MTC200/MT-CNC

Fast Measurement

18VRS

Application Manual

DOK-MTC200-QUIC*ME*V18-ANW1-EN-P

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Purpose of the document This document describes the "Fast measurement" function.

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Contents

1 Introduction

The "Fast measurement" function enables the operator to measure workpieces and tools before and/or after machining, to interpret the measuring results, and to perform the necessary machining corrections.

Ordering information

The "Fast measurement" function is an optional component of the MTC200/MT-CNC and may be ordered under the type name

SWS-MTC200-SME-18VRS-MS

„Fast measurement“ is an enhancement of the existing NC measuring cycles. Typically, the previously used measuring cycles process the measured points in pairs. Frequently, this requires long distances to be traveled in particular if several dimensions must be measured at a workpiece.

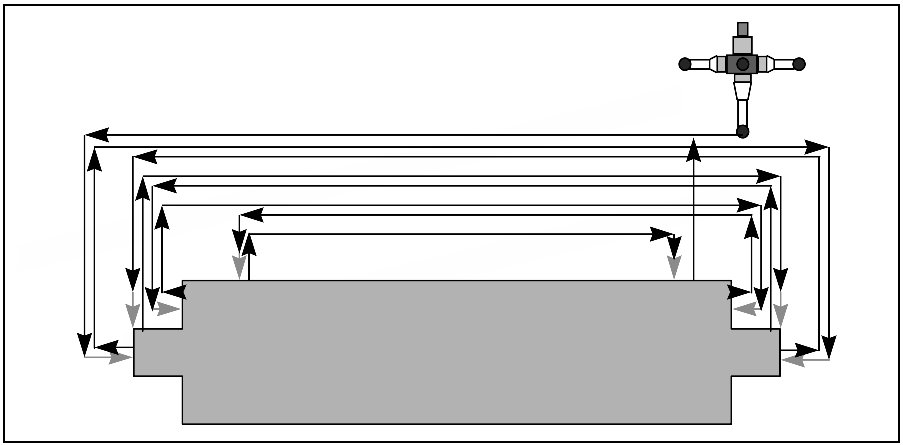

Figure 1-1: Motion sequence of the previously used measuring cycles

In "Fast measurement", an optimized NC code instead of the NC cycles is integrated directly into the NC program. This enables machine-specific axis designations and settings to be taken into account. Employing instructions (see NC Instructions, page 1-2), the user can define the sequence of the measuring process in the NC program.

The machine data is available for storing all relevant data items (measuring results, correction values, probe settings, etc.). The measuring results of several test points may be stored here simultaneously. This permits a time-optimized approach of the individual test points and the measuring results later to be included in the calculation.

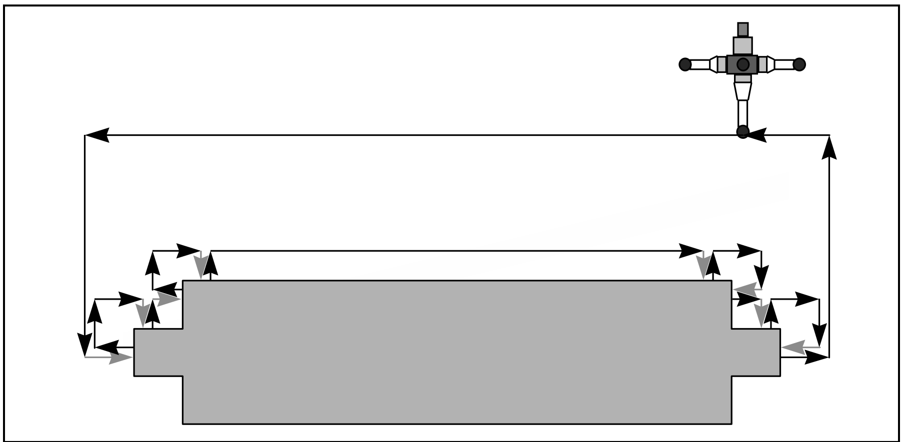

Figure 1-2: Optimized approach

Compared with the NC measuring cycles, this significantly reduces the duration of a measuring process.

2 NC Instructions

The following instructions are available to make workpiece measurement easier:

- SETTING( )
- SAVE( )
- MOVE( )
- PROBE( )
- COMPARE( )
- CORRECTION( )
- RESTORE( )

In the NC program editor (GUI), the "Fast measurement" instructions can be inserted in a menu driven manor under <F1> ‘Insert block + <F3> ‘Special functions’. Branching to the "Fast measurement" directory is required in the NC special functions.

2.1 Description of the Instructions

SETTING ( )

Function

The SETTING ( ) instruction is used for performing the settings that are required for "Fast measurement".

Position in the NC program

The SETTING ( ) instruction comes before any other measuring instruction.

Syntax

SETTING (A,B,C,D,E,F,G)

Parameter	Description	Assignment
A:	Axis 1 : Axis designation	
B:	Axis 2 : Axis designation	
C:	Axis 3 : Axis designation	
D:	Plane selection: G code	17, 18, 19
E:	Tool length correction: G Code	47, 48, 49
F:	Radius/diameter programming: G code	15, 16
G:	Stylus number	1 - 4

Note: Any designation that can be defined in the drive parameters may be used as an axis designation.

SETTING (A,B,C, D, E, F,G)

Example: Milling

SETTING (X,Y,Z,17,48,15,1)

- The axes X, Y and Z are available for workpiece measurement.
- Activating the G functions: G17 (plane); G48 (tool length correction) and G15 (radius programming).
- The first stylus that is listed in the machine data of the stylus page is employed.

SETTING (A,B,C,D, E, F,G)

Example: Turning

SETTING (X,Z,,18,48,16,3)

- The axes X and Z are available for workpiece measurement.
- Activating the G functions: G18 (plane); G48 (tool length correction) and G16 (diameter programming).
- The third stylus that is listed in the machine data of the stylus page is employed.

Note: If, for example, axis 2 of a turning machine does not exist, the position of axis 3 will be at location B. Location 3 remains empty in this case.

SAVE ( )

Function

Using this instruction, the user can save the machine state. Depending on the programmed parameter, the variables 100 - 112, the F value, and the axis positions that are stored in the SETTING can be saved in the buffer page.

Position in the NC program

The SAVE ( ) instruction can be placed at any location following the SETTING ( ) instruction.

Note: In order to save the machine state that existed immediately before the measuring cycles, the instruction must be located immediately after the SETTING ( ) instruction. If a MOVE or PROBE instruction has been executed before, the initial machine state can never be restored using the SAVE and RESTORE instructions.

Syntax

SAVE (A,B,C)

Parameter	Description	Assignment
A:	Variables 100 - 112	0: don’t save
B:	Axis positions	1: save
C:	F value	

SAVE (A,B,C)

Example SAVE(1,0,0)

- All variables between 100 and 112 are stored in the machine data buffer page.
- The axis positions and the F value are not saved.

MOVE ( )

Function The stylus must be prepositioned if a test point cannot be approached via the PROBE( ) instruction. The MOVE( ) instruction provides this functionality. The required axis position is approached in a 2- or 3-dimensional way. If there is an obstacle in the motion path, moving the axes individually may become necessary.

The user reverse program can still be started if the axes are stopped during the movement. Only the pervious movements that are to be reversed are programmed here.

The G code groups 1,2,3,5,6,7,13 are saved before a MOVE, and are written back at the end.

Note: Any collision that occurs during the motion will be detected.

Position in the NC program The instruction can be at any location following the SETTING ( ) instruction.

Syntax MOVE(A,B,C,D,E)

Parameter	Description	Assignment
A:	Position of axis 1	± 100 000.000
B:	Position of axis 2	± 100 000.000
C:	Position of axis 3	± 100 000.000
D:	Measuring sphere number	1 - 5
E:	Reverse variant	0: single point 1 - 10: Number of the linear path sequence

CAUTION

⇒ The position specifications are related to the center of the stylus measuring sphere. This means that approaching the workpiece to a distance that is smaller than the measuring sphere radius will lead to a collision and thus to a stop of the NC program execution. (see Using the MOVE Instruction for Moving the Stylus)

Note: If, for example, axis 2 of a turning machine does not exist, the position of axis 3 will be at location B. Location 3 remains empty in this case.

MOVE`(A, B,C,D,E)`

Example

Lathe:

MOVE`(50,20,,1,0)`

- Using G00, the first measuring sphere (tool edge 1) of the current stylus is prepositioned to X50 and Z20. Setup is performed in a two-dimensional way.
- When the reverse program is started, the movements that were performed in this instruction are reversed before a branch is made to the user reverse program.

Milling machine:

MOVE`(50,,10,2,0)`

- Using G00, the second measuring sphere (tool edge 2) of the current stylus is prepositioned to X50 and Z10. Setup is performed in a two-dimensional way. The Y axis is not moved.
- When the reverse program is started, the movements that were performed in this instruction are reversed before a branch is made to the user reverse program.

Note: If a MOVE is the first instruction within the „linear path sequence“, the position of all axis that are defined in the SETTING must be specified.

PROBE ( )

Function

This instruction generates the NC blocks that implement the approach to the test point (absolute dimension), the motion along the measuring path (incremental dimension), the determination of the measured value, and the escape from the test point. Distinction is made between test points and calibration points. At the beginning, the G code groups 1, 2, 3, 5, 6, 7, 13 are saved in the buffer page. At the end of the instruction, they are written back.

The user reverse program can still be started if the axes are stopped during the movement. Only the pervious movements that are to be reversed are programmed here.

Note: The number of test points depends on the size of the point page. During installation, it was set to 20 test points (control variable LV2). Up to 50 test points can be programmed in one machining sequence. This requires the LV2 control variable to be set to this value (see Pointpage 3-5)

Position in the NC program

The PROBE ( ) must be located after the SETTING instruction.

Syntax

PROBE (A,B,C,D,E,F,G,H,I,J,K)

Parameter	Description	Assignment
A:	Point number	1 - 20 (50)
B:	Calibration/measurement	0, 1
		0: Calibration
		1: Measurement
C:	Measuring position of axis 1	± 100 000.000
D:	Measuring position of axis 2	± 100 000.000
E:	Measuring position of axis 3	± 100 000.000
F:	Measuring axis	
G:	Measuring path	± 100 000.000
H:	Measuring feed	e.g.: 100
I:	Measuring sphere number	1 - 5
J:	Approach variant	1 - 4
		1: directly, with escape
c		2: indirectly, with escape
		3: directly, without escape
		4: indirectly, without escape
K:	Reverse variant	0: single point
		1 - 10: Number of the linear path sequence

Note: Any designation that can be defined in the drive parameters may be used as an axis designation.

PROBE(A,B, C,D, E ,F, G, H ,I,J,K)

Example

PROBE(5,1,20,0,-10,Z,-1,100,1,3,0)

- This test point is written to the following location in the point page: LV1 = current process; LV2 = 5
- The test point is located at the position X20 Y0 Z-10
- The Z axis is used for measuring
- The setup position is 1 mm away from the workpiece surface.
- Measuring is performed in the negative direction and at a feed rate of 100 mm/min
- The first measuring sphere is activated. This means that the first measuring sphere is activated that was defined in the tools list (tool edge selection in the NC program: ‘E1’)

- The test point is approached in three dimensions and there is no escape (i.e. the stylus remains at the setup position after the measurement).
- When the reverse program is started, only the movements that were performed in this instruction are reversed before a branch is made to the user reverse program.

Note: The radius of the measuring sphere is taken into account in the direction of the measurement (see Using the PROBE Instruction for Moving the Stylus 4-4). A PROBE that has been defined as "Calibration" may not be written in a linear path sequence.

COMPARE ( )

Function

Using the COMPARE ( ) instruction, two or (in an exception) one test point(s) can be taken into account. To do this, the test points are read from the point page, the calculation is performed according to the comparison strategy, and the result is written to the result page at the position that is specified by parameter A.

Note: As in the PROBE() instruction, the number of comparisons that must be performed depends on the size of the result page. During installation, it was set to 20 (control variable LV2). However, up to 50 COMPARE instructions can be programmed in one machining sequence. This requires the LV2 control variable to be set to this value (see result page 3-6).

Position in the NC program

The COMPARE ( ) instruction may be located at any position after the PROBE ( ) instruction COMPARE( ) refers to. This means that the measuring instructions for the points that are to be taken into account must have been executed before the actual values can be taken into account.

Syntax

COMPARE (A,B,C,D)

Parameter	Description	Assignment
A:	Storage point number	1 - 20 (50)
B:	Comparison strategy	0 - 4
		0: Point
		1: Stair
		2: Groove
		3: Diameter; 2 points
		4: Diameter; 1 point
C:	Test point number 1	1 - 20 (50)
D:	Test point number 2	1 - 20 (50)

COMPARE(A,B,C,D)

Example 1

COMPARE(10,1,2,8)

- Test points 2 and 8 are used for a comparison. The comparison strategy is based on stair measurement.
- The result is written to the result page at the following location: LV1 = current process; LV2 = 10

Note: Comparison is only possible for points that have the same measuring axis.

COMPARE(A,B,C,D)

Example 2

COMPARE(7,4,6,)

- Test points 6 is used for a comparison. The comparison strategy is based on diameter measurement.
- The result is written to the result page at the following location: LV1 = current process; LV2 = 7

Note: Comparison strategy 4 permits a comparison using the COMPARE() instruction if only one test point of a lathe can be measured at the diameter (X axis).

CORRECTION ( )

Function

This instruction is used for interpreting the comparison values and for determining the correction value.

- Monitoring certain dimension and tolerance ranges, providing the corresponding reaction in the process, and issuing messages.
- Recognizing rejected items.
- Determining the correction values as a function of the amount of the dimensional deviation.
- Setting qualities in the form of a dimensional accuracy.

In the NC program, the user may also assign the determined correction values to the programmed zero point or to a tool.

Examples of evaluating the determined correction value:

Requirement: The result page is on page 105; machining is performed using the tool T12.

TLD(,1,12,,11,) = TLD(,1,12,,11,) + MTD(105,,1,13)

Taking the correction value into account for the tool in the current process with the T number 12 and the geometry data item 11 (wear L1).

- or -

OTD(,,,4,1) = OTD(,,,4,1) + MTD(105,,1,13)

Assigns the correction value to the entry for the X axis in the active zero offset table for the shift according to G54 in the current NC memory for the active process.

Position in the NC program The CORRECTION ( ) instruction must be located after the COMPARE ( ) instruction in which the actual value is determined that is required for the correction cycle. However, the location after the COMPARE( ) instruction is insignificant.

Syntax CORRECTION (A,B,C,D,E,F,G,H,I,J)

Parameter	Description	Assignment
A:	Compare number	1 - 50
B:	Upper allowance	e.g.: 0.2
C:	Lower allowance	e.g.: -0.2
D:	Upper limit	e.g.: 0.4
E:	Correction limit	e.g.: 0.3
F:	Empirical value	e.g.: 0.0013
G:	Correction strategy	0: Averaging 1: Percentage correction
H:	Correction strategy = 0 --> averaging Weighting factor (0.5 ⇔ 50%)	0.00001 - 10
H:	Correction strategy = 1 --> percentage correction Percentage correction factor	0.00001 - 100
I:	Partial correction	e.g.: 0.1
J:	Lower limit	e.g.: 0.005

Example

```
CORRECTION(A, B , C , D , E , F ,G, H , I , J )
CORRECTION(1,0.1,-0.1,0.24,0.18,0.004,0,1.5,0.07, 0.01)
```

- The CORRECTION instruction is related to the COMPARE instruction that has the compare number 1 assigned.

- This is followed by the upper and lower allowances (0.1mm; -0.1mm), the upper limit (0.24mm), the correction limit (0.18mm) and the empirical value (0.004mm).
- The selected correction strategy is averaging (0) and a weighting factor of 1.5.
- There will be a partial correction if the dimension difference is less than 0.07mm. No correction value is calculated if it is less than 0.01mm.

RESTORE( )

Function

This instruction is used for loading back the machine state that has previously been saved using SAVE( ).

RESTORE( ) refers to the settings that have been programmed in SAVE( ). The axis positions are not moved to the saved position. The user may program this using the corresponding machine data elements of the buffer page.

Position in the NC program

The instruction can be at any location following the SAVE ( ) instruction.

Note: RESTORE( ) should be programmed as the last measuring instruction in the NC program.

CAUTION

⇒ Any additional „measuring instructions" after RESTORE( ) modify the saved-back machine state.

Syntax

RESTORE( )

The RESTORE( ) instruction does not contain any parameters.

2.2 Brief Summary of the Instructions

Instruction	Meaning of the parameters	Parameter assignments	Description
SETTING (A,B,C,D,E,F,G)	A: Axis 1 B: Axis 2 C: Axis 3 D: Plane E: Length correction: F: Diameter/radius G: Stylus number	D: 17 -> G17 18 -> G18 19 -> G19 E: 47 -> G47 48 -> G48 49 -> G49 F: 15 -> G15 16 -> G16	The SETTING instruction is located before any other instruction in the NC program. The necessary settings for machine and compiler are entered.
SAVE(A,B,C)	A: Variables B: Axis positions C: F values	0: don't save 1: save 0: don't save 1: save 0: don't save 1: save	The SAVE instruction is located after the word SETTING in the NC program. It permits the variables, axis position and F values to be saved that are required by the measuring program.
MOVE(A,B,C,D,E)	A: Position of axis 1 B: Position of axis 2 C: Position of axis 3 D: Measuring sphere number E: Reverse variant	E: 0 -> single point 1 - 10 -> Number of the linear path sequence	The MOVE instruction can be at any position following the SETTING instruction. The axes are moved simultaneously to the programmed end point.
PROBE (A,B,C,D,E,F,G,H,I,J,K)	A: Point number B: Calibration/measurement, C: Axis 1 measuring position D: Axis 2 measuring position E: Axis 3 measuring position F: Measuring axis G: Measuring path H: Measuring feed rate I: Measuring sphere number J: Approach variant K: Reverse variant	B: 0 -> Calibration 1 -> Measurement J: 1 -> direct, escape 2 -> indirect, escape 3 -> direct, no escape 4 -> indirect, no escape K: 0 -> single point 1 - 10 -> Number of the linear path sequence	The PROBE instruction can be at any position following the SETTING instruction. This instruction is used for approaching the test points or for calibrating the measuring axes.

