engineering
mmannesmann
Rexroth

MT-CNC

Auxiliary Function Output

V16

Description

Indramat

Title	Auxiliary Function Output
Kind of dokument	Description
Docu-Type	DOK-MT*CNC-AUX*FUN*V16-ANW1-EN-E1,44
Internel filing remarks	• Mappe 5 Reg 8 • M508163E.pdf • Drawing no.: 109-0768-4163-00/E
Purpose of this document	This document describes the extended functionality of the Auxiliary Function Output.
Reference	This electronic document is based on the hardcopy document with document desig.: DOK-MT*CNC-AUX*FUN*V16-ANW1-EN-P

Revision	Date	Remarks
109-0768-4163-00	11/95	New issue
DOK-MT*CNC-AUX*FUN*V16-ANW1-EN-E1,44	06/97	1st E-Dok

Table of Contents

1 Introduction

Reducing machining time

The primary and secondary times of a machine can only be reduced by a parallel or a swifter machining sequence, including all auxiliary and utility functions. Due to the specified number of axes and the arrangement of tools and workpieces, parallel machining is not possible for the majority of machine tools. There is a large number of obstacles to increasing the speed of machining; the mechanical part, in particular, frequently meets its limits (machine structure, bearings, tools, ...).

Time-optimized processing of auxiliary functions

Thus, time-optimized output and processing of auxiliary functions is of supreme importance to increasing the productivity of a manufacturing plant. This is even more important with machining centres that are capable of high-speed (cost-intensive) machining.

2 M, Q, S, T and E Functions

2.1 Basics

Available auxiliary functions
The following functions are available in the MT-CNC:

- Three-digit M functions (M0 through M999)
- Four-digit Q functions (Q0 through Q9999)
- S functions with up to five integer and up to two fractional part digits (S0.00 through S99999.99; the NC only transfers the integers to the PLC)
- Seven-digit T functions (T0 through T9999999)
- One-digit E functions (E0 through E9)

Within an NC block, the user may program a maximum of six auxiliary functions. In each block, a maximum of

- 6 M functions,
- 1 Q function,
- 1 S1 function,
- 1 S2 function,
- 1 S3 function,
- 1 T function and
- 1 E function

are permitted.

Example
.

.

N0423 M103 S1 200   M204 S2 400   M319 S3 0 ;activating spindles 1 and 2 and position tool spindle 3

.

.

2.2 M Functions

Task
'**M functions**' can be used for activating various machine functions. Some M functions have a fixed functionality assigned:

- M0   unconditional stop
- M1   conditional stop
- M2   end of program with reset
- M30   end of program with reset
- Mj03spindle j clockwise   j ∈ {'', '1', '2', '3'}
- Mj04spindle j counter-clockwise
- Mj05spindle j halt
- Mj13spindle j clockwise and coolant/lubricant ON
- Mj14spindle j counter-clockwise and coolant/lubricant ON
- Mj19positioning spindle j
- Mj40automatic gear changes for spindle j
- Mj41gear level 1 for spindle j
- Mj42gear level 2 for spindle j
- Mj43gear level 3 for spindle j
- Mj44gear level 4 for spindle j

Syntax	Mxxx	xxx ∈ {0 through 999}	
	M=Variable		
	Variable=M (group no.)	group no.. ∈ {1 through 16}	

Groups M functions may be grouped. Groups 1 through 4 and 11 through 13 are groups that have the program and spindle control functions and the gear changing functions invariably allocated. The other group can have up to 12 M functions allocated by the machine manufacturer.

Group	Name	M function
1	program control commands	M0, M1, M2, M30
2	control commands spindle 1	M3, M4, M5, M13, M14, M19, M103, M104, M105, M113, M114
3	control commands spindle 2	M203, M204, M205, M213, M214
4	control commands spindle 3	M303, M304, M305, M313, M314
5	group 5	(definable in the process parameters)

.
.
.

10	group 10	(definable in the process parameters)
11	changing gears for spindle 1	M40, M41, M42, M43, M44, M140, M141, M142, M143, M144
12	changing gears for spindle 2	M240, M241, M242, M243, M244
13	changing gears for spindle 3	M340, M341, M342, M343, M344
14	group 14	(definable in the process parameters)
15	group 15	(definable in the process parameters)
16	modal M functions	all M functions that do not belong to groups 1 through 15

The M functions for changing gears ('Mj40' through 'Mj44') may be used for other purposes if a multi-stage gearbox for spindle 'j' has not been entered in the parameters. However, the M functions 'Mj40' through 'Mj44' always belong to the M function groups 11 through 13.

The machine manufacturer defines the functionality of the other auxiliary functions.

Setting parameter values The machine manufacturer defines output time and acknowledgement behaviour of the individual M functions.

Programming
- An NC block may contain up to six M functions.

- Out of the function groups 1 though 16, the user may only program one M command in each NC block.

- If the machine manufacturer has selected 'acknowledgement later' for a given M function, the user may append a 'Q' (for Quick) to the name (example: MQ80) to output this function as a swift auxiliary function (without interruption of the movement).

- The processing state of a swift M function can be interrogated when a 'W' (for Wait) is added to the name.

- The same spindle index 'j' that has been stored in the axis parameters of the spindle designation must be programmed for the spindle-related

M functions 'Mj03', 'Mj04', 'Mj05', 'Mj13', 'Mj14', 'Mj19' and 'Mj40' through 'Mj44'. This is particularly important for the first spindle that is either designated as spindle 'S' (and must then be triggered with the M functions 'M3', 'M4', 'M5', 'M13', 'M14', 'M19', 'M40' through 'M44'), or as spindle 'S1' (that must be triggered with the M functions 'M103', 'M104', 'M105', 'M113', 'M114', 'M119', 'M140' through 'M144').

Peculiarities
- Within a block, the NC always outputs the program control commands 'M0', 'M1', 'M2' and 'M30' at the end of the movement, and waits for them to be acknowledged. The time of the output and the acknowledgement behaviour of these M functions cannot be altered.

- Provided that a multi-stage gearbox exists, the NC outputs the gear switching functions 'Mj40' through 'Mj44' at the beginning of a block. The NC then waits until the related M function has been acknowledged before it continues program execution .

