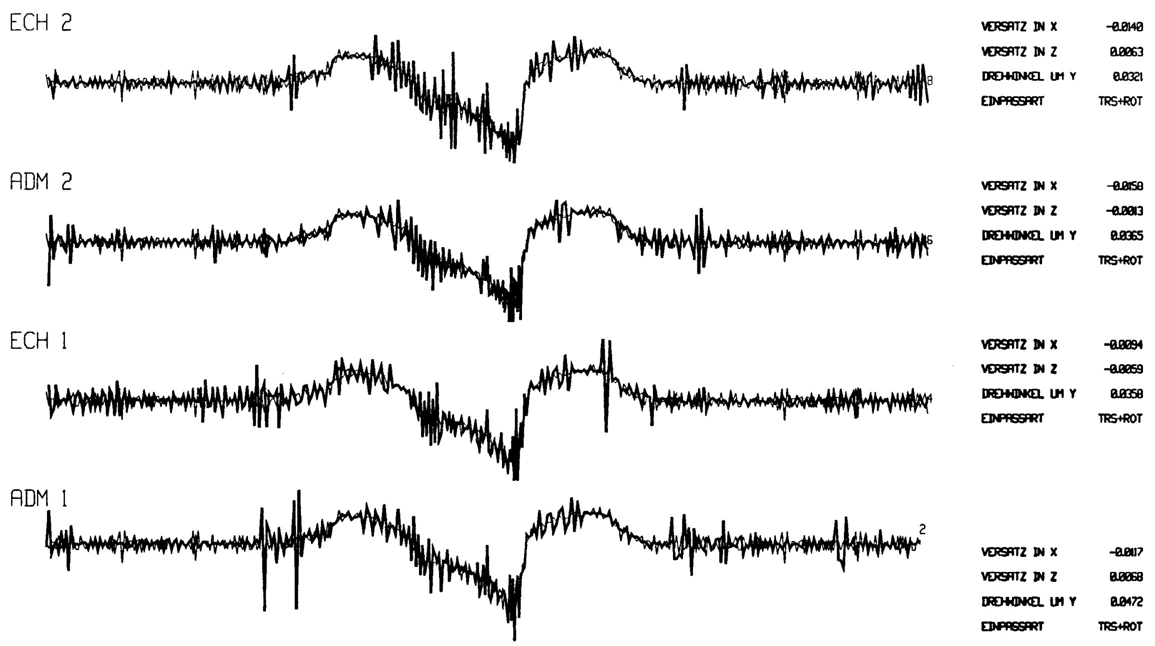
– Press **<DEFINE>**.
  The dialog window with the menu title **KUM COMMAND INPUT** is displayed.

ENTER

– Acknowledge the displayed line by pressing **<ENTER>**.
– Enter the KUM command in the data boxes.
  Object: **ACC**, Action: **PLO**

DEFINE

– Press **<DEFINE>**.
  The dialog window with the menu title **KUM POLAR PLOT - MAIN MENU** is displayed.



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