COMPARE(A,B,C,D)	A: Compare number B: Comparison strategy C: Point number 1 D: Point number 2	B: 0 -> Point 1 -> Stair 2 -> Groove 3 -> Diameter - 2 points 4 -> Diameter - 1 point	The COMPARE instruction may be located at any position following the PROBE instruction to which it is related. This instruction is used for establishing the reference that is required for the correction value calculation.
CORRECTION (A,B,C,D,E,F,G,H,I,J)	A: Compare number B: Upper allowance C: Lower allowance D: Upper limit E: Correction limit F: Empirical value G: Correction strategy H: Correction value calculation method I: Partial correction J: Lower limit	G: 0 -> Averaging H -> Weighting factor G: 1 -> percentage correction H -> Percentage correction factor	The CORRECTION instruction may be located at any position following the COMPARE instruction to which it is related. The CORRECTION instruction calculates the correction value according to the specifications that were made in the parameters. The correction value is available in the data element 13 of the result page.
RESTORE( )			The RESTORE instruction can be programmed after a SAVE. The data saved in SAVE are saved back again.

Figure 2-3: Instructions

3 Machine Data

In order to make the maximum possible number of variables available to the user, all required and determined data items are stored in the machine data pages.

These are the following pages:

- BASISMESSPAGE
- ZWISCHENSPEICHERPAGE
- TASTWERKZEUGPAGE
- EICHWERTEPAGE
- POINTPAGE
- ERGEBNISPAGE

The BASISMESSPAGE is the Indramat page 90. All other pages must be created using the import function.

3.1 Description of the Machine Data Pages

BASISMESSPAGE

The base measurement page is the only page whose number is predefined by the system softtware. It cannot be changed by the user. It is implemented as an Indramat page.

Description

The base measurement page contains the numbers of the employed pages, together with parameters (data elements 6 - 10) which are needed by the SPS for a correct execution of the NC program. The data elements 6 and 7 depend on the selected stylus.

The page requires a memory space of approximately 105 bytes.

Note: The values of the data elements 1 through 5 point to the other machine data pages. The numbers of the individual pages must be entered before the program download. The elements 6 through 10 are set by the NC program. Only the machine data structure of the master process (process 0) must be described. The structures of any other processes need not be described.

Control variable LV1

The variable is of the PROCESS type.

Control variable LV2

Does not exist

Machine data structure

STRUCT BASISMESSPAGE

Data element	Designation	Data type
00001	Buffer page	INT
00002	Stylus page	INT
00003	Calibration value page	INT
00004	Point page	INT
00005	Result page	INT
00006	PIN DDS	BOOL
00007	Pushbutton_contact	BOOL
00008	Measuring axis 1 available	BOOL
00009	Measuring axis 2 available	BOOL
00010	Measuring axis 3 available	BOOL

END_STRUCT

ZWISCHENSPEICHERPAGE

Description

Provided it has been selected through the SAVE( ) instruction in the NC program, G codes, current axis positions, variables and F values are saved in this page. Data element 1 of the buffer page enables the user to hide the programmed calibration points.

The page requires a memory space of approximately 588 bytes.

Control variable LV1

The variable is of the PROCESS type.

Control variable LV2

Does not exist

Machine data structure

STRUCT ZWISCHENSPEICHERPAGE

Data element	Designation	Data type
00001	Calibration OFF (1) / ON (0)	BOOL
00002	free	BOOL
00003	G(1)	INT
00004	G(2)	INT
00005	G(3)	INT
00006	G(5)	INT
00007	G(6)	INT
00008	G(7)	INT
00009	G(13)	INT
00010	@100	REAL
00011	@101	REAL
00012	@102	REAL
00013	@103	REAL
00014	@104	REAL
00015	@105	REAL
00016	@106	REAL
00017	@107	REAL
00018	@108	REAL
00019	@109	REAL
00020	@110	REAL
00021	@111	REAL
00022	@112	REAL
00023	Axis 1 position	REAL
00024	Axis 2 position	REAL
00025	Axis 3 position	REAL
00026	F value	REAL

END_STRUCT

Note: The elements 2 through 26 are written by the NC program.

TASTWERKZEUGPAGE

Description

Since a measuring stylus is handled like a tool, the user must know the T number under which the stylus has been entered in the tools list. Using this T number, the controller is able to read and compute the correct geometry data. The number of the switching contact is also contained in this page. The connector pin assignment at the SERCOS drive, via which the electrical connection between stylus and controller has been implemented, is another important specification for the stylus operation. Two connections are available here (see Operating Instructions Drive or Stylus Connection, see Stylus Connection 7-17).

The page requires a memory space of approximately 104 bytes.

Control variable LV1

The variable is of the NO_CLASS [1-4] type.

The number of different styluses in a system is limited to 4.

Control variable LV2 Does not exist

Machine data structure STRUCT TASTWERKZEUGPAGE

Data element	Designation	Data type
00001	Tool number (T number)	DINT
00002	NO (0) / NC (1)	BOOL
00003	PIN4 (0) / PIN5 (1)	BOOL
00004	Measuring sphere radius 1	REAL
00005	Measuring sphere radius 2	REAL
00006	Measuring sphere radius 3	REAL
00007	Measuring sphere radius 4	REAL
00008	Measuring sphere radius 5	REAL

END_STRUCT

Note: A maximum of four styluses may be used in a system.
The user must enter all the elements in this page (if they are required).

EICHWERTEPAGE

Description The measured calibration values and the measuring feed rates of the individual measuring directions are stored in the calibration value page. This table of calibration and feed values exists for each measuring sphere of each stylus.

The page requires a memory space of approximately 960 bytes.

Control variable LV1 The variable is of the NO_CLASS [1-4] type.

The number of styluses in a system is limited to 4.

Control variable LV2 The variable is of the NO_CLASS [1-5] type.

The maximum number of measuring spheres of a stylus is 5.

Machine data structure

STRUCT EICHWERTEPAGE

Data element	Designation		Data type
00001	Meas. direction	axis 1	REAL
00002	Meas. direction	– axis 1	REAL
00003	Meas. direction	axis 2	REAL
00004	Meas. direction	– axis 2	REAL
00005	Meas. direction	axis 3	REAL
00006	Meas. direction	–axis 3	REAL
00007	Meas. feed	axis 1	REAL
00008	Meas. feed	– axis 1	REAL
00009	Meas. feed	axis 2	REAL
00010	Meas. feed	– axis 2	REAL
00011	Meas. feed	axis 3	REAL
00012	Meas. feed	– axis 3	REAL

END_STRUCT

Note: All elements of this page are written to by the NC program. If the user modifies any values of this page during the execution of the NC program, this may lead to an incorrect execution of the NC program.

POINTPAGE

Description

The command values, the measured actual values, and the deviation between command and actual values are stored in the point page.

The page requires a memory space of approximately 1680 bytes.

Control variable LV1

The variable is of the PROCESS type.

Control variable LV2

The variable is of the NO_CLASS [1-20] type.

Note: The control variable LV2 is set to 20 during installation, thus limiting the number of test points that can be accommodated to 20. The control variable LV2 may be increased if more test points are programmed in an NC program. It must be noted that the maximum number of test points is limited to 50.

Machine data structure

STRUCT POINTPAGE

Data element	Designation	Data type
00001	Test point (command value)	REAL
00002	Test point (actual value)	REAL
00003	Deviation	REAL

END_STRUCT

Note: All elements of this page are written to by the NC program.

ERGEBNISPAGE

Description

The result page contains the test points that were required for a comparison (COMPARE), the result, and the comparison strategy. Furthermore, the results of the „CORRECTION“ instruction are stored here (dimensional accuracy, average value, correction value and correction strategy).

Due to its clarity, the result page may also be used for documentation purposes.

The page requires a memory space of approximately 6580 bytes.

Control variable LV1

The variable is of the PROCESS type.

Control variable LV2

The variable is of the NO_CLASS [1-20] type.

Note: The control variable LV2 is set to 20 during installation, thus limiting the number of COMPAREs that can be accommodated to 20. The control variable LV2 may be increased if more COMPAREs are programmed in an NC program. It must be noted that the maximum number of test points is limited to 50.

Machine data structure

STRUCT ERGEBNISPAGE

Data element	Designation	Data type
00001	Measured value 1 (command)	REAL
00002	Measured value 1 (actual)	REAL
00003	Measured value 1 (deviation)	REAL
00004	Measured value 2 (command)	REAL
00005	Measured value 2 (actual)	REAL
00006	Measured value 2 (deviation)	REAL
00007	Comparison strategy	SINT
00008	Comparison value (command)	REAL
00009	Comparison value (actual)	REAL
00010	Comparison value (deviation)	REAL
00011	Dimensional accuracy	SINT
00012	Average value	REAL
00013	Correction value	REAL
00014	Correction strategy	BOOL

END_STRUCT

Note: All elements of this page are written to by the NC program.

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4 Boundary Conditions

4.1 Programming Instructions

Programmable NC Axes

Only the linear main axes with the axis meanings X, Y and Z may be programmed for a measuring process. Secondary axes (axis meanings U, V, W ...) are not permitted in the NC instructions for "Fast measurement".

Milling machine The axes with the axis meanings X, Y and Z are available in a milling machine. A correct execution of the NC instructions for "Fast measurement" is not possible if axes with different axis meanings are programmed.

Lathe The axes with the axis meanings X and Z are available in a lathe. A correct execution of the NC instructions for "Fast measurement" is not possible if axes with different axis meanings are programmed.

Tool Path and Length Correction

G40 Tool path correction must be switched off (G40) prior to a ’MOVE’ or ’PROBE’ travel instruction of "Fast measurement".

An active (G41 or G42) tool path correction leads to an incorrect movement and may damage the stylus.

Note: The user must set G40 before the measuring instructions. The original state of the tool path correction must be restored following the measuring instructions.

G49 Tool length correction G49 (negative tool length correction) cannot be programmed in "Fast measurement".

Entering G49 in the SETTING instruction will lead to an error message.

G48 A programmed G48 always requires a tools list to be employed. The tool data is accessed in the NC program.

An error is generated during program execution if G48 is entered in the SETTING and if a tools list does not exist.

G47 G47 must be programmed in the SETTING if work shall be done without a tools list. G47 does not read the tool data.

D corrections The D corrections are not interpreted.

Additional tool length offset values that are stored in the D correction will not be taken into account when the target positions are calculated.

Plane Selection

The ’Free plane selection G20’ cannot be used in the NC instructions for "Fast measurement".

Entering G29 in the SETTING instruction will lead to an error message.

Diameter and Radius Programming

Diameter programming (G16) is only possible in turning. Only the axes with the axis meanings X and Z are entered in the SETTING. Diameter programming only refers to the X axis.

Entering G16 in the SETTING instruction of a milling process will lead to an error message.

Feed Programming

The movements for "Fast measurement" (MOVE and PROBE) are always performed with G94 ’Velocity programming’.

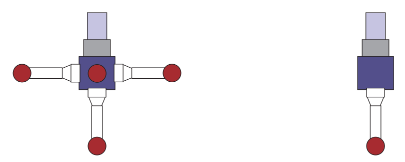
Note: G94 is set automatically in the NC instructions MOVE and PROBE. The old state is restored at the end of the instructions.

The programmed feed rate in the PROBE instruction should be dimensioned for velocity programming. There will be no verification.

Tool Correction Type

When tool management is used, the measuring tool correction type must be selected such that all existing tool length are taken into account.

Z. e.g.:



Correction type 4 Correction type 2

Assigned Q Functions and NC Events

The Q functions Q9992, Q9998 and Q9999 and the NC events E7, E29 and E30 are required for the correct handling between SPS and NC. As soon as "Fast measurement" has been implemented, these Q functions and NC events may no longer be used at any other location.

Entering the NC Instructions

Only one instruction for "Fast measurement" may be programmed in an NC block. No other NC syntax may be written in this NC block.

Since several blocks are generated from an instruction, further NC code could incorrectly be processed.

An NC block with an instruction for "Fast measurement" may consequently not be marked as a skipped block.

Instructions for "Fast measurement" cannot be programmed in the NC cycles. Converting the instructions into the corresponding NC code is not possible under Windows NT 4.0.

4.2 Using the PROBE Instruction for Moving the Stylus

Using the Positioning Logic for Movement

The following procedure is employed for approaching the stylus to the calculated measurement start point using the positioning feed (G00):

- Positioning in parallel to the measuring path and into the plane that runs through the setup position, and is perpendicular to the measuring direction. (1st broken line)
- Positioning to the measurement start point. (2nd broken line)

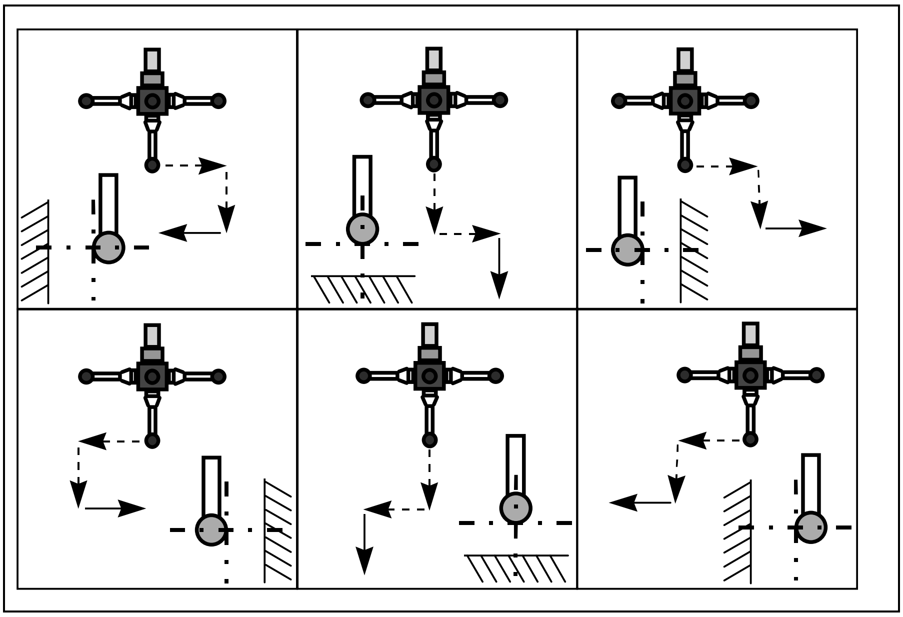


Figure 4-4: Using the positioning logic for movement

When escaping to the initial point after measurement has been programmed, the stylus is set up in the reverse direction. This means that the axes that are perpendicular to the measuring axis will first be moved together before the measuring axis is moved.

Note:	During the movement, the radius of the measuring sphere is taken into account in the direction of the measurement.

2- or 3-Dimensional Movement

The three main axis of a milling machines or the two main axes of a lathe are moved simultaneously (broken line).

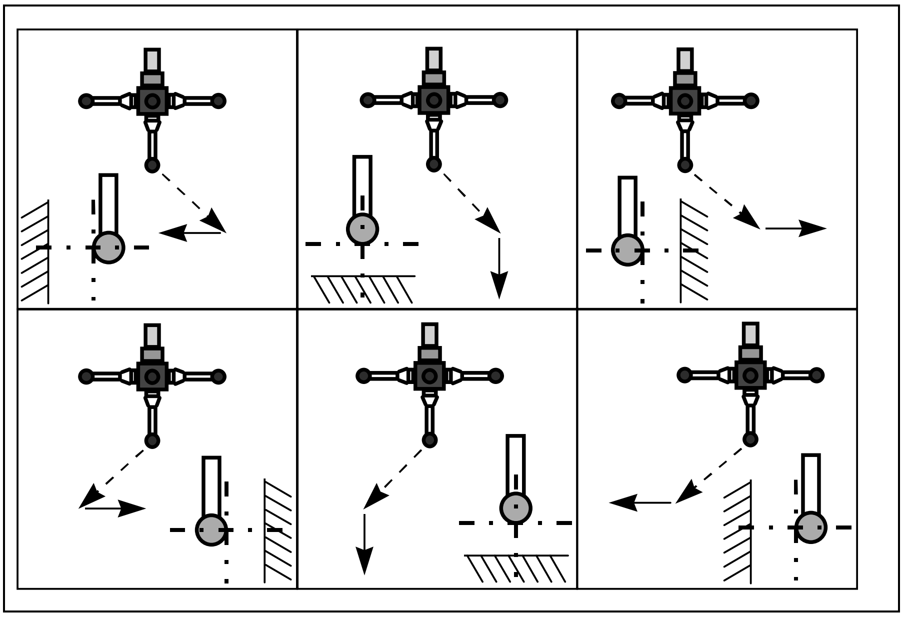


Figure 4-5: 2- or 3-D movement using PROBE

Escaping is performed in the reverse sequence.