- The machine manufacturer may define output time and acknowledgement behaviour of the 'Mj03', 'Mj04', 'Mj05', 'Mj13', 'Mj14' and 'Mj19' spindle control commands according to the requirements. With the exception of 'Mj19', the spindle control commands may be selected as swift M functions and, with an inserted 'Q', asynchronously to NC block processing be accelerated or decelerated to the required speed. Irrespective of the acknowledgement of the auxiliary function and whether or not the spindle has attained the programmed speed, the NC transitions to the next block.

2.3   Q Functions

Task   The machine manufacturer defines the functionality of the '**Q functions**'.

Syntax   Qxxxx   xxxx $\in$ {0 through 9999}

Q=Variable

Variable= Q

Setting parameter values   The machine manufacturer defines output time and acknowledgement behaviour of the individual Q functions.

Programming
- An NC block may contain a maximum of one Q function.

- If the machine manufacturer has selected 'acknowledgement later' for a given Q function, the user may add a 'Q' (for Quick) to the name (example: QQ80) to output this function as a swift auxiliary function (without interruption of the movement).

- The processing state of a swift Q function can be interrogated when a 'W' (for Wait) is added to the name.

2.4   S Functions

Task   The '**S functions**' 'S' and/or 'S1', 'S2' and 'S3' are used in the NC program for specifying
- spindle speed [rpm],
- spindle position [°],
- cutting speed [m/min] or [inch/min] and
- speed limitation [rpm] and
- grinding wheel peripheral speed [m/s] or [feet/s]

for the first, second and third spindle of a process.

Syntax   Sxxxxx.xx, Sj xxxxx.xx or Sj=xxxxx.xx   xxxxx.xx $\in$ {0.00 through 99999.99}

S=Variable or Sj= Variable $j \in$ {1, 2, 3}

	integer part digits	fractional part digits

spindle speed	5	2
spindle position	3	2
constant cutting speed	5	2
speed limitation	5	2
grinding wheel peripheral speed	3	2

Setting parameter values The machine manufacturer defines output time and acknowledgement behaviour of the individual S functions.

Programming
- The same spindle index 'j' that has been stored in the axis parameters of the spindle designation must be programmed for the S functions.
- An NC block may contain up to three S functions. The S functions must have different axis indices.

Peculiarities
- The NC always starts the execution of the motion of NC-controlled spindles at the beginning of the feed movement, irrespective of the selected output and acknowledgement behaviour of the related S or M function. If the spindle movement has been initiated by a normal M function, the NC waits at the end of the feed movement until the expected spindle value has reached the programmed final value.
- The NC continues program execution without this check if the spindle movement has been caused by a swift M function (MQj03, MQj04, MQj05, MQj13, MQj14; j∈{1, 2, 3}).
- Using the parameters, the machine manufacturer can output the S functions to the PLC for both, PLC-controlled spindles and NC-controlled spindles.

2.5 T Function

Task The '**T function**' specifies the tool and/or location number of the next tool that is to be changed in.

Syntax Txxxxxxx   x ∈ {0 through 9999999}

T=Variable

Variable=T

Setting parameter value The machine manufacturer defines output time and acknowledgement behaviour of the T/E functions.

Programming An NC block may contain a maximum of one T function.

Peculiarities Provided that tool management has not been selected, the user may employ the T functions like any other auxiliary function for implementing tasks.

2.6 E Function

Task The '**E function**' is used for selecting the current tool edge.

Syntax Ex   x ∈ {0 through 9}

E=Variable

Variable=E

Setting parameter values The machine manufacturer defines output time and acknowledgement behaviour of the T/E functions.

Programming An NC block may contain a maximum of one E function.

Peculiarities Provided that tool management has not been selected, the user may employ the E functions like any other auxiliary function for implementing tasks.

3 Machine Parameters

3.1 Basics

Options The parameters below are used for defining the output and acknowledgement behaviour of the M, Q, S, T, and E functions. The output behaviour can be specified as 'at the beginning of the movement', 'at the end of the movement', or 'no output'. The acknowledgement behaviour can be 'at the beginning of the movement', 'at the end of the movement', or 'later'.

Output behaviour If the machine manufacturer defines the output behaviour as 'at the beginning of the movement' or 'at the end of the movement', the NC transfers the auxiliary function concerned as a normal auxiliary function to the PLC and, if necessary, waits for the acknowledgement at the beginning or at the end of the movement. If the machine manufacturer defines the output behaviour as 'no output', the auxiliary function concerned will not reach the PLC.

Acknowledgement behaviour If the acknowledgement behaviour is defined as 'at the beginning of the movement' or 'at the end of the movement', the NC waits at the beginning or at the end of the movement for the acknowledgement of the functions concerned. If, in contrast, the machine manufacturer defines the acknowledgement behaviour as 'later', the NC transfers the auxiliary function as a swift auxiliary function to the PLC and continues program execution without interruption (provided that the user has programmed this feature by a 'Q' in the function designation). If the user does not insert a 'Q' in the function designation, the NC only continues program execution at the end of the movement after the PLC has acknowledged the output auxiliary function.

3.2 Global M Function Mode

Name Global M function mode

Number A00.087

Parameter System parameter

Value range
Output behaviour: at the end, at the beginning, no output
Acknowledgement behaviour: at the end, at the beginning, later

Default value
Output behaviour: at the end
Acknowledgement behaviour: at the end

Unit -

Purpose The '**Global M function mode**' parameter defines the output behaviour and acknowledgement behaviour of all M functions across the processes.

Instruction:

• Up to 40 M functions with an output and acknowledgement behaviour that differs from the global M function mode may be defined for each process.

• The M functions 'M0', 'M01', 'M02', 'M30' cannot be entered. The NC always outputs these functions at the end and waits until the PLC has acknowledged them before it continues with executing the next block.

• The NC always outputs the gear shift functions 'Mj40' through 'Mj44' (j ∈ {'', '1', '2', '3'}) at the beginning of a block. If a multi-stage gearbox exists, the NC waits at the end of the movement, and continues program execution only after the output M function has been acknowledged. Independently of the selected behaviour, the NC always responds like this if the M functions 'Mj40' through 'Mj44' are used for selecting gears. The NC only considers the entered output and acknowledgement behaviour of

the M functions 'Mj40' through 'Mj44' if these functions are not used for changing gears.