Note: During the movement, the radius of the measuring sphere is taken into account in the direction of the measurement.

4.3 Using the MOVE Instruction for Moving the Stylusł

2- or 3-Dimensional Movement

The three main axis of a milling machines or the two main axes of a lathe are moved simultaneously

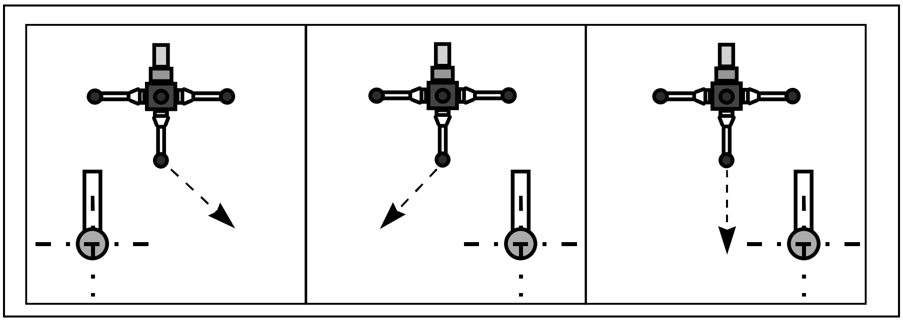


Figure 4-6: 2- or 3-D movement using MOVE

Note: The measuring sphere radius is not taken into account during the movement. The programmed position refers to the center of the measuring sphere.

4.4 Reverse Vectors

Reverse vectors and the motion paths that are used for retracting the stylus are written to ensure that the reverse program (.HOME) can be started from any position in the event of a malfunction.

User-programmed reverse vectors are not overwritten in this process.

Only the position at which the user reverse program can directly be started and/or the point at which movements must be reversed must be taken into consideration when the reverse variant is programmed in the PROBE or MOVE instruction.

There are two reverse variants:

- Single point reversing
  The movements of the interrupted MOVE or PROBE instructions are reversed before a branch is made to the user reverse program.
- Linear path reversing
  The movements of the interrupted reverse linear path sequence are reversed before a branch is made to the user reverse program.

Note: If a MOVE instruction is the first instruction within the reverse linear path sequence, all axis that are defined in the SETTING must be programmed in the instruction.
A calibration PROBE may not be programmed in a reverse linear path sequence.

Only movements that are performed using PROBE or MOVE are taken into account in the reverse program of the linear path sequence. Movements through G00, G01, G02 or G03 will lead to an incorrect escape.

CAUTION

⇒ The jump labels of the reverse vectors begin with the following letters and must not be used by the user: NC-Syntax rev .*$.........

The following example explains this.

There are a lathe with the axes X and Z, the home program and the workpiece that is to be measured.

NC block:	Comment:
.HOME	Jump label for the homing program
G74 G0 G53 G90 X210	Retracting the X axis
G74 G0 Z360	Retracting the Z axis
RET	Program end

Figure 4-7: .HOME

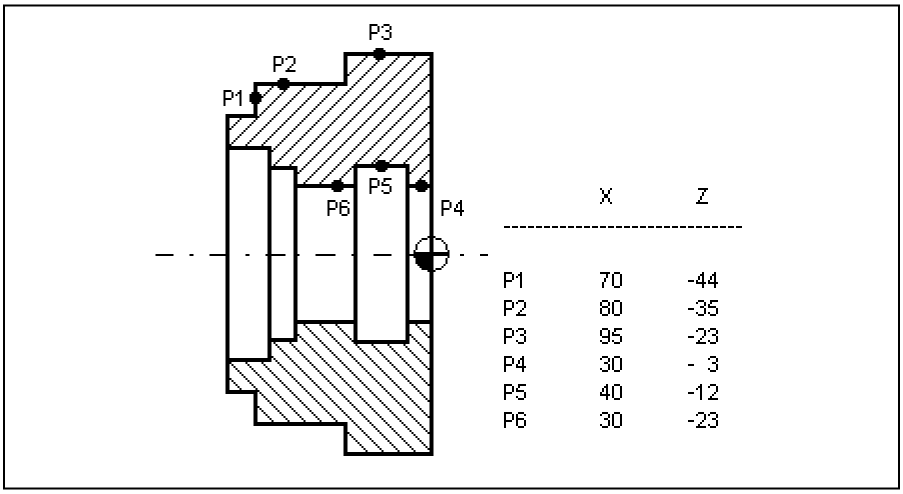


Figure 4-8: Typical reverse vectors

The NC program could look like this:

Block no.:	NC program:	Comment:
50	MOVE(,44,,2,0)	Pre-positions the stylus for the measurement at P1
51	PROBE(1,1,70,-44,,Z,1,100,2,4,0)	Measuring P1
52	PROBE(2,1,80,-35,,X,-2,100,2,4,0)	Measuring P2
53	PROBE(3,1,95,-23,,X,-2,100,2,4,0)	Measuring P3
54	MOVE(100,30,,1,0)	Positions stylus in front of the workpiece and selects measuring sphere 1
55	MOVE(24,30,,4,0)	Pre-positions the stylus for measuring P4 and activates measuring sphere 4
56	PROBE(4,1,30,-3,,X,2,100,4,3,5)	Measuring P4
57	MOVE(,-12,,4,5)	Pre-positions the stylus for the measurement at P5
58	PROBE(5,1,40,-12,,X,2,100,4,3,5)	Measuring P5
59	PROBE(6,1,30,-23,,X,2,100,4,4,5)	Measuring P6
60	MOVE(24,30,,4,5)	Retracting stylus from the workpiece

Figure 4-9: Reverse program

Reverse variant: Single point

With NC blocks 50 through 55, the distance the axes have moved can be reversed before a branch is made to the use reverse program. The reverse variant must be declared as a single point (parameter assignment: 0).

Reverse variant: Linear path sequence

This is no longer possible from NC block 56 through 60 onwards. Here, the stylus is inside the workpiece. Starting the reverse program in this area requires all movements to be reversed until the stylus is outside the workpiece. The linear path sequence reverse variant is available to make this possible. When a linear path sequence is programmed it must be ensured that the reverse variant number is the same from the first instruction up to the instruction at which the stylus leaves the workpiece.

The number may be in the range from 1-10. This means that a maximum of 10 linear path sequences may be defined in a program.

4.5 Measuring Path

Safety clearance and setup position

The safety clearance describes the distance between the measuring sphere and the measured surface.

Expected and programmed measuring path

This term stands for the path or distance between the measuring sphere and the measured surface.

Actual measuring path

The actual measuring path is twice the programmed measuring path.

Note: The individual specifications are always related to the command value of the measurement.

The following figure illustrates the terms:

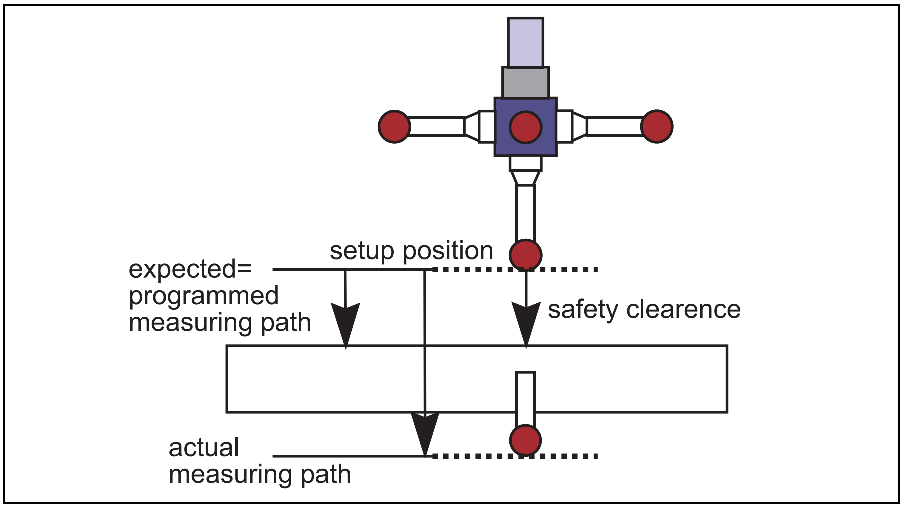


Figure 4-10: Safety clearance

CAUTION

⇒ In order to avoid collisions, the measuring sphere radius must be taken into account when the stylus is moved (except when the MOVE instruction is used). If the PROBE instruction is used for approaching the setup position, the measuring sphere radius is already taken into account in the direction of measurement.

Note: If diameter programming G16 has been selected, it must be remembered that the distance between the stylus and the part is only 0.5 mm when a measuring path of 1 mm has been programmed.

Example: The expected measuring path shall be 1 mm, and diameter programming G6 has been selected. These values require the following measuring path to be programmed:

$$s_{programmed} = s_{expected} * x$$
$$= 1mm * 2 = \underline{\underline{2mm}}$$

$s_{programmed}$: measuring path to be programmed
$s_{expected}$: expected measuring path
x: Variable that refers to the G codes G15 and G16
G15 --> x = 1 G16 --> x = 2

Figure 4-11: Measuring path calculation

4.6 Definition of Terms

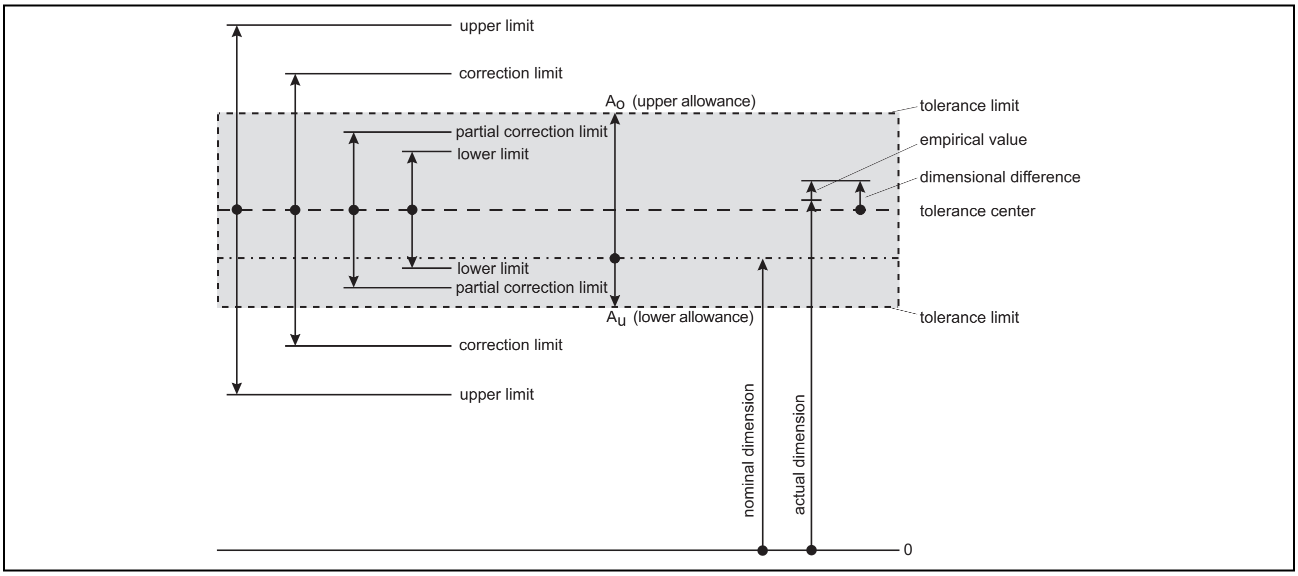


Figure 4-12: Correction terms

Nominal dimension Dimension that is specified in the drawing and to which the allowance specifications A_o and A_u are related.

Actual dimension The actual dimension is the value that is determined by the comparison calculation using the measured values that were gathered by the measuring system during the measuring process on the workpiece.

Upper allowance A_o

Lower allowance A_u

Related to the nominal dimension, upper and lower allowance define the tolerance range in which the actual dimension corrected by the empirical value must lie to satisfy the tolerance requirement. We have:

$$\text{maximum dimension} = \text{nominal dimension} + A_o$$
$$\text{minimum dimension} = \text{nominal dimension} + A_u$$

Upper limit The upper limit is a limit value that is only used for diagnosis purposes. When this value is exceeded there will not be any correction. In this case it can be assumed that the measuring process could not properly be performed due to a gross error in the parameter specification (e.g. incorrect measuring position) or a malfunction in the mechanical system of the stylus.

The cycle is stopped and can only be continued using the reverse program (Q9999). The following message is issued:

‘ ILLEGALLY HIGH DIMENSIONAL DEVIATION ‘

Correction limit The correction limit is also a limit value that is used for diagnosis purposes. When this value is exceeded there will not be any correction. A possible cause of exceeding this limit may be in an excessive tool wear. The dimension is only corrected below the correction limit.

The cycle is stopped and can only be continued using the reverse program (Q9999). The following message is issued:

‘ CHECK TOOL ‘

Partial correction limit A full correction is performed if the dimensional difference exceeds the partial correction limit and is below the correction limit. The correction value corresponds to the full dimensional difference.

There is no full correction in the range between partial correction limit and lower limit.

Lower limit

The lower limit represents an area in which correction is not performed. The deviations (dimensional difference) are statistically distributed in this tolerance band. A specific correction of the machining process would not improve the dimensional accuracy.

The determined dimensional difference is fed to the averaging calculation when correction is applied through averaging.

Empirical value

The empirical value compensates the measured value difference between internal measurement via the measuring system and an external reference measurement on a measuring device. The empirical value is added to the actual value.

Tolerance limit

The tolerance limit is a reference dimension that does not have any influence on the correction value generation. With respect to the tolerance center, the tolerance limit delimits the tolerance field that is defined by A_o and A_u. The comparison with the actual dimension, taking the empirical value into account, yields the information whether or not the workpiece dimensions are inside the required tolerance.

The advance program is interrupted if the measured dimension lies between tolerance limit and correction limit. The following NC message is issued:

[OVERSIZE] (dimensional difference > 0) or [UNDERSIZE] (dimensional difference < 0)

The program can be continued after the fault has been acknowledged.

Tolerance center

With respect to the nominal dimension, the tolerance center is the dimension which is in the middle of the tolerance field that is delimited by A_o and A_u. All tolerance limits are related to the tolerance center and are symmetrical to it.

We have:

$$\text{Tolerance center} = \text{nominal dimension} + (A_o + A_u) \ / \ 2$$

Dimensional difference

The dimensional difference is the calculated difference between the actual value corrected by the empirical value, and the tolerance center. Thus, it theoretically represents the dimension that is to be corrected with respect to the ideal state, the tolerance center.

Dimensional difference = actual dimension + empirical value - tolerance center

Correction strategy

The correction strategy specifies the correction calculation method.

Note: There is a ’0’ in the instruction if averaging is to be used for determining the correction value.
There is a ’1’ in the instruction if percentage correction is to be used for determining the correction value.

Weighting factor

The weighting factor does not have a unit. A weighting factor of 0.8 corresponds to approximately 1.25 (i.e. a percentage correction factor of 125%).

Percentage correction factor

If applicable, the percentage correction factor enters the calculation of the correction value. It specifies the correction value as a percentage of the dimensional difference.

Correction value

The correction value is calculated by the CORRECTION instruction, and is available to the user for further utilization in the data element 13 of the result page

The following equation shows the calculation of the correction value with correction strategy "averaging".

$$\mathrm{Korr.W} = \mathrm{MW_{alt}} - \frac{(\mathrm{MW_{alt}} - \mathrm{Diffm.})}{\mathrm{Wichtf.}}$$

Korr.W	correction value
MW_{alt}	old average value
Diffm.	dimensional difference
Wichtf.	weighting factor

Figure 4-13: Correction value calculation by averaging

Note: The correction value is stored as the old average value in data element 13 of the result page if it is smaller than the lower limit.

The following equation shows the calculation of the correction value with correction strategy "percentage correction".

$$\mathrm{Korr.W} = \mathrm{Diffm.} * \frac{\mathrm{Korr.f}}{100}$$

Korr.W	correction value
Diffm.	dimensional difference
Korr.f.	percentage correction factor

Figure 4-14: Percentage correction value calculation

Dimensional accuracy

The CORRECTION instruction sets variables that are referred to as dimensional accuracy. They specify the quality of the dimensional deviation as a function of the comparison between the amount of the dimensional difference and the tolerance limits.

Dimensional accuracy = 0

Taking the empirical value into account, the determined actual dimension lies inside the tolerance field A_o - A_u. This means that the accuracy that is specified by the tolerance specifications has been reached at the workpiece.

Dimensional accuracy = 1

The dimensional difference lies between tolerance limit and correction limit. Even though the area permitted by the tolerance field A_o - A_u has been *exceeded*, this can be corrected. The cycle is interrupted (Q9998) and the following NC message issued:

[OVERSIZE]

The cycle can be continued.

Dimensional accuracy = 2

The dimensional difference lies between tolerance limit and correction limit. Even though the area permitted by the tolerance field A_o - A_u has been *fallen below*, this can be corrected. The cycle is interrupted (Q9998) and the following NC message issued:

[UNDERSIZE]

The cycle can be continued.

Dimensional accuracy = 3 The dimensional difference lies above the correction limit. Further correction value determination is not possible. The cycle is *interrupted* and can only be continued with the reverse program (Q9999). There is a fatal error in measured data acquisition.

Dimensional accuracy = 0,1,2 Correction value determination can be continued if dimensional accuracy is 0, 1 or 2.

Note: The dimensional accuracy is stored in the data element 11, the old average value in the data element 12, and the correction value in the data element 13 of the result page. Thus, variables are not reserved.

Test points There is no correlation between the individual measured test points. A correlation is only established when the COMPARE instruction and the comparison strategy are used. The entered point number in the PROBE instruction gives the test points a defined position in the point page.

Calibration points Acquiring a test point requires the axis to be calibrated in the corresponding measuring direction. Calibration must be performed once; it may be omitted for the subsequent measurements but should be repeated at regular intervals.

The calculated values are stored in the calibration value page.

Actual values The actual values are always stored as absolute values in the point page. This means that the measured value is available in radius programming in the page, even if diameter programming (G16) has been selected at the lathe.

The same applies to the Stair and Groove comparison strategies. Stair measurement in the X direction, for example, always employs radius programming for determining the height of the stair. Obviously, the Diam comparison strategy is an exception to this rule.

The specified point number in the PROBE instruction gives the individual actual values a defined position in the point page.

The actual value that is produced using a comparison strategy is stored in the result page. The compare number specifies the location of the comparison result in the result page.

Stylus During program execution, the switching contact of the stylus and the connection PIN of the SERCOS drive are automatically written to the base measuring page. This means that up to four different probes can be used in a plant for measuring the workpiece.

5 NC Program Examples

5.1 Calibrating the Probe

CAUTION

⇒ A workpiece can only be measured after the measuring axes for the corresponding direction have been calibrated.

Example 1:

In the following example, the X axis of a milling machine is calibrated for the negative direction. The axes are fed without interpolation and return to the start point.

This cycle is subdivided into four steps:

1. Specification of the base settings.
2. Saving the machine state.
3. Approaching and recording the calibration point, and return to the start point.
4. Restoring the machine state.

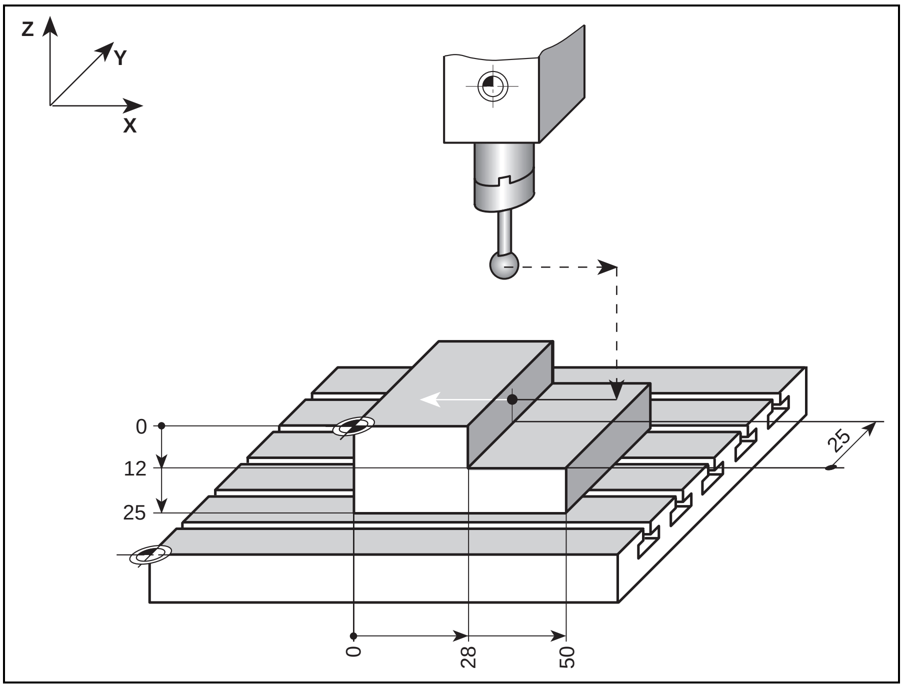


Figure 5-15: Calibration cycle 1

NC block:	Comment:
SETTING(X,Y,Z,17,48,15,25)	Specifying the base settings
SAVE(1,1,1)	Saving the machine state
PROBE(,0,28,25,-6,X,-1,100,2,0)	Moving the axes, acquiring the calibration point and writing it to the calibration value page.
RESTORE()	Restoring the machine state

Figure 5-16: NC program

Example 2: Lathe

In the following example, the X axis of a lathe is calibrated for the negative direction. The axes are fed with interpolation and return to the start point.

This cycle is subdivided into four steps:

1. Specification of the base settings.
2. Saving the machine state.
3. Approaching and recording the calibration point, and return to the start point.
4. Restoring the machine state.

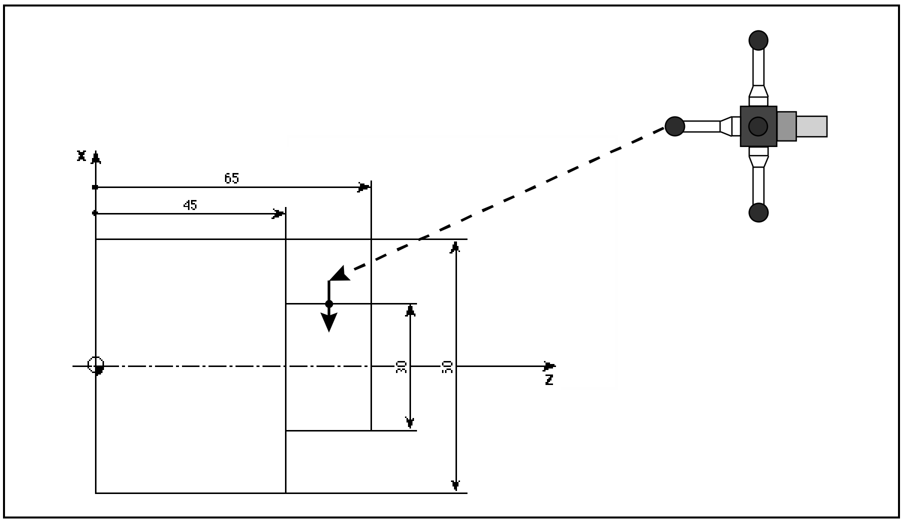


Figure 5-17: Calibration cycle 2

NC block:	Comment:
SETTING(X,Z,,18,48,16,25)	Specifying the base settings
SAVE(1,1,1)	Saving the machine state
PROBE(,0,30,55,,X,-2,100,1,0)	Moving the axes, acquiring the calibration point and writing it to the calibration value page.
RESTORE()	Restoring the machine state

Figure 5-18: NC program

5.2 Measuring the Workpiece

Example 1: Lathe

In the following example, three diameters (X axis) and three faces (Z axis) are measured at a lathe.

This cycle is subdivided into ten steps:

1. Specification of the base settings.
2. Saving the machine state.
3. Two-dimensional approach of the first test point and acquiring the measured value P1(X 64 Z 35)
4. Approaching the second test point according to the positioning logic, and acquiring the measured value P2(X 52 Z 40)
5. Two-dimensional approach of the third test point and acquiring the measured value P3(X 40 Z 50)
6. Approaching the fourth test point according to the positioning logic, and acquiring the measured value P4(X 32 Z 55)
7. Approaching the fifth test point according to the positioning logic, and acquiring the measured value P5(X 24 Z 50)
8. Two-dimensional approach of the sixth test point and acquiring the measured value P6(X 12 Z 30)
9. Positioning the Z axis to Z=60.
10. Restoring the machine state.

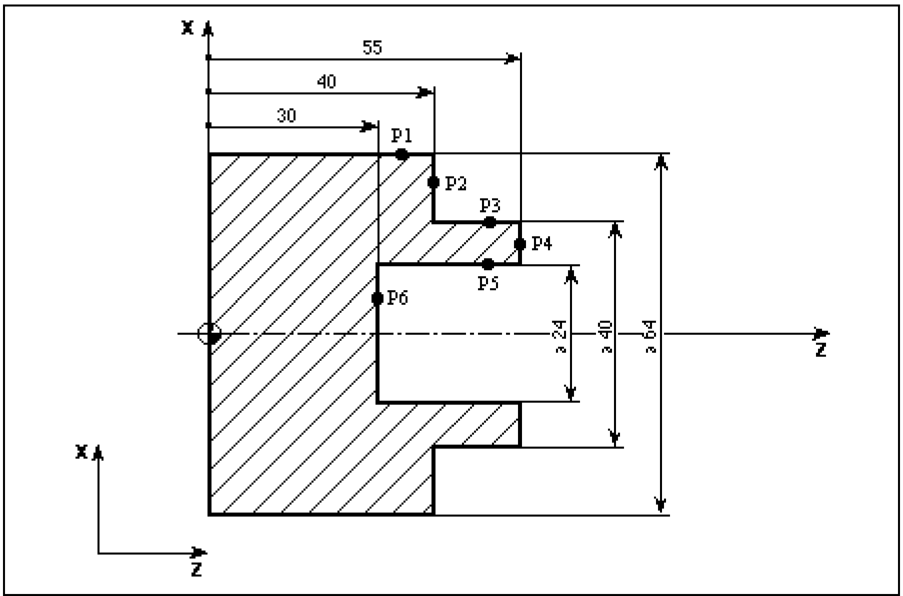


Figure 5-19: Measuring the workpiece, example 1

NC block:	Comment:
SETTING(X,Z,,18,48,16,25)	Specifying the base settings
SAVE(1,1,1)	Saving the machine state
PROBE(1,1,64,35,,X,-2,100,1,3,0)	Moving the axes, acquiring the test point P1 and writing it to the point page.
PROBE(2,1,52,40,,Z,-1,100,1,4,0)	Test point P2
PROBE(3,1,40,50,,X,-2,100,1,3,0)	Test point P3
PROBE(4,1,32,55,,Z,-1,100,1,4,10)	Test point P4
PROBE(5,1,24,50,,X,2,100,1,4,10)	Test point P5
PROBE(6,1,12,30,,Z,-1,100,1,3,10)	Test point P6
G0 Z60	Moving the Z axis away from the collision area
RESTORE()	Restoring the machine state

Figure 5-20: NC program

Example 2: Lathe

In the following example, two diameters (X axis) and three faces (Z axis) are measured at a lathe.

This cycle is subdivided into 13 steps:

1. Specification of the base settings.
2. Saving the machine state.
3. Three-dimensional approach of the first test point and acquiring the measured value P1(X 180 Z 0)
4. Approaching the second test point according to the positioning logic, and acquiring the measured value P2(X 160 Z -20)
5. Three-dimensional approach of the third test point and acquiring the measured value P3(X 130 Z -100)
6. Approaching the fourth test point according to the positioning logic, and acquiring the measured value P4(X 100 Z -110)
7. Three-dimensional approach of the fifth test point and acquiring the measured value P5(X 50 Z -150)
8. Three-dimensional approach of the sixth test point and acquiring the measured value P6(X -50 Z -150)
9. Three-dimensional approach of the seventh test point and acquiring the measured value P7(X -110 Z -100)
10. Approaching the eighth test point according to the positioning logic, and acquiring the measured value P8(X -130 Z -100)
11. Three-dimensional approach of the ninth test point and acquiring the measured value P9(X -160 Z -20)
12. Approaching the tenth test point according to the positioning logic, and acquiring the measured value P10(X -180 Z 0)
13. Restoring the machine state.

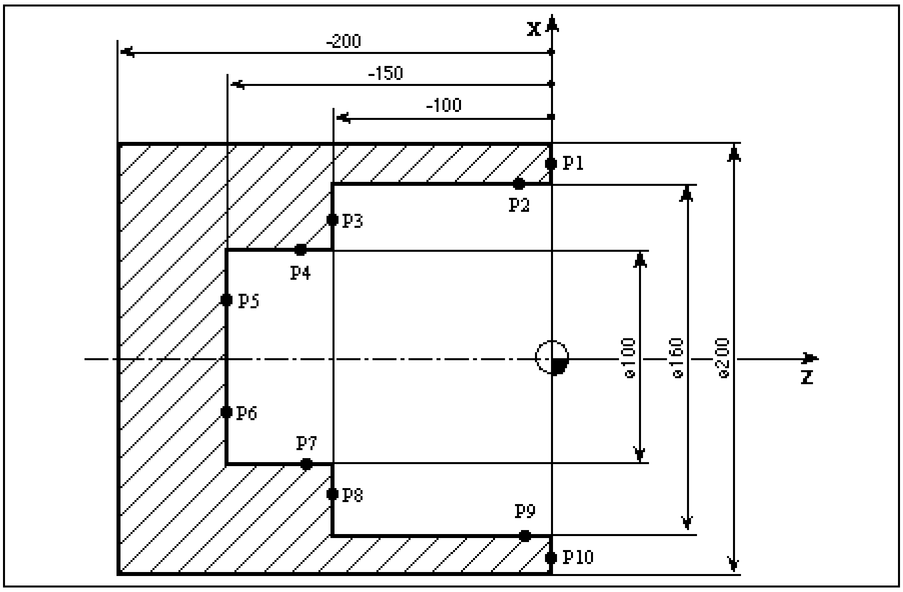


Figure 5-21: Measuring the workpiece, example 2

NC block:	Comment:
SETTING(X,Z,,18,48,16,25)	Specifying the base settings
SAVE(1,1,1)	Saving the machine state
PROBE(1,1,180,0,,Z,-1,100,1,3,0)	Moving the axes, acquiring the test point P1 and writing it to the point page.
PROBE(2,1,160,-20,,X,2,100,1,4,8)	Test point P2
PROBE(3,1,130,-100,,Z,-1,100,1,3,8)	Test point P3
PROBE(4,1,100,-110,,X,2,100,1,4,8)	Test point P4
PROBE(5,1,50,-150,,Z,-1,100,1,3,8)	Test point P5
PROBE(6,1,-50,-150,,Z,-1,100,1,3,8)	Test point P6
PROBE(7,1,-100,-110,,X,-2,100,1,3,8)	Test point P7
PROBE(8,1,-130,-1000,,Z,-1,100,1,4,8)	Test point P8
PROBE(9,1,-160,-20,,X,-2,100,1,3,8)	Test point P9
PROBE(10,1,-180,0,,Z,-1,100,1,4,0)	Test point P10
RESTORE()	Restoring the machine state

Figure 5-22: NC program

5.3 Interpreting the Measured Values

The COMPARE instruction is used for interpreting the test points.

Example

In the following example, the Groove comparison strategy is used for comparing the points P1 and P2.

COMPARE(1,2,1,2)

The comparison result is stored at the following positions of the machine data result page, and is available there for further utilization.

Control variable LV1: Number of the current process.

Control variable LV2: First position.

5.4 Correcting Measured Values

The CORRECTION instruction is available to be used for correcting measured values.

Example

The correction value that results from the previous example is calculated in this example.

CORRECTION(1,0.1,-0.1,0.2,0.14,0.005,1,85,0.06,0.02)

Correction value, dimensional accuracy, and correction strategy are stored at the following positions of the machine data result page, and are available there for further utilization.

Control variable LV1: Number of the current process.

Control variable LV2: First position.

5.5 Including Correction Values for Further Processing

The OTD and TLD functions enable the user to include the correction value in the further machining sequence.

Example

In this example, the correction value is added to the wear register L1 of the tool T5.

TLD(,1,3,,1,11,) =TLD(,1,3,,1,11,) + MTD(105,,1,13)

See NC Programming Instructions for a description of the NC instructions TLD(...) and MTD(...).

5.6 Summary

Example : Lathe

In the following example, one diameter (X axis) and two faces (Z axis) are measured at a lathe. The calculated correction values are added to the wear register of the machining tool T3.

This cycle is subdivided into 15 steps:

1. Specification of the base settings.
2. Saving the machine state.
3. Two-dimensional approach of the first test point and acquiring the measured value P1(X 180 Z -100)
4. Two-dimensional approach of the second test point and acquiring the measured value P2(X 125 Z -10)
5. Approaching the third test point according to the positioning logic, and acquiring the measured value P3(X 115 Z 0)
6. Comparing with P3; comparison strategy „Point“, Compare C1
7. Comparing with P2; comparison strategy „Diam“, C2
8. Comparing with P1 and P2; comparison strategy „Stair“, C3
9. Performing correction value calculation with C1
10. Performing correction value calculation with C2
11. Performing correction value calculation with C3
12. Including correction value of step 9 in calculation with wear register L1 of T3 (Z axis; P3)
13. Including correction value of step 10 in calculation with wear register L2 of T3 (X axis; P2)
14. Check Z axes stair (P1 - P3; step 11.) for dimensional accuracy
15. Restoring the machine state.