3.3 Global Q Function Mode

Name	Global Q function mode	
Number	A00.088	
Parameter	System parameter	
Value range	Output behaviour:	at the end, at the beginning, no output
	Acknowledgement behaviour:	at the end, at the beginning, later
Default value	Output behaviour:	at the end
	Acknowledgement behaviour:	at the end
Unit	-	
Purpose	The '**Global Q function mode**' parameter defines the output behaviour and acknowledgement behaviour of all Q functions across the processes.	

> **Hinweis**: Up to 40 Q functions with an output and acknowledgement behaviour that differs from the global Q function mode may be defined for each process.

3.4 S Function Mode

Name	S function mode	
Number	A00.089	
Parameter	System parameter	
Value range	Output behaviour:	at the end, at the beginning, no output
	Acknowledgement behaviour:	at the end, at the beginning, later
Default value	Output behaviour:	no output
	Acknowledgement behaviour:	later
Unit	-	
Purpose	The '**S function mode**' parameter defines the output behaviour and acknowledgement behaviour of all S functions across the processes.	

3.5 T/E Function Mode

Name	T/E function mode	
Number	A00.090	
Parameter	System parameter	
Value range	Output behaviour:	at the end, at the beginning, no output
	Acknowledgement behaviour:	at the end, at the beginning, later
Default value	Output behaviour:	no output
	Acknowledgement behaviour:	later
Unit	-	
Purpose	The '**T/E function mode**' parameter defines the output behaviour and acknowledgement behaviour of all T and E functions across the processes.	

3.6 Deviating M and Q Functions

Name	• Deviating M functions
	• Deviating Q functions
Number	Bxx.046
	Bxx.047

Parameter   Process parameter (in list form)

Value range   Output behaviour: at the end, at the beginning, no output
                  Acknowledgement behaviour: at the end, at the beginning, later

Default value Output behaviour: at the end
                  Acknowledgement behaviour: at the end

Unit   -

Purpose   These two parameters, that are offered in the form of a list, enable up to 40 M function and up to 40 Q functions to be defined in each process. The output and acknowledgement behaviour of these functions differ from the global function behaviour.

3.7   M Function Groups

Name   M functions of M function group 5
                  .
                  .
                  .
                  M functions of M function group 10
                  M functions of M function group 14
                  M functions of M function group 15

Number   Bxx.048
                  .
                  .
                  .
                  Bxx.053
                  Bxx.054
                  Bxx.055

Parameter   Process parameter

Value range   3 through 999

Default value M functions of M function group 5   7, 8, 9, 107, 108, 109
                  M functions of M function group 6   207, 208, 209
                  M functions of M function group 7   307, 308, 309
                  M functions of M function group 8   10, 11, 110, 111
                  M functions of M function group 9   210, 211
                  M functions of M function group 10   310, 311
                  M functions of M function group 14   46, 47
                  MM functions of M function group 15   48, 49

Unit   -

Purpose   These parameters enable the machine manufacturer to define the M functions that belong to the groups 5 through 10, 14, and 15.

Instruction:

- Each group can have a maximum of 12 M functions.

- An M function that belongs to the program control, spindle control, or gear change command group <u>must not</u> be assigned to the groups 5 through 10, 14, and 15.

- Multiple entries are <u>not</u> permitted.

- Please note when allocating the M functions to the M function groups, that each NC block from each M function group may only contain one M function. This must also be observed for M function group 16 that has automatically all functions assigned that have not been allocated to another group.

---

4 Output and Acknowledgement Behaviour

4.1 Normal Auxiliary Functions

Output and Acknowledgement 'at the Beginning of a Movement'

Effect   The NC stops the movement at the end of the previous block, and transfers the auxiliary function to the PLC at the beginning of the current block. The NC only performs the programmed feed movements of the active NC block after the PLC user program has sent an acknowledgement.

Fig. 4-1: Input of auxiliary function 'at the beginning of the movement' and acknowledgement 'at the beginning of the movement'

Output and Acknowledgement 'at the End of the Movement'

Effect   Only after the PLC has acknowledged the auxiliary function, the NC transfers the auxiliary function 'at the end of the movement' to the PLC and begins processing the

* tool management commands
* event commands,
* process control commands, and
* program control commands.

The NC transitions to the next block after these additional commands have been executed.

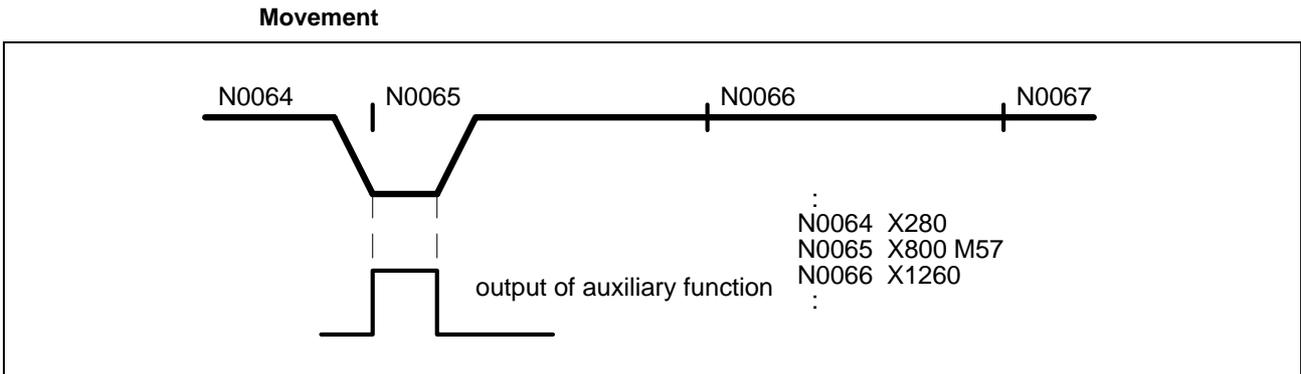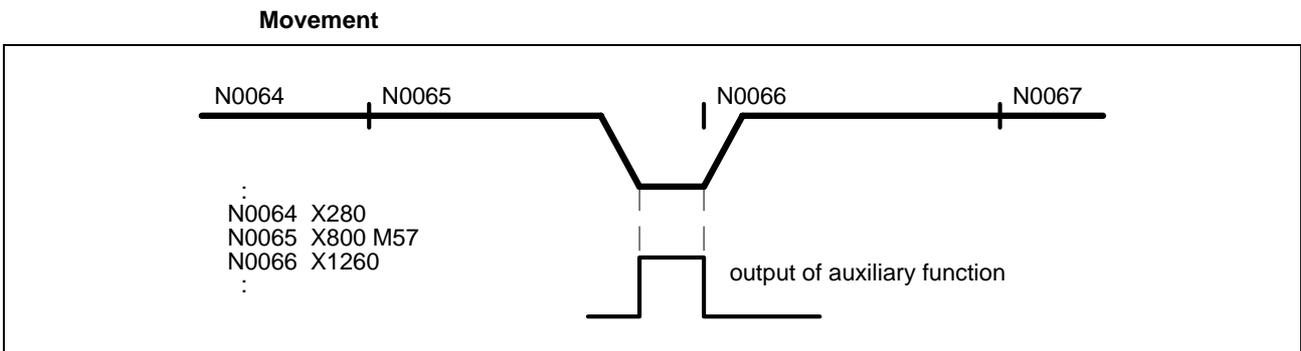Fig. 4-2: Input of auxiliary function 'at the beginning of the movement' and acknowledgement 'at the beginning of the movement'

⚠️ **WARNING** ⇒ Within an NC block, the NC always issues the 'M0', 'M1', 'M2' and 'M30' program control commands and the 'Mj40' through 'Mj44' (j ∈ {", '1', '2', '3'} gear changing functions (if there is a multi-stage gearbox for spindle 'j') at the end of the movement, and waits for them to be acknowledged before it processes the tool management, event, process control, and program control commands.

⚠️ **WARNING** ⇒ Only auxiliary functions that are output and acknowledged at the end of the movement may be used for activating and de-activating follower and Gantry axes and main spindle synchronization.

Output 'at the Beginning of the Movement' and Acknowledgement 'at the End of the Movement'

Effect **Auxiliary function output 'at the beginning of the movement'** and **acknowledgement 'at the end of the movement'** help in asynchronous processing of auxiliary functions since the NC only stops program execution if the auxiliary function has not yet completely been processed at the end of the movement.

An auxiliary function that shall be in effect before the axes start moving must be programmed in the preceding block.
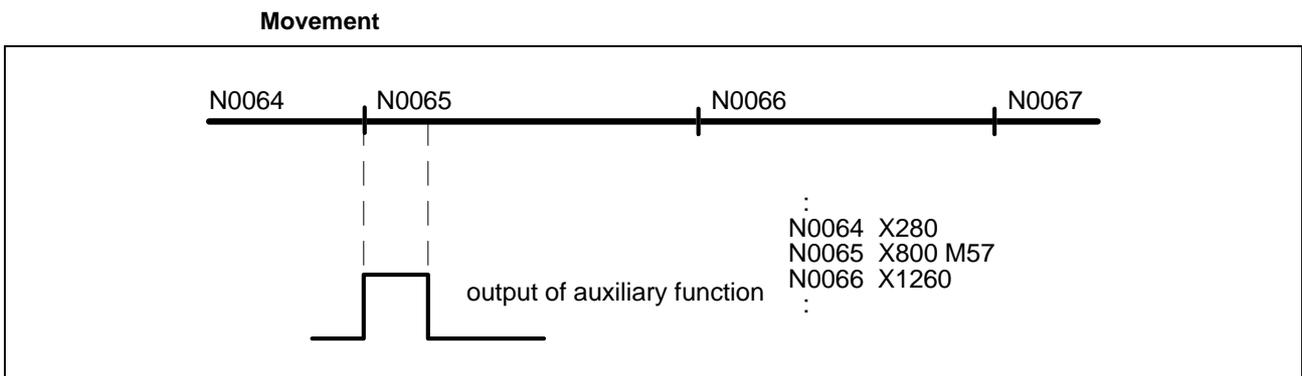
Movement

Fig. 4-3: Auxiliary function output 'at the beginning of the movement' and acknowledgement 'at the end of the movement'

Short motion blocks Where very short motion blocks are concerned, whose execution takes less time that the execution of the programmed auxiliary function and/or the safe recognition of the auxiliary function (at least one PLC cycle), the NC interrupts the further execution of the block until the auxiliary function is acknowledged at the end of the movement. Only after acknowledgement has been received, the NC processes the auxiliary commands (tool management, event, process control, and program control commands) and transitions to the next NC block.

To avoid jerky interruptions of the movement, the path velocity 'F' must be reduced accordingly or the auxiliary function concerned must be output as a swift auxiliary function.

This type of auxiliary function output permits only a limited execution of contouring mode. Even if speed-optimized block transition (G08) has been selected, the NC reduces the path velocity at the end of the movement to the computed maximum velocity jump in order to be able to stop the axes when the acknowledgement fails to appear.