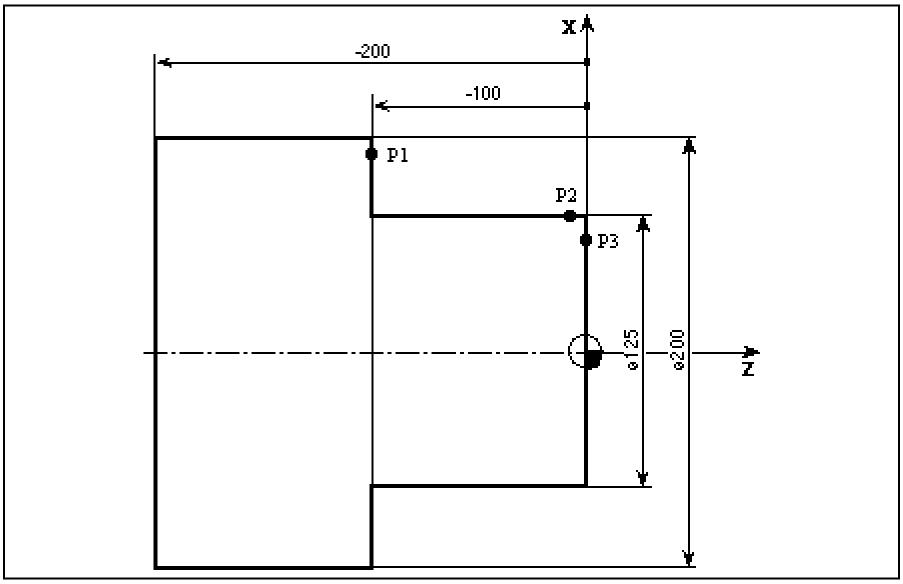


Figure 5-23: Measuring the workpiece, example 3

NC block:	Comment:
SETTING(X,Z,,18,48,16,25)	Specifying the base settings
SAVE(1,1,1)	Saving the machine state
PROBE(1,1,180,-100,,Z,-1,100,1,3,0)	Moving the axes, acquiring the test point P1 and writing it to the point page.
PROBE(2,1,125,-10,,X,-2,100,1,3,0)	Test point P2
PROBE(3,1,115,0,,Z,-1,100,1,4,0)	Test point P3
COMPARE(1,0,3,)	Comparing with P3
COMPARE(2,4,2,)	Comparing with P2
COMPARE(3,1,1,3)	Comparing with P1 and P3
CORRECTION(1,0.01,-0.01,0.12,0.1, 0.001,0,1.1,0.005,0.002)	Performing correction value calculation with C1
CORRECTION(2,0.02,-0.02,0.35,0.28, 0.001,0,1.8,0.01,0.007)	Performing correction value calculation with C2
CORRECTION(3,0.01,-0.01,0.12,0.1, 0.001,0,1.1,0.005,0.002)	Performing correction value calculation with C3
TLD(,1,3,,1,11,) = TLD(,1,3,,1,11,) + MTD(105,,1,13)	Including correction value in calculation with wear register L1 of T3
TLD(,1,3,,1,12,) = TLD(,1,3,,1,12,) + MTD(105,,2,13)	Including correction value in calculation with wear register L2 of T3
@100 = MTD(105,,3,11) - 0 BEQ .FEHLER	Check Z axes stair for dimensional accuracy
RESTORE()	Restoring the machine state

Figure 5-24: NC program

6 Interface Signals Between NC and SPS

6.1 Auxiliary Functions: NC → SPS

Q9992

The auxiliary function Q9992 is issued in the SETTING instruction. This causes the measuring function block to initialize the probe. From now on, measuring is possible.

Q9998

If the amount of the dimensional difference is greater than the amount of the tolerance limit and less than the amount of the correction limit, the CORRECTION instruction issues the auxiliary function Q9998.

The NC program can issue the following messages:

[OVERSIZE] or

[UNDERSIZE]

The auxiliary function Q9998 has been defined as follows, and should be integrated into the SPS program according to the definition:

- *Fault category* 2
- *Message text*

CNC software fault message of TYPE 2

- *Additional text*

The fault has been triggered by programming Q9998 in the NC program. The NC program was stopped for safety reasons.

Please note the additional comments that were issued by the NC program.

Acknowledging the fault by pressing the key provided for this purpose permits the interrupted advance program to be continued after a new advance program start or the home position to be approached by a reverse program start.

Fault category 2

In fault category 2, only a process stop is issued by removing the process enabling signal. Acknowledging the fault by pressing the key provided for this purpose permits the interrupted NC program to be continued after a new advance program start (ADVANCE) or the home position to be approached by a reverse program start (REVERSE).

Q9999

If the amount of the dimensional difference is greater than the amount of the upper limit or greater than the amount of the correction limit, the auxiliary function Q9999 is issued in the measured data monitoring cycle.

If a test point cannot be found or if the probe is displaced even though it is not in the measuring path (event 29 reset), the NC program also issues the auxiliary function Q9999.

The NC program can issue the following messages:

[TEST POINT NOT FOUND],

[ILLEGALLY HIGH DIMENSIONAL DEVIATION] or

[CHECK TOOL]

The auxiliary function Q9999 has been defined as follows, and should be integrated into the SPS program according to the definition:

- *Fault category* 1
- *Message text*

CNC software fault message of TYPE 1

- *Additional text*

The fault has been triggered by programming Q9999 in the NC program. For safety reasons, the NC program can no longer be executed.

Please note the additional comments that were issued by the NC program.

Acknowledging the fault by pressing the key provided for this purpose permits machining to be continued after a reverse program has been triggered by pressing a reverse program start key.

Fault category 1

In fault category 1, only a process stop by removing the process enabling signal and an advance program inhibit are issued.

The process enabling signal is restored after the fault has been acknowledged via the key that is provided for this purpose. Further execution of the advance program is inhibited. This means that the only options are starting a reverse program or moving the system to its home position in manual mode.

Note: Later activation is not permitted as acknowledgment response of these Q functions.

The Q function numbers have invariably been specified. The NC program does not interpret any other Q function number.

6.2 Events: NC ←→ SPS

Event 7

The SPS program sets event 7 when stylus monitoring is active (Event 30 = 1; NC syntax: SE 7) and the probe is displaced.

Event 29

The NC program sets event 29 at the beginning of the MOVE and PROBE instructions and is used for internal initialization of the collision monitoring function (NC syntax: SE 29).

Event 30

If the setup position was approached, the compiler sets event 30, and the system waits until there is an acknowledgment from the SPS program (event 29 = 0). This means that the collision monitoring function is switched off and the measuring path monitoring function is switched on (NC-Syntax: SE 30 and RE 29).

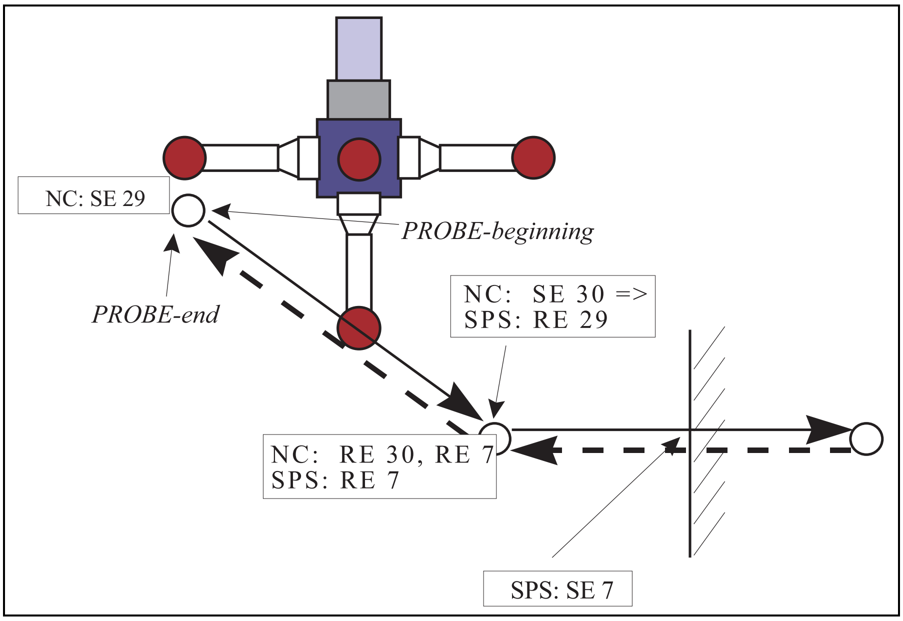


Figure 6-25: Signal exchange (NC<=>SPS) of the probe instruction

CAUTION

⇒ The events may not be used elsewhere when "Fast measurement" is active.

⇒ The event numbers have invariably been specified. The NC program does not interpret any other event numbers.

6.3 Messages: SPS → NC

The SPS program monitors the displacement (collision) of the probe outside the measuring path. This means that the SPS program must provide for the messages to the NC, stopping the drives, and any other conditions.

7 Commissioning Information

7.1 Installation

Setting Up the Machine Data Pages

The machine data pages for „Fast measurement“ must be imported in the menu item „F3 machine data of the main menu (MUI)“.

Relevant machine data pages

- Buffer page
- Stylus page
- Calibration value page
- Point page
- Result page

Entry into the machine data menu item

- Machine data preparation is invoked upon the entry into the menu if there is no machine data in the controller yet.
- The current machine data is invoked upon the entry into the menu if there is machine data in the controller. <CTRL> <F8> Branches to machine data preparation.

Importing the machine data pages

If a machine data directory has not yet been created, a new directory must be created using <F1>. The newly created directory contains the standard Indramat pages in the range between 1 and 99. The base measurement page is at position 90.

If directories with user pages exist, one of these directories may be used for fast measurement.

<F7> is used for zooming into the corresponding directory.

<CTRL> <F2> is used for importing machine data pages here.

The pages for "Fast measurement" are in the „..MT-CNC\MACHDATA“ directory. The pages with the extension .EXP (default selection) are the user pages in English. The pages with the corresponding extension must be imported if a different language is to be used.

z. e.g. .ger for German

The page numbers 101 through 105 have been defined as default setting. However, any other free user page number may be entered during import.

Downloading the pages

The machine data directory must be loaded into the controller after the user pages have been imported.

<F8> is used for branching to the list of directories. <F6> loads the corresponding directory into the controller.

Structure and purpose of the machine data pages (see Machine Data, page 2-11).

Integrating a Function Block into the SPS

The „QMFB1Axx“ function block is available for "Fast measurement". It must be integrated into the SPS program.

Importing the function block

The „QMFB1Axx“ function block can be inserted as a user function block in the SPS programming menu under <Project> <Archive> <Fetch>

The drive on which the user interface has been installed must be selected as the "source".

If <without> has been selected under "Name", the „QMFB1Axx“ function block can be selected for fetching under "File". The subsequent inquiry must be confirmed with <Mixing>.

Next, the FB is imported into the SPS program under <Edit> <Import> <FUNCTION_BLOCK>.

The function block is now available to the SPS program and the user may employ it like any other standard function block.

Description and typical connection of the function block (see SPS Connection 7-2).

Software Option

The „Fast measurement“ function requires the corresponding enabling code to be entered under <Software-Option> in the Setup (MUI main menu, <SHIFT> <F1>). The software option is marked by „SME - Fast measurement“.

The function is not active without this enabling code.

7.2 SPS Connection

A function block is available for the connection to the SPS.

The QMFB1Axx function block performs the following functions:

- Initializing the probe inputs from up to three SERCOS drive controllers.
- Selecting the two probe inputs of the controllers.
- Communication with the measuring NC program using one Q function and three events.
- Monitoring the measuring process for faults.

Thus, only the probe-specific adaptations, fault handling and error display remain to be programmed in the SPS program.

Connection Summary

Measurement

QMFB1Axx

Input description	Type	Input	Output	Type	Output description
0=>Resetting 1=>Block is processed	BOOL	ENABLE	Init_OK_1	BOOL	1st meas. axis prepared for measurement
Clear error and reset block	BOOL	RESET	Init_OK_2	BOOL	2nd meas. axis prepared for measurement
Q function number Read machine data	INT	Q_Nummer	Init_OK_3	BOOL	3rd meas. axis prepared for measurement
Event number Collision monitoring	INT	Koll_EV	QDDS_1	BOOL	Axis 1 real-time control bit
Event number meas. path	INT	Mess_EV	QDDS_2	BOOL	Axis 2 real-time control bit
Event number probe displaced	INT	Touch_EV	QDDS_3	BOOL	Axis 3 real-time control bit
Number of base meas. page	INT	BasisPage	Q_MTst1	BOOL	Activate probe 1
Number of NC process	INT	MessProc	Q_MTst2	BOOL	Activate probe 2
Axis number of 1st M axis; 0= no axis	INT	ACHS_NR_1	Q_MTstOK	BOOL	Ready for measurement
Axis number of 2nd M axis; 0= no axis	INT	ACHS_NR_2	Q_MTstKol	BOOL	Probe collision
Axis number of 3rd M axis; 0= no axis	INT	ACHS_NR_3	Q_MTstKMp	BOOL	Meas. cycle has not found a test point
Probe 1 input ready	BOOL	I_MT_OK1	Q_MTst	BOOL	Probe displaced
Probe 1 input displaced	BOOL	I_MTast1	FEHLER	BOOL	Error detected
Probe 2 input ready	BOOL	I_MT_OK2	FEHLER_NR	INT	Error number
Probe 2 input displaced	BOOL	I_MTast2	AXDaktiv	BOOL	Transfer via AXD channel active
Axis 1 real-time status bit	BOOL	IDDS_1	MTDaktiv	BOOL	Transfer via MTD active
Axis 2 real-time status bit	BOOL	IDDS_2	P_Dat_ovr	BOOL	Process data channel overflow (MTD_WR)
Axis 3 real-time status bit	BOOL	IDDS_3			
Disable communic. via AXD channel	BOOL	AXDdisabl			
Disable communic. MTD	BOOL	MTDdisabl			

Figure 7-26: Overview of the FB QMFB1A00 connections

Functional Sequence - Block Diagram

```
 |
╔══════════╗
║Q_Funkt   ║            Waiting for the "initialize probe" Q function.
╚══════════╝
 |
 +aQ_Fkt
 +<iRESET
┌──────────┐
│SetDaten  │            Reading the measured data from the measuring page and initializing
└──────────┘            the drive controllers accordingly.
 |
 +_Init_OK
 |
┌──────────┐
│Meas.     │            Measuring sequence control is done by the events for collision
└──────────┘            monitoring, probe in measuring path and probe displaced.
 ├────────────>┐
 +Reset        +nQ_Fkt
 |             |
┌──────────┐  ┌──────────┐
│sRESET    │  │Init      │  Resetting the block or new initialization if the NC issues the
└──────────┘  └──────────┘  "initialize probe" Q function.
 |             |
 +fRESET       +iRESET
 |             |
 V             V
Q_Funkt_      SetDaten
 V             V
```

Figure 7-27: Functional sequence - block diagram

Description of the Function Block Inputs and Outputs

Inputs

ENABLE

BOOL

0 = FB is not processes; pending errors are cleared and the FB is reset.

1 = FB is processed

RESET

BOOL

Clears errors and resets the measuring sequence

Q_Nummer

INT

Number of the Q function that triggers reading the initialization values from the machine data.

The input is preset for Q 9992

Koll_EV

INT

Number of the "switch on collision monitoring" event.

The input is preset for EV 29

Mess_EV

INT

Number of the "NC block measuring path active" event.

The input is preset for EV 30

Touch_EV

INT

Number of the "probe is displaced" event.

The input is preset for EV 7

BasisPage

INT

Number of the base measurement page from which the initialization values can be read.

The input is preset to 90

MessProc INT

Number of the NC process that shall be used for measurement.

ACHS_NR_1 INT

Axis number of the 1st measuring axis

0 = Axis does not exist

ACHS_NR_2 INT

Axis number of the 2nd measuring axis

0 = Axis does not exist

ACHS_NR_3 INT

Axis number of the 3rd measuring axis

0 = Axis does not exist

I_MT_OK1 BOOL

Probe 1 ready message

I_MTast1 BOOL

Probe 1 measuring contact.

Since the probe contact is also connected to the drive controller where it causes the position values to be entered, positive or negative probe logic is and must be selected via the initialization in the stylus page.

Note: The probe contact is connected to the controller and to the SPS input. The logic of the employed contacts must always be the same.

I_MT_OK2 BOOL

Probe 2 ready message

I_MTast2 BOOL

Probe 2 measuring contact.

Since the probe contact is also connected to the drive controller where it causes the position values to be entered, positive or negative logic is and must be selected via the initialization in the stylus page.

Note: The probe contact is connected to the controller and to the SPS input. The logic of the employed contacts must always be the same.

IDDS_1 BOOL

Axis 1 real-time status bit (AxxSIDDS).
The measuring function block has configured the drive controller such that the real-time status bit becomes TRUE when the measured value is accepted.

IDDS_2 BOOL

Axis 2 real-time status bit (AxxSIDDS).

The measuring function block has configured the drive controller such that the real-time status bit becomes TRUE when the measured value is accepted.

IDDS_3 BOOL

Axis 3 real-time status bit (AxxSIDDS).

The measuring function block has configured the drive controller such that the real-time status bit becomes TRUE when the measured value is accepted.

AXDdisabl BOOL

Disabling the AXD_WR function. This function is used for initializing the drive controllers.

MTDdisabl BOOL

Disabling the MTD_WR function. This function is used for reading the probe data from the base measurement page.

Outputs

Init_OK_1 BOOL

The 1st measuring axis has been prepared for measurement

Init_OK_2 BOOL

The 2nd measuring axis has been prepared for measurement

Init_OK_3 BOOL

The 3rd measuring axis has been prepared for measurement

QDDS_1 BOOL

Real-time control bit of the first axis that has been initialized for measurement.

The measuring function block initializes the AxxCQDDS interface signal of the drive controller for enabling the acceptance of the measured value.

QDDS_2 BOOL

Real-time control bit of the second axis that has been initialized for measurement.

The measuring function block initializes the AxxCQDDS interface signal of the drive controller for enabling the acceptance of the measured value.

QDDS_3 BOOL

Real-time control bit of the third axis that has been initialized for measurement.

The measuring function block initializes the AxxCQDDS interface signal of the drive controller for enabling the acceptance of the measured value.