4.2 Swift Auxiliary Functions

General

Swift auxiliary function   If, during the selection of the parameter values, the machine manufacturer sets the acknowledgement behaviour to 'later' and if the user programs an inserted 'Q' in the NC program, the NC interprets the auxiliary function concerned as a swift auxiliary function. At the selected output time, the NC transfers '**swift auxiliary functions**' to the PLC without waiting for them to be acknowledged. It does not interrupt block processing. Contouring mode without velocity-optimized block transition (G08) is possible without velocity dips. Irrespective of the output of the auxiliary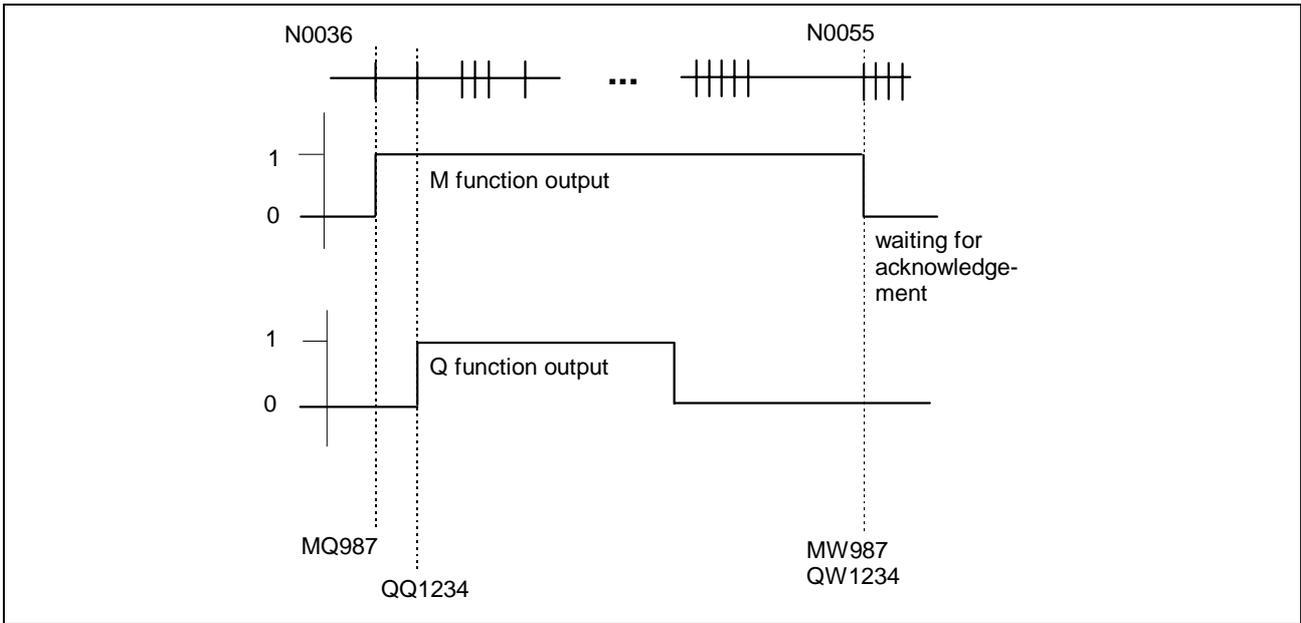 function and in the same way as in operation without auxiliary function output, the NC adjusts the velocity at the end of the block such that it transitions to the next NC block at the highest speed possible.

The user may program the **swift M and Q functions** without the inserted Q as normal auxiliary functions. The NC will then wait at the end of the movement for the auxiliary function concerned to be acknowledged.

Exceptions   The following M functions are excluded from this type of programming:

- 'M0', 'M1', 'M2' and 'M30' for program control,
- spindle positioning with 'Mj19' for spindle 'j', and
- gear changing commands 'Mj40' through 'Mj44'
  (only if there is a multi-stage gearbox for spindle 'j').

Programming   For each NC block, the user may program up to six auxiliary functions (swift, normal or mixed).

Swift M and Q Function Output

Syntax   An inserted 'Q' (for quick) enables M and Q functions that have been selected as swift auxiliary functions by the machine manufacturer during commissioning, to be output as swift auxiliary functions to the PLC.

Output of swift M functions: MQxxx   xxx $\in$ {0 through 999}
                                MQ=Variable
Output of swift Q functions: QQxxxxxxxx $\in$ {0 through 9999}
                                QQ=Variable

Instruction: The NC ensures during program execution, that only auxiliary functions that have been set by the machine manufacturer as to be acknowledged 'later' are output as swift auxiliary functions.

Example   M80:   • output at the beginning

• acknowledgement later

```
              NC program          PLC program
•
•
•                                     ┌────────┐
•                                     │ M_FKT  │
N0082  MQ80      ───────────→         │        │
•                                     └────────┘
•
•                                     ┌────────┐
•                                     │ M_FKT_Q│
N00197 MW80      ←───────────         │        │
•                                     └────────┘
•
•
```

Inquiring Swift M and Q Functions

Syntax   Using an appended 'W' (for wait), the user may inquire the execution of a swift M or Q function at a later point in time:

Inquiring swift M functions:	MWxxx	xxx $\in$ {0 through 999}
	MW=Variable	
Inquiring swift Q functions:	QWxxxx	xxxx $\in$ {0 through 9999}
	QW=Variable	

Effect   If the function concerned has not yet been acknowledged when it is inquired, the NC waits at the end of the movement for the auxiliary function to be acknowledged before it executes further commands.

If the PLC has executed and acknowledged the function before the auxiliary function inquiry has been processed, the NC continues execution without interruption. Even if velocity-optimized block transition has been selected, it reduces the path velocity to the computed maximum velocity jump in order to be able to stop the axes if necessary.

Programming   Within a block, the user may wait for the execution of up to six auxiliary functions.

Instruction: Please note that only

- the last M function of group 1,
- the last M function of group 2,
- .
- .
- the last M function of group 16,
- the last Q function,
- the last S1 function,
- the last S2 function,
- the last S3 function,
- the last T function, and
- the last E function

can be inquired. The user may inquire any auxiliary functions that are further back by a new output as a normal auxiliary function.

If the user attempts to inquire the execution of a (swift or normal) auxiliary function that is further back, the NC interrupts processing and generates an error message.

Instruction: Due to the cycle time (NC block changing intervals < PLC cycle time), the PLC may be unable to recognize all outputs within the group if the user programs a number of swift auxiliary functions of one group in succession (to increment or decrement a counter in the PLC, for example) and at very short block changing intervals.

Here, and in similar applications, the last auxiliary function to have been output must be inquired before the next swift auxiliary function within the associated group is output.

Example
```
             .
             .
; Contouring mode
N0036 X5.35 Y10.05 MQ987      ; outputs M987 as swift auxiliary function
N0037 X5.43 Y10.63 QQ1234     ; outputs Q1234 as swift auxiliary function
             .
             .
N0054 X7.80 Y12..38
N0055 X7.95 Y12.41 MW987 QW1234   ; waits for M987 and Q1234 if they
                                    have not yet been executed
```

Fig. 4-4: Typical inquiry of swift M and Q functions

Swift S, T and E Function Output

Task   In contrast to the M and Q functions, the S, T, and E functions are not used for activating different functions.

S functions	T functions	E functions
are exclusively used for specifying • spindle speed, • spindle position, • surface speed, • speed limitation • grinding wheel peripheral speed	are used for specifying • tool or location number	are used for specifying • tool edge number

Programming   The user cannot use an appended 'Q' for influencing the output behaviour of the S, T, or E functions that has been defined by the machine manufacturer. If the user employs the appendix 'Q' for these functions, the user interface generates an error message during syntax check.

Likewise, using an appended 'W' for waiting for the execution of an S, T, or E function is not possible either.

No Auxiliary Function Output

Task   Usually, the machine manufacturer only selects '**no auxiliary function output**' for auxiliary functions that have no functions allocated in the PLC (e.g. the spindle control commands).

Programming   M and Q functions that are not to be output can be programmed with or without an appended 'Q'.

5   PLC User Programming

5.1   Inquiring a Change in the Auxiliary Functions (with Group Specification)

General   Using the standard functions

- M_ALL,
- Q_ALL,
- S_ALL,
- T_ALL and
- E_ALL,

the PLC is able to recognize a newly output auxiliary function. These standard functions can be used for skipping program sections in which auxiliary functions are executed if there is no change, thus permitting time-optimized program execution.

If there is a change, the PLC can either

- directly inquire (M_FKT, Q_FKT, S_FKT, T_FKT, E_FKT, *see Chapter 5.2, page 5-2*) or read (M_NR, Q_NR, S_NR, T_NR, E_NR, *see Chapter 5.4, page 5-4*) an auxiliary function, and, after they have been processed,

- acknowledge the auxiliary functions either individually (M_FKT_Q, Q_FKT_Q, S_FKT_Q, T_FKT_Q, E_FKT_Q, *see Chapter 5.3, page 5-3)*, or acknowledge all pending auxiliary functions (M_ALL_Q, Q_ALL_Q, S_ALL_Q, T_ALL_Q, E_ALL_Q, *see Chapter 5.5, page 5-6*).

Task   Using the 'M_ALL', 'Q_ALL', 'S_ALL', 'T_ALL', 'E_ALL' standard functions, it can be inquired according to the external circuitry whether the NC has output new M, Q, S, T, or E functions (and in which M function groups and/or for which spindle they have been transferred).

Circuitry

```
              ┌─────────────┐
              │   M_ALL      │
              │              │
BOOL  ─────── │   ACTIVE     │
INT   ─────── │   PROC       │ ─────── BOOL
INT   ─────── │   GROUP      │
              └─────────────┘
```
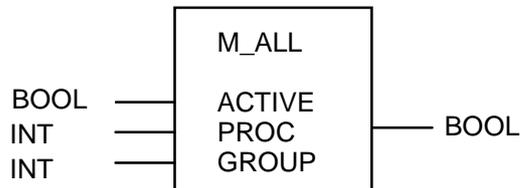
Deviations   Q_ALL   The Q_NR standard function does not possess a GROUP input.

S_ALL   Instead of the GROUP input, the S_NR standard function has the SPINDLE input (spindle number 1 through 3 of the INT type).

T_ALL   The T_NR standard function does not possess a GROUP input.

E_ALL   The E_NR standard function does not possess a GROUP input.

Signals   ACTIVE   0:   Inquiry of M function changes is not active

1:    Inquiry of M function changes is active

PROC   Process number (0 through 6)

GROUP   M function group number (0 through 16)

0:    Inquiry whether or not the NC has output an M function in one of the function groups 1 through 16.

1 through 16:   Inquiry whether or not the NC has output an M function in the related function group 1 through 16

<table>
<tr><td>Function</td><td>0:</td><td>The standard function is not active, or the standard function is activeresult and there is no change.</td></tr>
<tr><td></td><td>1:</td><td>The standard function is active, and there is a change.</td></tr>
</table>

Example

```
(* Inquiry: has an M function word changed ? ---------------------------*)|
|                                                                        |
|   ┌─────────┐                                                          |
|   │M_ALL    │                                                          |
|   │         │                                                          |
|   │ ACTIVE  │                                                          |
├───┤         ├──────────────────────────────────────────────0>NO_MFKT  |
|0──┤ PROC    │                                                          |
|0──┤ GROUP   │                                                          |
|   │         │                                                          |
|   └─────────┘                                                          |
|                                                                        |
|(* M function processing ------------------------------------------*)   |
|                                                                        |
|                                  .                                     |
|                                  .                                     |
|                                  .                                     |
|                                                                        |
|(* No M function processing ---------------------------------------*)   |
|NO_MFKT                                                                 |
|                                                                        |
```

5.2 Direct Inquiry of an Auxiliary Function (Specifying the Number)

General   Using the following standard functions, the validity of an auxiliary function can be inquired in the PLC user program:

- M_FKT,
- Q_FKT,
- S_FKT,
- T_FKT and
- E_FKT.

If auxiliary functions of different functionality must be processed (as this is usually the case with M functions), this type of auxiliary function inquiry takes the least programming effort in the user program.

Task   The 'M_FKT', 'Q_FKT', 'S_FKT', 'T_FKT', 'E_FKT' standard functions permit the validity of a specific M, Q, S, T, or E function to be checked independently of the M function groups.

Circuitry

```
              ┌──────────┐
              │  M_FKT   │
              │          │
   BOOL ──────┤ ACTIVE   │
   INT  ──────┤ PROC     ├────── BOOL
   INT  ──────┤ NR       │
              │          │
              └──────────┘
```

Deviations   Q_FKT   The NR input is of the INT type and has a value range of 0 through 9999.

S_FKT   The S_FKT standard function has an additional SPINDLE input (spindle number 1 through 3 of the INT type). The NR input is of the DINT type, and has a value range of 0 through 99999.

T_FKT   The NR input is of the DINT type and has a value range of 0 through 9999999

E_FKT   The NR input is of the INT type and has a value range of 0 through 9.

Signals ACTIVE 0: Auxiliary function inquiry is not active.

1: Auxiliary function inquiry is active.

PROC Process number (0 through 6)

NR M function number

Function 0: The standard function is not active or the standard function is active result and the NC has not transferred the auxiliary function concerned.

1: The standard function is active and the NC has output the auxiliary function concerned.