Q_MTst1 BOOL

Activates probe 1

The measuring program requests probe 1.

Q_MTst2 BOOL

Activates probe 2

The measuring program requests probe 2.

Q_MTstOK BOOL

The selected probe that has been requested by the measuring program is ready for measurement.

Q_MTstKol BOOL

Probe collision

The probe requested by the measuring program has already been displaced during the approach to the measuring path.

At the same time, the NC program monitors the probe collision and issues Q 9999 in the event of a malfunction.

Note: If the measuring function block sets this signal to TRUE or if the NC issues a Q9999, an NC stop must be triggered and the advance program start must be suppressed until the reverse program is started or the axes have been retracted.

An error message must be issued when the error occurs.

Q_MTstKMp BOOL

Test point not found.

The probe was not displaced up to the end of the measuring path motion block.

The NC program monitors the ‘Test point not found’ error state at a high priority, and issues a Q 9998 in the event of an error.

Note: If the measuring function block sets this signal to TRUE or if the NC issues a Q9998, an NC stop must be triggered and the advance program start must be suppressed until the error is cleared or a reverse program is started.

An error message must be issued when the error occurs.

Q_MTst BOOL

Selected probe has been displaced.

FEHLER BOOL

Error detected.

Note: If the measuring function block sets this signal to TRUE, an NC stop must be triggered and the advance program start must be suppressed until the reverse program is started and the error is cleared.

When the error occurs, an error message must be issued that corresponds to the error number (FEHLER_NR).

FEHLER_NR INT

1	Incorrect parameter value at the measuring function block: No axis specified at function block All function block inputs ACHS_NR_1, ACHS_NR_2 and ACHS_NR_3 have been set to 0.
2	Incorrect parameter value at the measuring function block: Axis number of 1st axis > 32 at function block input ACHS_NR_1
3	Incorrect parameter value at the measuring function block: Axis number of 2nd axis > 32 at function block input ACHS_NR_2
4	Incorrect parameter value at the measuring function block: Axis number of 3rd axis > 32 at function block input ACHS_NR_3
5	Incorrect parameter value at the measuring function block: Axis number of 1st axis < 1 at function block input ACHS_NR_1
6	Incorrect parameter value at the measuring function block: Axis number of 2nd axis < 1 at function block input ACHS_NR_2
7	Incorrect parameter value at the measuring function block: Axis number of 3rd axis < 1 at function block input ACHS_NR_3
10	Execution error in the NC program : Probe has not been initialized (Q9992)
11	Incorrect parameter value in the measuring pages: No axis requested for measurement
12	Execution error in the NC program : No EV29 before EV30
13	Execution error in the NC program : EV measuring path has been set before EV collision monitoring
20	Incorrect parameter value in the measuring pages: 1st axis was requested for measurement but ACHS_NR_1 = 0
21	Incorrect parameter value in the measuring pages: 2nd axis was requested for measurement but ACHS_NR_2 = 0
22	Incorrect parameter value in the measuring pages: 3rd axis was requested for measurement but ACHS_NR_Ł3 = 0
23	Communication problem between NC and SPS : Reading the probe selection from the base measurement page failed
24	Communication problem between NC and SPS : Reading the probe logic from the base measurement page failed
25	Communication problem between NC and SPS : Reading measuring with axis 1 from the base measurement page failed.
26	Communication problem between NC and SPS : Reading measuring with axis 2 from the base measurement page failed.

27	Communication problem between NC and SPS : Reading measuring with axis 3 from the base measurement page failed.
28	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_303 axis 1
29	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_303 axis 2
30	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_303 axis 3
31	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_307 axis 1
32	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_307 axis 2
33	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_307 axis 3
34	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_169 axis 1
35	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_169 axis 2
36	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_169 axis 3
37	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_170 axis 1
38	Communication problem between NC and SPS : Error in writing SERCOS data item S_0_170 axis 2
40	Incorrect parameter value in the measuring pages or SPS: Error in setting the axis designation parameters; or setting the parameter values of a non-existent axis.

Figure 7-28: Description of the error numbers at the function block's FEHLER_NR output

AXDaktiv BOOL

AXD_WR function is active

The SERCOS data channel for writing drive data is used by the XD_WR function.

MTDaktiv BOOL

MTD_RD function is active

The MTD_RD function employs the process data channel for reading machine data pages.

P_Dat_ovr BOOL

Process data channel overflow (MTD_RD)

All eight process data channels to the NC process are occupied. Currently, the measuring function block cannot read data from the machine data.

Typical Application

1
```
|(*Generation of probe ready message slightly delayedsince the Renishaw  *)|
|(*Probe also closed the meas. contact when the ready message is issued. *)|
|           T_MESSOK                                                       |
|           ┌────────────────────┐                                         |
|           |TON                 |                                         |
|I_MESSOK   |                    |                                M_MESSOK1|
├┤ ├────────┤IN_              Q_ ├────────────────────────────────( )──────┤
|   T#100ms─┤PT_             ET_ ├                                         |
|           └────────────────────┘                                         |
T_MESSOK.................... Probe ready time delay ................ .......... TON
I_MESSOK.................... Probe OK.............................. %I11.3.6.. BOOL
M_MESSOK1................... Probe ready........................... .......... BOOL
T#100ms..................... ...................................... .......... TIME
```