Example A specific action is to be performed in the PLC user program when the NC outputs the 'M890' M function.

```
(* Inquiry: Has an M function been output ? -----------------------------*)|
    |
    ┌─────────┐
    │ M_ALL   │
    │         │
    │ ACTIVE  ├─────────────────────────────────────────────0>NO_MFKT|
  0─┤ PROC    │
  0─┤ GROUP   │
    │         │
    └─────────┘

(* M function = M890 ? -------------------------------------------------*)|
    ┌─────────┐
    │ M_FKT   │
    │         │                                              Q_ACTION
    │ ACTIVE  ├────────────────────────────────────────────────(S)────
  0─┤ PROC    │
890─┤ NR      │
    │         │
    └─────────┘

  I_ACTION              ┌─────────┐                                  X
────┤ ├─────────────────┤ M_FKT_Q ├──────────────────────────────( )───
                        │         │
                        │ ACTIVE  ├
                      0─┤ PROC    │
                    890─┤ NR      │
                        │         │
                        └─────────┘
                             .
                             .
                             .
    |
(* No M function processing ----------------------------------------------*)|
NO_MFKT                                                                     |
```
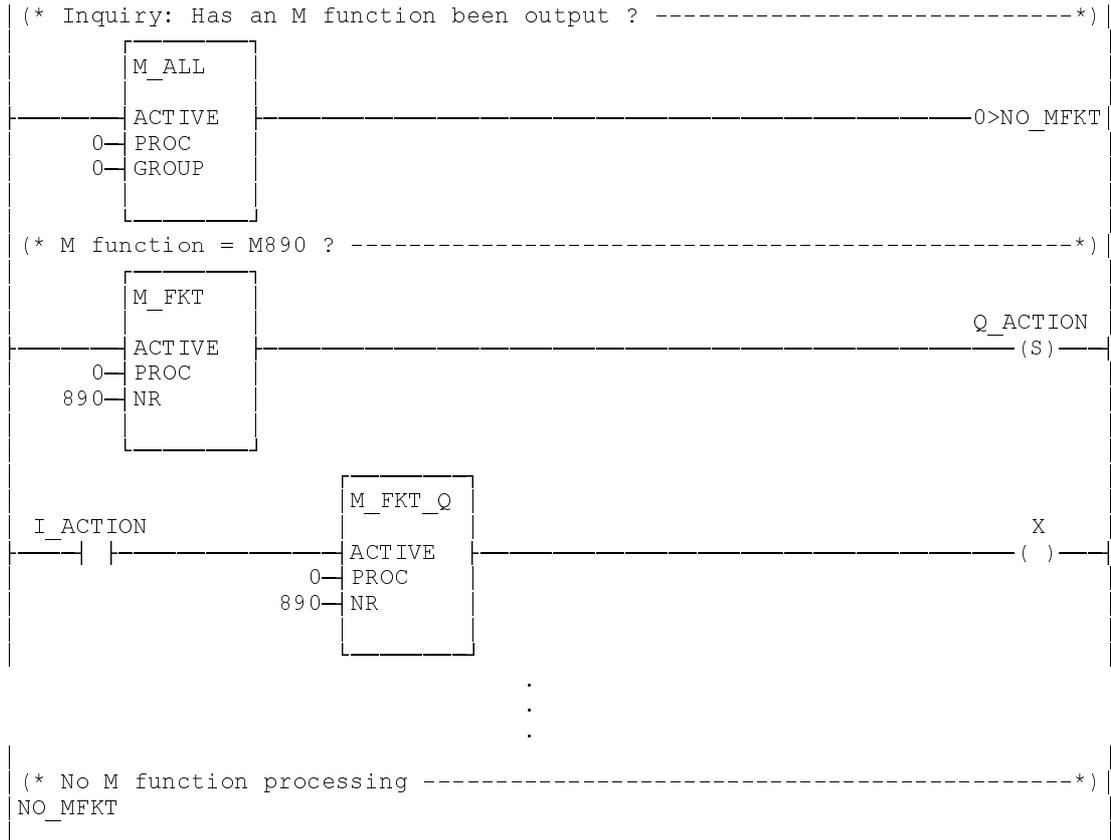
5.3 Direct Acknowledgement of an Auxiliary Function (Specifying a Number)

General All M and Q functions which the NC transfers to the PLC must be acknowledged in the PLC user program. Since the user is able to inquire them with an appended 'W', this must also be done if the NC outputs the M or Q function as a swift auxiliary function.

Merely swift S, T, or E functions can do without acknowledgement; the execution of these functions cannot be inquired from the user program.

The following standard functions are available for acknowledging the auxiliary functions which the user has initiated with the 'inquiring an auxiliary function' standard function:

• M_FKT_Q,
• Q_FKT_Q,
• S_FKT_Q
• T_FKT_Q and
• E_FKT_Q.

Task

The 'M_FKT_Q', 'Q_FKT_Q', 'S_FKT_Q', 'T_FKT_Q', 'E_FKT_Q' standard functions enable a specific M, Q, S, T, or E function to be acknowledged.

Circuitry

```
                    ┌─────────────┐
                    │   M_FKT_Q   │
                    │             │
      BOOL ─────────│ QUIT        │
      INT  ─────────│ PROC        │───── BOOL
      INT  ─────────│ NR          │
                    └─────────────┘
```
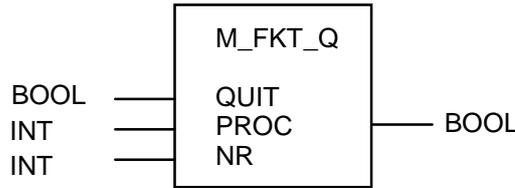
Deviations

Q_FKT_Q	The NR input is of the INT type and has a value range of 0 through 9999.
S_FKT_Q	The S_FKT standard function has an additional SPINDLE input (spindle number 1 through 3 of the INT type). The NR input is of the DINT type and has a value range of 0 through 99999
T_FKT_Q	The NR input is of the DINT type and has a value range of 0 through 9999999.
E_FKT_Q	The NR input is of the INT type and has a value range of 0 through 9.

Signals

QUIT	0:	no acknowledgement of the M function
	1:	the M function is acknowledged
PROC	Process number (0 through 6)	
NR	M function number (0 through 999)	
Function result	The acknowledgement is transferred to the NC.	

⚠️ **WARNING**

⇒ From software version 5.16 onwards, the related auxiliary function inquiry 'M_FKT', 'Q_FKT', 'S_FKT', 'T_FKT' or 'E_FKT' may no longer be programmed when an 'M_FKT_Q', 'Q_FKT_Q', 'S_FKT_Q', 'T_FKT_Q' or 'E_FKT_Q' auxiliary function is acknowledged.
An auxiliary function must always be acknowledged as long as the related external state exist.