2
```
|(***********************************************************************)
|(*********************  MESSEN00 function block***********************)
|(***********************************************************************)
|(*The FB MESSEN00 provides the following functions:                     *)
|(*1. A Q function (preassigned with 9992 in the FB) triggers reading the *)
|(*   probe data froma machine data page (BasisPage preassigned with 100) *)
|(*                                                                       *)
|(*2. The NC program can use an event (preassigned with EV30) for acti-   *)
|(*   vating the probe collision monitoring function after 1.             *)
|(*3. If the NC sets the measuring path event next, probe collision moni- *)
|(*   toring functin is switched off, the probe collision monitoring      *)
|(*   function reset for acknowledgement, and the measuring inputs at the *)
|(*   drives are enabled.                                                 *)
|                         Measuring                                        |
|                        ┌────────────────────┐                            |
|                        |QMFB1Axx            |                            |
|TRUE                    |                    |                  M_MESS_X  |
├┤ ├─────────────────────┤ENABLE    Init_OK_1 ├──────────────────( )───────┤
|iCTRLRES   P00S.STOP    |                    |                  M_MESS_Y  |
├┤ ├────────┬┤ ├────────┬┤RESET     Init_OK_2 ├──────────────────( )───────┤
|           |P00S.RUN   ||                    |                  M_MESS_Z  |
|           └┤/├────────┘|          Init_OK_3 ├──────────────────( )───────┤
|                        |                    |                  A01C.QDDS |
|                       ─┤Q_Nummer     QDDS_1 ├──────────────────( )───────┤
|                        |                    |                  A02C.QDDS |
|                       ─┤Koll_EV      QDDS_2 ├──────────────────( )───────┤
|                        |                    |                  A03C.QDDS |
|                       ─┤Mess_EV      QDDS_3 ├──────────────────( )───────┤
|                        |                    |                  M_MESSAK1 |
|                       ─┤Touch_EV    Q_MTst1 ├──────────────────( )───────┤
|                       ─┤BasisPage   Q_MTst2 ├                            |
|                        |                    |                  M_MTstOK  |
|                       ─┤MessProc   Q_MTstOK ├──────────────────( )───────┤
|                        |                    |                  M_MTstKol |
|                      1─┤ACHS_NR_1 Q_MTstKol ├──────────────────( )───────┤
|                        |                    |                  M_MTstKMp |
|                      2─┤ACHS_NR_2 Q_MTstKMp ├──────────────────( )───────┤
|                      3─┤ACHS_NR_3    Q_MTst ├                            |
|M_MESSOK1               |                    |                  MesFbFlt  |
├┤ ├─────────────────────┤I_MT_OK1     FEHLER ├──────────────────( )───────┤
|I_MESSTAS               |                    |                            |
├┤ ├─────────────────────┤I_MTast1  FEHLER_NR ├─MessFltNr                  |
|                       ─┤I_MT_OK2   AXDaktiv ├                            |
|                       ─┤I_MTast2   MTDaktiv ├                            |
|A01S.IDDS               |                    |                            |
├┤ ├─────────────────────┤IDDS_1    P_Dat_ovr ├                            |
|A02S.IDDS               |                    |                            |
├┤ ├─────────────────────┤IDDS_2              |                            |
|A03S.IDDS               |                    |                            |
├┤ ├─────────────────────┤IDDS_3              |                            |
|                       ─┤AXDdisabl           |                            |
|                       ─┤MTDdisabl           |                            |
|                        └────────────────────┘                            |
Measuring................... New meas. FB 14.1.98.................. .......... QMFB1A00
M_MESS_X.................... Measuring using axis X................ .......... BOOL
iCTRLRES.................... MI CONTROL RESET...................... .......... BOOL
P00S.STOP................... Program stopped....................... .......... BOOL
M_MESS_Y.................... Measuring using axis Y................ .......... BOOL
P00S.RUN.................... Block active.......................... .......... BOOL
M_MESS_Z.................... Measuring using axis Z................ .......... BOOL
A01C.QDDS................... Output to DDS......................... .......... BOOL
A02C.QDDS................... Output to DDS......................... .......... BOOL
A03C.QDDS................... Output to DDS......................... .......... BOOL
M_MESSAK1................... Activate flag probe 1................. .......... BOOL
M_MEstOK1................... Probe ready........................... .......... BOOL
1........................... ...................................... .......... ANY_INT
M_MTstKol................... Probe collision....................... .......... BOOL
```

```
2............................ ........................................ .......... ANY_INT
M_MTstKMp.................... Error, no test point found............. .......... BOOL
3............................ ........................................ .......... ANY_INT
M_MESSOK1.................... Probe ready............................ .......... BOOL
MesFbFlt..................... Error message meas. FB................. .......... BOOL
I_MESSTAS.................... PROBE INPUT............................ %I11.3.5.. BOOL
MessFltNr.................... Error number of meas. FB............... .......... INT
A01S.IDDS.................... Input to DDS........................... .......... BOOL
A02S.IDDS.................... Input to DDS........................... .......... BOOL
A03S.IDDS.................... Input to DDS........................... .......... BOOL
```

```
3     |(***********************************************************************)
      |(************************   Adaptation to probe  ************************)
      |(***********************************************************************)
      |(*RENISHAW :*)                                                            |
      |(*The probe requires an impulse for activation. Switching off the probe  *)
      |(*cannot be influenced and is done automatically after a certain time.   *)
      |(*The end of this time and thus the de-activation of the probe is indica- *)
      |(*ted by the I_MESSTAST and I_MESSOK tripping at the same time. The probe *)
      |(*can be switched on again after 5 sec. The axes are inhibited during    *)
      |(*this waiting time (with AM_schmierxC.MHOLD).                           *)
      |                                                                          |
      |(*Activating the probe by an impulse          *)                          |
      |                      T_MESSAKT                                           |
      |                     +-------------------+                                |
      |                     |TP                 |                                |
      |M_MESSAK1  M_MESSERR |                   |                       Q_MESSAKT|
      |-| |--------| |------|IN_              Q_|-----------------------( )------|
      |I_MESSOK  |          |                   |                                |
      |-| |------+          |               ET_|-                                |
      |           T#15ms----|PT_                |                                |
      |                     +-------------------+                                |
T_MESSAKT.................... Switch on probe impulse time........... .......... TP
M_MESSAK1.................... Activate flag probe 1.................. .......... BOOL
M_MESSERR.................... PROBE ERROR............................ .......... BOOL
Q_MESSAKT.................... ACTIVATE PROBE......................... %Q10.0.1.. BOOL
I_MESSOK..................... Probe OK............................... %I11.3.6.. BOOL
T#15ms....................... ........................................ .......... TIME
```

```
4     |(*5 sec waiting time when probe time has elapsed*)              |
      |                                  T_MESSERR                               |
      |                                 +-------------------+                    |
      |                                 |TON                |                    |
      |M_MESSAK1  M_MESSERR  M_MESSOK1  |                   |           M_MESSERR|
      |-| |--------|/|--------|/|-------|IN_              Q_|-----------( )------|
      |                         T#5s----|PT_             ET_|-                   |
      |                                 +-------------------+                    |
T_MESSERR.................... Probe error recovery time.............. .......... TON
M_MESSAK1.................... Activate flag probe 1.................. .......... BOOL
M_MESSERR.................... PROBE ERROR............................ .......... BOOL
M_MESSOK1.................... Probe ready............................ .......... BOOL
M_MESSERR.................... PROBE ERROR............................ .......... BOOL
T#5s......................... ........................................ .......... TIME
```

```
5     |(***********************************************************************)
      |(************************** Error evaluation ***************************)
      |(***********************************************************************)
      |(*Error response to Q9999 : no process enable signal until error deletion*)|
      |(*                           and start of reverse program*)               |
      |           +---------+                                                    |
      |           |Q_FKT    |                                         M_Q9999    |
      |-----------|ACTIVE   |-----------------------------------------(S)--------|
      |  MessProc-|PROC     |                                                    |
      |      9999-|NR       |                                                    |
      |           +---------+                                                    |
Q_FKT........................ ........................................ .......... Q_FKT
M_Q9999...................... Probe program error message type 1 ..... .......... BOOL
MessProc..................... Measuring cycles process number........ .......... INT
9999......................... ........................................ .......... ANY_INT
```

```
6     |(*Error response to Q9998 : No process enable signal until error deletion*)|
      |(*                          and start of advance or reverse program*)     |
      |           +---------+                                                    |
      |           |Q_FKT    |                                         M_Q9998    |
      |-----------|ACTIVE   |-----------------------------------------(S)--------|
      |  MessProc-|PROC     |                                                    |
      |      9998-|NR       |                                                    |
      |           +---------+                                                    |
Q_FKT........................ ........................................ .......... Q_FKT
M_Q9998...................... Probe program error message type 2 ..... .......... BOOL
MessProc..................... Measuring cycles process number........ .......... INT
9998......................... ........................................ .......... ANY_INT
```

```
7     |(*Suppress collision monitoring when PrgRev or JOG is active*)          |
      |P00S.REV                                                        M_MTstKol|
      ├┤ ├──────────┬───────────────────────────────────────────────────(R)──────┤
      |M_S_JOG      |                                                          |
      ├┤ ├──────────┘                                                          |
      P00S.REV.................... Reverse program active................. .......... BOOL
      M_MTstKol................... Probe collision........................ .......... BOOL
      M_S_JOG..................... Group message axes moved manually....... .......... BOOL

8     |(*Start advance prog. and set programlock if collision or the auxiliary*) |
      |(*functions Q9999 or Q9998 are set by the NC.*)                         |
      |M_MTstKol                                                       M_ADSPERR|
      ├┤ ├──────────┬──────────────────────────────────────────────────┬(S)──────┤
      |MesFbFlt     |                                                  |M_PRSPERR|
      ├┤ ├──────────┤                                                  └(S)──────┤
      |M_Q9999      |                                                          |
      ├┤ ├──────────┤                                                          |
      |M_Q9998      |                                                          |
      ├┤ ├──────────┘                                                          |
      M_MTstKol................... Probe collision........................ .......... BOOL
      M_ADSPERR................... LOCK PROGRAM ADVANCE................... .......... BOOL
      MesFbFlt.................... Error message meas. FB................. .......... BOOL
      M_PRSPERR................... LOCK PROCESS........................... .......... BOOL
      M_Q9999..................... Probe program error message type 1 ..... .......... BOOL
      M_Q9998..................... Probe program error message type 2 ..... .......... BOOL

9     |(*Acknowledging the auxiliary function only if reverse program becomes active *)   |
      |            ┌─────────┐                                                 |
      |M_Q9999     |Q_FKT_Q  |                                         M_schmier|
      ├┤/├─────────┤QUIT     ├─────────────────────────────────────────( )──────┤
      |   MessProc─┤PROC     |                                                 |
      |       9999─┤NR       |                                                 |
      |            └─────────┘                                                 |
      M_Q9999..................... Probe program error message type 1 ..... .......... BOOL
      Q_FKT_Q..................... ....................................... .......... Q_FKT_Q
      M_schmier................... Scratch flag........................... .......... BOOL
      MessProc.................... Measuring cycles process number........ .......... INT
      9999........................ ....................................... .......... ANY_INT

10    |P00C.REV   M_Q9999                                              M_ADSPERR|
      ├┤ ├─────────┤ ├─────────────────────────────────────────────────┬(R)──────┤
      |                                                                |M_Q9999  |
      |                                                                ├(R)──────┤
      |                                                                |M_PRSPERR|
      |                                                                └(R)──────┤
      P00C.REV.................... Reverse program start.................. .......... BOOL
      M_Q9999..................... Probe program error message type 1 ..... .......... BOOL
      M_ADSPERR................... LOCK PROGRAM ADVANCE................... .......... BOOL
      M_Q9999..................... Probe program error message type 1 ..... .......... BOOL
      M_PRSPERR................... LOCK PROCESS........................... .......... BOOL

11    |(*Acknowledging the auxiliary function only if reverse program becomes active, *)  |
      |(*clear error, CTRL_Reset or JOG becomes active.*)                      |
      |            ┌─────────┐                                                 |
      |M_Q9998     |Q_FKT_Q  |                                         M_schmier|
      ├┤/├─────────┤QUIT     ├─────────────────────────────────────────( )──────┤
      |   MessProc─┤PROC     |                                                 |
      |       9998─┤NR       |                                                 |
      |            └─────────┘                                                 |
      M_Q9998..................... Probe program error message type 2 ..... .......... BOOL
      Q_FKT_Q..................... ....................................... .......... Q_FKT_Q
      M_schmier................... Scratch flag........................... .......... BOOL
      MessProc.................... Measuring cycles process number........ .......... INT
      9998........................ ....................................... .......... ANY_INT

12    |M_S_JOG    M_Q9998                                              M_Q9998  |
      ├┤ ├──────────┬┤ ├───────────────────────────────────────────────┬(R)──────┤
      |P00S.REV     |                                                  |M_ADSPERR|
      ├┤ ├──────────┤                                                  └(R)──────┤
      |iCLRERR      |                                                          |
      ├┤ ├──────────┤                                                          |
      |iCTRLRES     |                                                          |
      ├┤ ├──────────┘                                                          |
      M_S_JOG..................... Group message axes moved manually....... .......... BOOL
      M_Q9998..................... Probe program error message type 2 ..... .......... BOOL
      M_Q9998..................... Probe program error message type 2 ..... .......... BOOL
      P00S.REV.................... Reverse program active................. .......... BOOL
      M_ADSPERR................... LOCK PROGRAM ADVANCE................... .......... BOOL
      iCLRERR..................... MI CLEAR ERROR......................... .......... BOOL
      iCTRLRES.................... MI CONTROL RESET....................... .......... BOOL
```

```
13   (**********************************************************************)
     (*Output of meas. FB error messages 1-13 with MSG-WR to the CNC :      *)
     (**********************************************************************)
     (*|0206\#Error message @ from meas. FB (expl. add. text)\O             *)
     (*meas. FB error message : @                                           *)
     (* = 1  : No axis specified at function block                          *)
     (* = 2  : Axis number of X axis greater than 20                        *)
     (* = 3  : Axis number of Y axis greater than 20                        *)
     (* = 4  : Axis number of Z axis greater than 20                        *)
     (* = 5  : Axis number of X axis less than 1                            *)
     (* = 6  : Axis number of Y axis less than 1                            *)
     (* = 7  : Axis number of Z axis less than 1                            *)
     (* = 10 : Execution error; probe not initialized (Q9992)               *)
     (* = 11 : No axis requested for measurement                            *)
     (* = 12 : No EV29 before EV30                                          *)
     (* = 13 : EV measuring path set before EV collision monitoring         *)
     (**********************************************************************)
    |          ┌────────┐                                                   |
    |          |<       | MesFbFlt    ┌MSG_WR_N┐                  M_schmier|
    | MessFltNr┤        ├─┤ ├─────────┤WRITE   ├──────────────────────( )─────|
    |        14┤        |             |        |                            |
    |          └────────┘             |        |                            |
    |                               0─┤PROC    |                            |
    |                             206─┤NR      |                            |
    |                       MessFltNr─┤INFO    |                            |
    |                                 └────────┘                            |
    MessFltNr.................. Error number of meas. FB.............. .......... INT
    MesFbFlt................... Error message meas. FB................ .......... BOOL
    MSG_WR_N................... ...................................... .......... MSG_WR_N
    M_schmier.................. Scratch flag.......................... .......... BOOL
    14......................... ...................................... .......... ANY_INT
    0.......................... ...................................... .......... ANY_INT
    206........................ ...................................... .......... ANY_INT
    MessFltNr.................. Error number of meas. FB.............. .......... INT

14   (**********************************************************************)
     (*Output of meas. FB error messages 14-27 with MSG-WR to the CNC :     *)
     (**********************************************************************)
     (*|0207\#Error message @ from measuring FB\O                           *)
     (*Meas. FB error number : @                                            *)
     (* = 20 : X axis has been requested for measurement but ACHS_NR_X = 0  *)
     (* = 21 : Y axis has been requested for measurement but ACHS_NR_Y = 0  *)
     (* = 22 : Z axis has been requested for measurement but ACHS_NR_Z = 0  *)
     (* = 23 : Reading probe selection from machine data failed             *)
     (* = 24 : Reading probe logic from machine data failed                 *)
     (* = 25 : Reading measurement using axis 1 from machine data failed    *)
     (* = 26 : Reading measurement using axis 2 from machine data failed    *)
     (* = 27 : Reading measurement using axis 3 from machine data failed    *)
     (**********************************************************************)
    |          ┌────────┐                                                   |
    |          |<       |                                         M_schmier|
    | MessFltNr┤        ├─────────────────────────────────────────────( )─────|
    |        28┤        |                                                   |
    |          └────────┘                                                   |
    MessFltNr.................. Error number of meas. FB.............. .......... INT
    M_schmier.................. Scratch flag.......................... .......... BOOL
    28......................... ...................................... .......... ANY_INT

15  |          ┌────────┐                                                   |
    |          |>       | M_schmier                               M_schmier|
    | MessFltNr┤        ├─┤ ├─────────────────────────────────────────( )─────|
    |        13┤        |                                                   |
    |          └────────┘                                                   |
    MessFltNr.................. Error number of meas. FB.............. .......... INT
    M_schmier.................. Scratch flag.......................... .......... BOOL
    M_schmier.................. Scratch flag.......................... .......... BOOL
    13......................... ...................................... .......... ANY_INT

16  |                      ┌────────┐                                       |
    |M_schmier  MesFbFlt   |MSG_WR_N|                             M_schmier|
    ┤ ├────────┤ ├─────────┤WRITE   ├─────────────────────────────────( )─────|
    |                    0─┤PROC    |                                       |
    |                  207─┤NR      |                                       |
    |            MessFltNr─┤INFO    |                                       |
    |                      └────────┘                                       |
    M_schmier.................. Scratch flag.......................... .......... BOOL
    MesFbFlt................... Error message meas. FB................ .......... BOOL
    MSG_WR_N................... ...................................... .......... MSG_WR_N
    M_schmier.................. Scratch flag.......................... .......... BOOL
    0.......................... ...................................... .......... ANY_INT
    207........................ ...................................... .......... ANY_INT
    MessFltNr.................. Error number of meas. FB.............. .......... INT
```

```
17  |(************************************************************************)
    |(*Output of meas. FB error messages from 27 with MSG-WR to the CNC :     *)
    |(************************************************************************)
    |(*|0208\#Error message @ from measuring FB\O                             *)
    |(*meas. FB error message : @                                             *)
    |(* = 28 : Error in writing SERCOS data item S_0_303 axis 1               *)
    |(* = 29 : Error in writing SERCOS data item S_0_303 axis 2               *)
    |(* = 30 : Error in writing SERCOS data item S_0_303 axis 3               *)
    |(* = 31 : Error in writing SERCOS data item S_0_307 axis 1               *)
    |(* = 32 : Error in writing SERCOS data item S_0_307 axis 2               *)
    |(* = 33 : Error in writing SERCOS data item S_0_307 axis 3               *)
    |(* = 34 : Error in writing SERCOS data item S_0_169 axis 1               *)
    |(* = 35 : Error in writing SERCOS data item S_0_169 axis 2               *)
    |(* = 36 : Error in writing SERCOS data item S_0_169 axis 3               *)
    |(* = 37 : Error in writing SERCOS data item S_0_170 axis 1               *)
    |(* = 38 : Error in writing SERCOS data item S_0_170 axis 2               *)
    |(* = 40 : Error in setting axis designation parameter value              *)
    |(************************************************************************)
    |                                                                          |
    |          |>       |  MesFbFlt  |MSG_WR_N|                       M_schmier|
    | MessFltNr-|        |--| |-------|WRITE   |-----------------------( )------|
    |        27-|        |            |        |                                |
    |                                 |        |                                |
    |                               0-|PROC    |                                |
    |                             208-|NR      |                                |
    |                       MessFltNr-|INFO    |                                |
    |                                                                          |
   MessFltNr.................... Error number of meas. FB............... .......... INT
   MesFbFlt..................... Error message meas. FB................. .......... BOOL
   MSG_WR_N..................... ....................................... .......... MSG_WR_N
   M_schmier.................... Scratch flag........................... .......... BOOL
   27........................... ....................................... .......... ANY_INT
   0............................ ....................................... .......... ANY_INT
   208.......................... ....................................... .......... ANY_INT
   MessFltNr.................... Error number of meas. FB............... .......... INT

18  |(************************************************************************)
    |(*Error message output if NC outputs the Q function 9999 :               *)
    |(************************************************************************)
    |(*|0205\#CNC program error message type 1\O                              *)
    |(*                                                                       *)
    |(*                                                                       *)
    |(*                                                                       *)
    |(*        Error message by programming Q9999 in the NC program           *)
    |(*                                                                       *)
    |(*      For safety reasons, the NC program can no longer be executed     *)
    |(*                                                                       *)
    |(*               Note the comments from the NC program                   *)
    |(*                                                                       *)
    |(*          After the <CLEAR-ERROR> key has been pressed, <REVERSE>      *)
    |(*                     can be used to continue                           *)
    |(************************************************************************)
    |                                                                          |
    |M_Q9999     |MSG_WR  |                                         M_schmier|
    |-| |--------|WRITE   |-----------------------------------------( )------|
    |          0-|PROC    |                                                   |
    |        205-|NR      |                                                   |
    |                                                                          |
   M_Q9999...................... Probe program error message type 1 ..... .......... BOOL
   MSG_WR....................... ....................................... .......... MSG_WR
   M_schmier.................... Scratch flag........................... .......... BOOL
   0............................ ....................................... .......... ANY_INT
   205.......................... ....................................... .......... ANY_INT
```

```
19  |(**********************************************************************)
    |(*Error message output if NC outputs the Q function 9998 :             *)
    |(**********************************************************************)
    |(*|0204\#CNC program error message type 2\O                            *)
    |(*                                                                     *)
    |(*                                                                     *)
    |(*                                                                     *)
    |(*        Error generation by programming Q9998 in the NC program      *)
    |(*                                                                     *)
    |(* For safety reasons, the NC program can no longer be executed        *)
    |(*                                                                     *)
    |(*              Note the comments from the NC program                  *)
    |(*                                                                     *)
    |(*        After the <CLEAR-ERROR> key has been pressed, <ADVANCE> and  *)
    |(*                     <REVERSE> canbe used to continue                *)
    |(**********************************************************************)
    |            ┌────────┐                                                 |
    |M_Q9998     |MSG_WR  |                                       M_schmier|
    ├┤ ├─────────┤WRITE   ├───────────────────────────────────────( )──────┤
    |          0─┤PROC    |                                                 |
    |        204─┤NR      |                                                 |
    |            └────────┘                                                 |
    M_Q9998...................... Probe program error message type 2 ..... .......... BOOL
    MSG_WR....................... ....................................... .......... MSG_WR
    M_schmier.................... Scratch flag........................... .......... BOOL
    0............................ ....................................... .......... ANY_INT
    204.......................... ....................................... .......... ANY_INT

20  |(*Error response to stylus displacement during startup :              *)
    |(*Evaluate probe 1*)                                                   |
    |M_MESSAK1  M_MTstKol  M_KollFL                               M_WACH1  |
    ├┤ ├────────┤ ├────────┤/├────────────────────────────────────(S)──────┤
    M_MESSAK1.................... Activate flag probe 1.................. .......... BOOL
    M_MTstKol.................... Probe collision........................ .......... BOOL
    M_KollFL..................... Edge flag probe collision.............. .......... BOOL
    M_WACH1...................... Probe monitoring 1 -> MSG 203.......... .......... BOOL

21  |(*Evaluate probe 2*)                                                   |
    |M_MESSAK2  M_MTstKol  M_KollFL                               M_WACH2  |
    ├┤ ├────────┤ ├────────┤/├────────────────────────────────────(S)──────┤
    M_MESSAK2.................... Activate flag probe 2.................. .......... BOOL
    M_MTstKol.................... Probe collision........................ .......... BOOL
    M_KollFL..................... Edge flag probe collision.............. .......... BOOL
    M_WACH2...................... Probe monitoring 2 -> MSG 202.......... .......... BOOL

22  |(*Edge evaluation probe collision*)                                    |
    |M_MTstKol  P00S.REV   M_S_JOG                                M_KollFL |
    ├┤ ├────────┤/├────────┤/├────────────────────────────────────( )──────┤
    M_MTstKol.................... Probe collision........................ .......... BOOL
    P00S.REV..................... Reverse program active................. .......... BOOL
    M_S_JOG...................... Group message axes moved manually...... .......... BOOL
    M_KollFL..................... Edge flag probe collision.............. .......... BOOL

23  |(*Suppress error message if :*)                                        |
    |(*Axes are moved manually in jog mode or a reverse program*)           |
    |(*has been started.*)                                                  |
    |M_S_JOG                                                      M_WACH1  |
    ├┤ ├──────────┬──────────────────────────────────────────────┬(R)──────┤
    |P00S.REV     |                                              |M_WACH2  |
    ├┤ ├──────────┘                                              └(R)──────┤
    M_S_JOG...................... Group message axes moved manually...... .......... BOOL
    M_WACH1...................... Probe monitoring 1 -> MSG 203.......... .......... BOOL
    P00S.REV..................... Reverse program active................. .......... BOOL
    M_WACH2...................... Probe monitoring 2 -> MSG 202.......... .......... BOOL

24  |M_WACH1                                                      M_PRSPERR|
    ├┤ ├──────────┬──────────────────────────────────────────────┬(S)──────┤
    |M_WACH2      |                                              |M_ADSPERR|
    ├┤ ├──────────┘                                              └(S)──────┤
    M_WACH1...................... Probe monitoring 1 -> MSG 203.......... .......... BOOL
    M_PRSPERR.................... LOCK PROCESS........................... .......... BOOL
    M_WACH2...................... Probe monitoring 2 -> MSG 202.......... .......... BOOL
    M_ADSPERR.................... LOCK PROGRAM ADVANCE................... .......... BOOL
```

```
25  |(*Disable axes if probe is not ready*)                               |
    |M_S_JOG    P00S.REV   M_MESSOK1  M_MESSAK1                  A01C.MHOLD
    ├┤/├────────┤/├────────┤/├────────┤ ├────────┬───────────────────┬(S)──────┤
    |M_MTstKol                                   |                   |A02C.MHOLD
    ├┤ ├─────────────────────────────────────────┘                   ├(S)──────┤
    |                                                                |A03C.MHOLD
    |                                                                └(S)──────┤

    M_S_JOG..................... Group message axes moved manually....... .......... BOOL
    P00S.REV.................... Reverse program active................. .......... BOOL
    M_MESSOK1................... Probe ready............................ .......... BOOL
    M_MESSAK1................... Activate flag probe 1.................. .......... BOOL
    A01C.MHOLD.................. Motion hold............................ .......... BOOL
    M_MTstKol................... Probe collision........................ .......... BOOL
    A02C.MHOLD.................. Motion hold............................ .......... BOOL
    A03C.MHOLD.................. Motion hold............................ .......... BOOL
```

```
26  |(*Generating group flag for axis jogging*)                           |
    |IJGPOS_X                                                    M_S_JOG  |
    ├┤ ├─────────┬───────────────────────────────────────────────( )──────┤
    |IJGPOS_X    |                                                        |
    ├┤ ├─────────┤                                                        |
    |IJGNEG_X    |                                                        |
    ├┤ ├─────────┤                                                        |
    |IJGPOS_Y    |                                                        |
    ├┤ ├─────────┤                                                        |
    |IJGNEG_Y    |                                                        |
    ├┤ ├─────────┤                                                        |
    |IJGPOS_Z    |                                                        |
    ├┤ ├─────────┤                                                        |
    |IJGNEG_Z    |                                                        |
    ├┤ ├─────────┤                                                        |
    |ISPDLPOS    |                                                        |
    ├┤ ├─────────┤                                                        |
    |ISPDLNEG    |                                                        |
    ├┤ ├─────────┘                                                        |
    IJGPOS_X.................... PB JOG POSITIV AXIS X.................. %I201.2.5. BOOL
    M_S_JOG..................... Group message axes moved manually....... .......... BOOL
    IJGPOS_X.................... PB JOG POSITIV AXIS X.................. %I201.2.5. BOOL
    IJGNEG_X.................... PB JOG NEGATIV AXIS X.................. %I201.2.3. BOOL
    IJGPOS_Y.................... PB JOG POSITIV AXIS Y.................. %I201.2.1. BOOL
    IJGNEG_Y.................... PB JOG NEGATIV AXIS Y.................. %I201.2.7. BOOL
    IJGPOS_Z.................... PB JOG POSITIV AXIS Z.................. %I201.2.2. BOOL
    IJGNEG_Z.................... PB JOG NEGATIV AXIS Z.................. %I201.2.6. BOOL
    ISPDLPOS.................... PB JOG POSITIV SPINDLE................. %I201.3.0. BOOL
    ISPDLNEG.................... PB JOG NEGATIV SPINDLE................. %I201.2.0. BOOL
```

```
27  |(*Resetting the holds *)                                             |
    |M_S_JOG                                                     M_ADSPERR|
    ├┤ ├─────────┬───────────────────────────────────────────────(R)──────┤
    |P00C.REV    |                                                        |
    ├┤ ├─────────┘                                                        |
    M_S_JOG..................... Group message axes moved manually....... .......... BOOL
    M_ADSPERR................... LOCK PROGRAM ADVANCE................... .......... BOOL
    P00C.REV.................... Reverse program start.................. .......... BOOL
```

```
28  |P00C.STOP                                                   M_PRSPERR|
    ├┤ ├─────────┬───────────────────────────────────────────────(R)──────┤
    |P00C.REV    |                                                        |
    ├┤ ├─────────┘                                                        |
    P00C.STOP................... Program stop........................... .......... BOOL
    M_PRSPERR................... LOCK PROCESS........................... .......... BOOL
    P00C.REV.................... Reverse program start.................. .......... BOOL
```

29

```
|(**************************************************************************)
|(*Error message output :                                                  *)
|(**************************************************************************)
|(*|0203\#Probe 1 already actuated\O                                       *)
|(*                                                                        *)
|(*                                                                        *)
|(*                                                                        *)
|(*  Probe 1 has been actuated during loading.                             *)
|(*                                                                        *)
|(*                                                                        *)
|(*  The program must be terminated : 1.   Press <STOP>       key          *)
|(*                                                                        *)
|(*                                   2. Press <CLEAR-ERROR> key           *)
|(*                                                                        *)
|(*                                   3.  Press <REVERSE>    key           *)
|(**************************************************************************)
|            ┌─────────┐                                                   |
|M_WACH1     |MSG_WR   |                                          M_schmier|
├┤ ├─────────┤WRITE    ├──────────────────────────────────────────────( )──────┤
|          0─┤PROC     |                                                   |
|        203─┤NR       |                                                   |
|            └─────────┘                                                   |
M_WACH1..................... Probe monitoring 1 -> MSG 203.......... .......... BOOL
MSG_WR...................... ...................................... .......... MSG_WR
M_schmier................... Scratch flag.......................... .......... BOOL
0........................... ...................................... .......... ANY_INT
203......................... ...................................... .......... ANY_INT
```

30

```
|(**************************************************************************)
|(*0202\#Probe 2 already actuated\O                                        *)
|(*                                                                        *)
|(*                                                                        *)
|(*                                                                        *)
|(* Probe 2 has been actuated during loading.                              *)
|(*                                                                        *)
|(*                                                                        *)
|(* The program must be terminated : 1.   Press <STOP>       key           *)
|(*                                                                        *)
|(*                                  2. Press <CLEAR-ERROR> key            *)
|(*                                                                        *)
|(*                                  3.  Press <REVERSE>    key            *)
|(*                                                                        *)
|(**************************************************************************)
|            ┌─────────┐                                                   |
|M_WACH2     |MSG_WR   |                                          M_schmier|
├┤ ├─────────┤WRITE    ├──────────────────────────────────────────────( )──────┤
|          0─┤PROC     |                                                   |
|        202─┤NR       |                                                   |
|            └─────────┘                                                   |
M_WACH2..................... Probe monitoring 2 -> MSG 202.......... .......... BOOL
MSG_WR...................... ...................................... .......... MSG_WR
M_schmier................... Scratch flag.......................... .......... BOOL
0........................... ...................................... .......... ANY_INT
202......................... ...................................... .......... ANY_INT
```

7.3 Stylus Connection

Probe Function in the DDS

There are two probe inputs on the DSS master communication module that permit positions to be measured via two binary input signals. They permit the actual position values to be measured when the edges of the two inputs transition.

Note: The probe inputs are scanned every 250 µsec. The "actual position value 1/2" measured signal also is generated every 250 µsec. The maximum time offset between probe edge and actual position value measurement is approximately 170 µsec.

Drive parameters

The following drive parameters exist for the function:

- S-0-0170, Probe cycle command
- S-0-0401, Probe-1
- S-0-0402, Probe-2
- S-0-0169, Probe control parameter
- S-0-0405, Probe-1 enabled
- S-0-0406, Probe-2 enabled
- S-0-0130, Measured value 1 positive
- S-0-0131, Measured value 1 negative
- S-0-0132, Measured value 2 positive
- S-0-0133, Measured value 2 negative
- S-0-0409, Probe-1 positive latched
- S-0-0410, Probe-1 negative latched
- S-0-0411, Probe-2 positive latched
- S-0-0412, Probe-2 negative latched

Probe evaluation function

S-0-0170 ‘Probe cycle command’ performs the general activation of the function. Even though the function has been activated as a command, it does not supply any positive or negative command acknowledgments. The command modification bit is not controlled.

To activate the function, S-0-0170 must be set to "3".

From this time on, the state of the probe signals is shown in the parameters **S-0-401 ‘Probe-1’** and **S-0-402 ‘Probe-2’**.

The parameters **S-0-0405 ‘Probe-1 enable’** and/or **S-0-0406 ‘Probe-2 enable’** are used for enabling a probe input. The trigger mechanism for the interpretation of the positive and/or negative edge of the probe signal is activated upon the 0-1 transition of this signal.

If an edge of the related probe is detected after this point, the selected actual position value is stored in the parameter ’Measured value positive’ or ’Measured value negative’. The status messages **S-0-0409 ‘Probe-1 positive latched’** and **S-0-0410 ‘Probe-1 negative latched’**, or **S-0-0411 ‘Probe-2 positive latched’** and **S-0-0412 ‘Probe-2 negative latched’** are correspondingly set to "1".

The status messages S-0-0409 ‘Probe-1 positive latched’ and S-0-0410 ‘Probe-1 negative latched’, or S-0-0411 ‘Probe-2 positive latched’ and S-0-0412 ‘Probe-2 negative latched’ are cleared when probe enabling is cleared.

Note: Only the first positive and the first negative edge of the corresponding input are interpreted after the 0-1 edge of the probe enabling signal. Each new measurement requires the probe enabling signal to be set to 0 and back to 1. The corresponding parameters 'Measured value latched' are also cleared when the probe enabling signal is cleared.

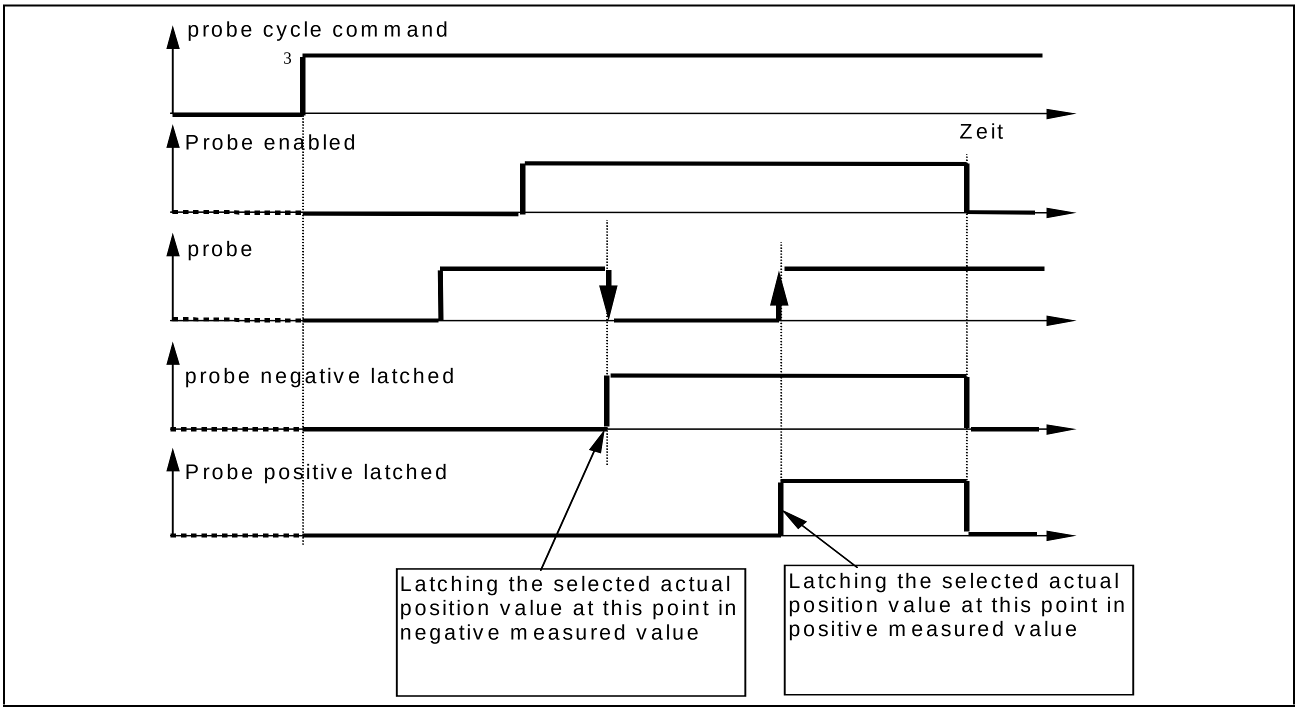


Figure 7-29: Interpretation of the probe edges when the interpretation of the positive and negative edges in the probe control parameter have been switched on

Probe control parameter S-0-0169

For each probe input there is one 'positive measured value' and one 'negative measured value'. The positive measured value is assigned to the 1-0 edge of the probe signal. Whether or not the two edges will actually be interpreted and cause the measured value to be stored in the registers 'positive/negative measured value' must be specified in the parameter S-0-0169, probe control parameter.

The parameter value should be entered before the function is activated. It has the following structure :

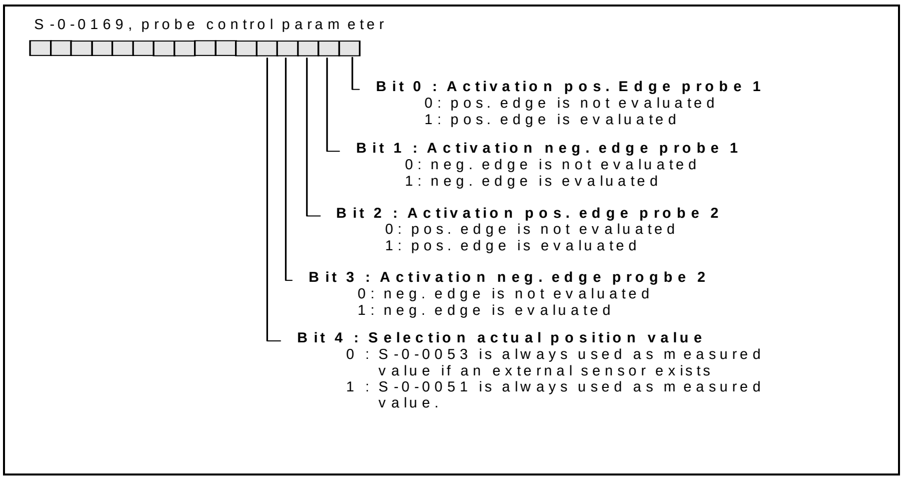


Figure 7-30: Structure of the parameter S-0-0169, probe control parameter

Real-time status bit 2
S-0-0307

Master control word and drive status word contain two configurable real-time status bits each. The following parameters are used for configuring these binary signals:

- S-0-0301, Allocation of real-time control bit 1
- S-0-0303, Allocation of real-time control bit 2
- S-0-0305, Allocation of real-time status bit 1
- S-0-0307, Allocation of real-time status bit 2

These parameters specify from which parameter bit 0 (LSB) is mapped in the corresponding real-time status bit (and thus cyclically sent to the master), and to which parameters the real-time status bits are mapped.

To assign a signal to the real-time status bit 2, the signal ident number is written to the operating data item of the **'Allocation of real-time status bit 2'** parameter.

If such an assignment is made, the related signal (bit 0) appears in the real-time status bit 2 (= part of the drive status word).

Connection at the Drive Module

The probe is connected to terminal 4 (E4) or 5 (E5) of the X12 connector on the DSS plug-in module. Any input can be selected as long as the correct allocation is established in the probe page.

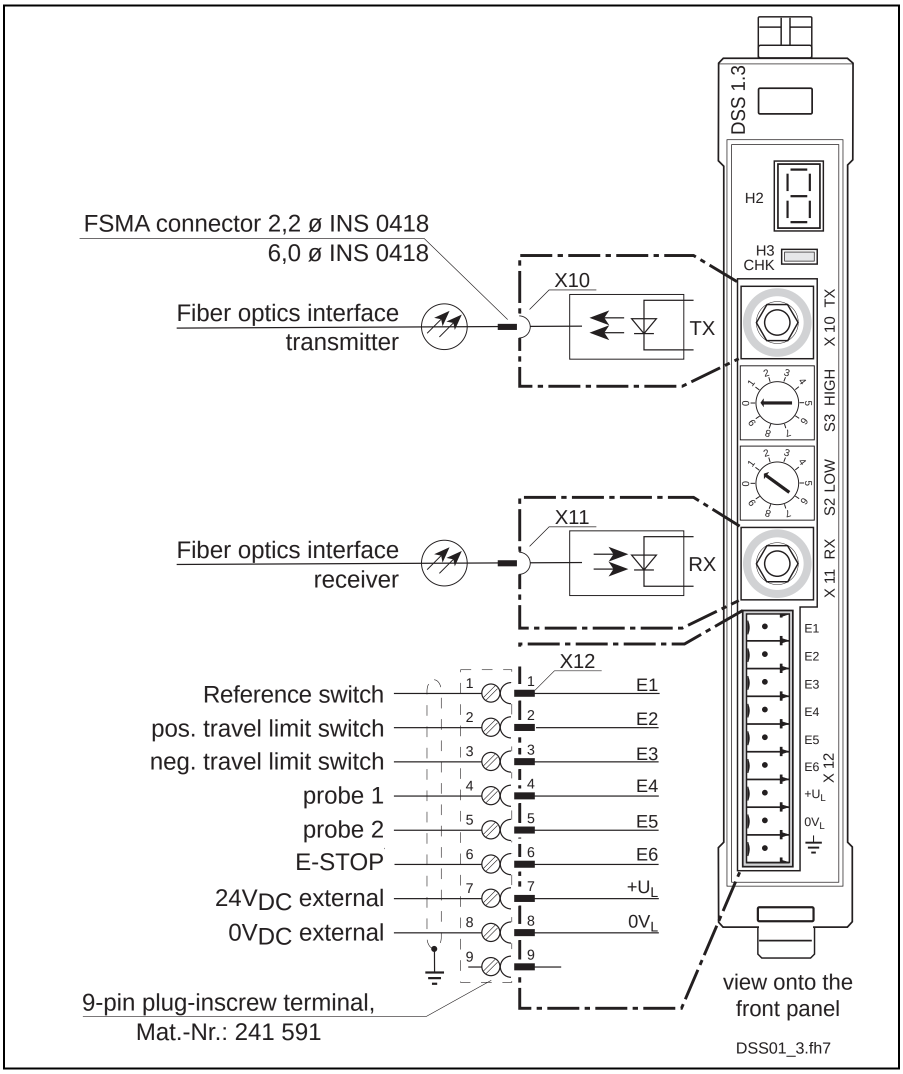


Figure 7-31: Connecting the probe to the DSS

Note: The inputs are isolated and require an external power supply unit (terminals 7 and 8).

Connection to the SPS

Two inputs and one output are required for connecting the probe to the SPS.

The third input shown in the example is an option input that is used for diagnosis purposes only. It does not have any effect on the workpiece measurement function.

The inputs are related to the following signals:

1. The probe is ready for measurement — enable
2. The probe is displaced — switch contact

The output is related to the following signal:

1. Activate probe — Activation

Example

The following example shows the connection of a probe to the SPS and the drive modules (DSS).

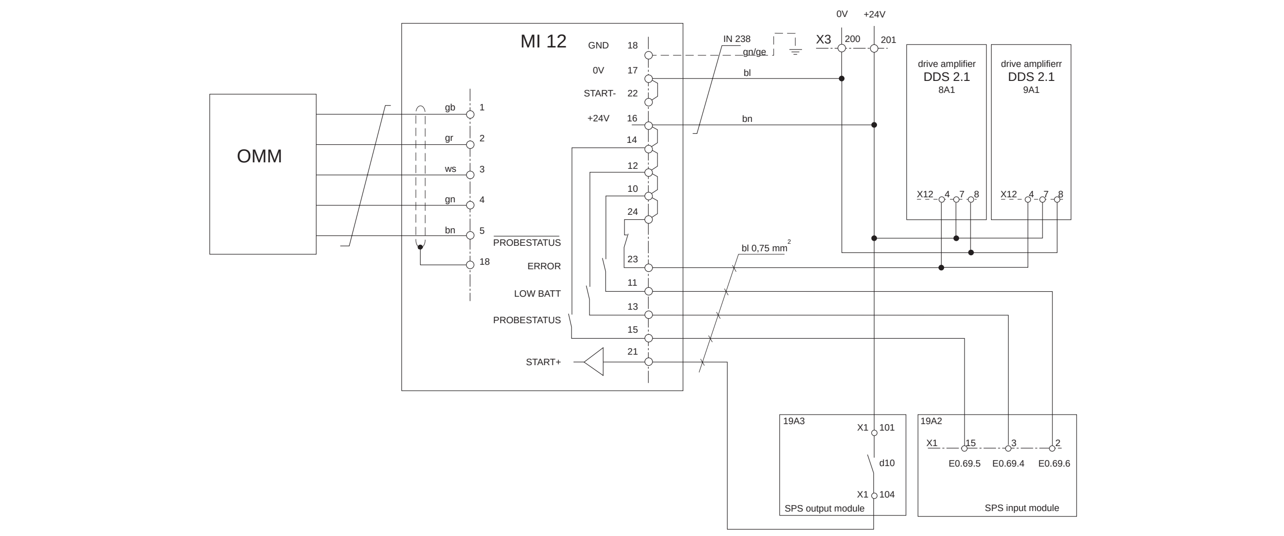


Figure 7-32: Connecting the SPS to the machine

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