5.4 Reading an Auxiliary Function Number

General

The

- M_NR,
- Q_NR,
- S_NR,
- T_NR and
- E_NR

standard functions enable the auxiliary function numbers from the NC to be read in the PLC program. They are best utilized for inquiring a complete range, as it is usually required for the S values of spindles, for example (*see the example below*).

Task

The 'M_NR', 'Q_NR', 'S_NR', 'T_NR', 'E_NR' standard functions enable the function numbers (of each function group 1 through 16) to be read.

Circuitry

```
                    ┌─────────────┐
                    │    M_NR     │
                    │             │
      BOOL ─────────│ READ        │
      INT  ─────────│ PROC        │───── INT
      INT  ─────────│ GROUP       │
                    └─────────────┘
```

Deviations

	Q_NR	The Q_NR standard function does not possess a GROUP input. As a function result it supplies an INT value with a value range of -1 through 9999.
	S_NR	Instead of the GROUP input, the S_NR standard function possesses the SPINDLE input (spindle number 1 through 3 of the INT type). As a function result, S_NR supplies a DINT value of a value range of -1 through 99999.
	T_NR	The T_NR standard function does not possess a GROUP input. As a function result it supplies a DINT value with a value range of -1 through 9999999.
	E_NR	The E_NR standard function does not possess a GROUP input. As a function result it supplies a DINT value with a value range of -1 through 9.

Signals	READ	0:	Reading M function number is not active
		1:	Reading M function number is active
	PROC	Process number (0 through 6)	
	GROUP	M function group number	
		0:	Reading the M function numbers that have not yet been acknowledged in one of the 16 M function groups (starting at group 1).
		1 through 16:	Reading the last M function number to have been output within the selected group 1 through 16.

Function result	GROUP=Ø	
	-1:	No M function is active.
	0 through 999:	The last M function number to have been output that has not yet been acknowledged. The M function number of the lowest group is displayed if auxiliary functions are output at the same time.
	GROUP=1 through 16	
	-1:	Since the controller has been switched on, an M function has not yet been output for the M function group concerned.
	0 through 999:	Last M function number to have been output. Even after acknowledgement, it remains pending up to the next auxiliary function output (in the group concerned).
		Thus, reading the M function number permits the state of the M function as it exists in the NC (as it is shown in the status display) to be inquired at any time.

Instruction:

- Within an PLC cycle, one M function number can be read in each group (GROUP=1 through 16).
- If the user applies '0' to the GROUP input, the 'M_NR' function only reports the next active M function after the previous M function has been acknowledged.

Example	When the S function of spindle '1' moves in the range from 'S8000' through 'S16000', an action shall be initiated in the PLC user program.

```
(* Inquiry: has the S word of spindle 1 changed ? ----------------------*)|
       ┌─────────┐
       │ S_ALL   │
       │         │
       │ ACTIVE  │                                              0>NO_SFKT
    0──┤ PROC    │
    1──┤ SPINDLE │
       │         │
       └─────────┘
(* Reading the S word of spindle 1----------------------------------------*)|
       ┌─────────┐
       │ S_NR    │
       │         │
       │ READ    ├──── S1_NR
    0──┤ PROC    │
    1──┤ SPINDLE │
       │         │
       └─────────┘
(* S1 word >= 8000 ? ----------------------------------------------------*)|
       ┌─────────┐
       │ GE      │
       │         │
 S1_NR─┤         ├──── M_S8000
       │         │
  8000─┤         │
       │         │
       └─────────┘
(* S1 word <= 16000 ? ---------------------------------------------------*)|
       ┌─────────┐
       │ LE      │
       │         │
 S1_NR─┤         ├──── M_S16000
       │         │
 16000─┤         │
       │         │
       └─────────┘
(* Action, if M3 or M4 is active and S is in the required range ---------*)|
  M_S8000   M_S16000   M_M3                                      Q_ACTION
├──┤ ├──────┤ ├────┬──┤ ├────────────────────────────────────────( )───┤
                   │  M_M4                                                
                   └──┤ ├───┘                                            


(* Acknowledging S function of spindle 1 --------------------------------*)|
       ┌─────────┐
  I_ACTION │ S_ALL_Q │                                              X
├──┤ ├────┤ QUIT    ├──────────────────────────────────────────────( )───┤
       0──┤ PROC    │
       1──┤ SPINDLE │
       │         │
       └─────────┘
(* No S function processing ---------------------------------------------*)|
NO_SFKT
```

5.5 Acknowledging an Auxiliary Function (Specifying the Group)

General	The

- M_ALL_Q,
- Q_ALL_Q
- S_ALL_Q,
- T_ALL_Q and
- E_ALL_Q

standard functions enable an executed auxiliary function to be acknowledged.

Task The 'M_ALL_Q', 'Q_ALL_Q', 'S_ALL_Q', 'T_ALL_Q', 'E_ALL_Q' standard functions permit all pending functions to be acknowledged according to the circuitry.

Circuitry

```
                    ┌─────────────┐
                    │   M_ALL_Q   │
                    │             │
  BOOL ─────────────┤ QUIT        │
  INT  ─────────────┤ PROC        ├──── BOOL
  INT  ─────────────┤ GROUP       │
                    │             │
                    └─────────────┘
```
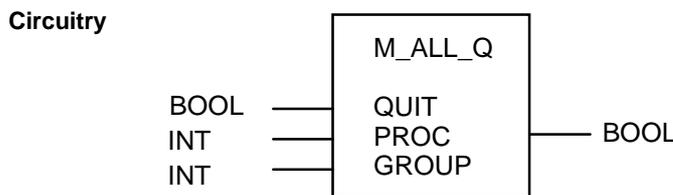
Deviations

Q_ALL_Q	The Q_ALL_Q standard function does not possess a GROUP input.
S_ALL_Q	Instead of the GROUP input, the S_NR standard function possesses the SPINDLE input (spindle number 1 through 3 of the INT type).
T_ALL_Q	The T_NR standard function does not possess a GROUP input.
E_ALL_Q	The E_NR standard function does not possess a GROUP input.

Signals

QUIT	0:	No acknowledgement of the M function
	1:	The auxiliary function is acknowledged
PROC	Process number (0 through 6)	
GROUP	M function group number	
	0:	Acknowledgement of all pending M functions in all M function groups.
	1 through 16:	Acknowledgement of the pending M function in the selected M function group 1 through 16.
Function result	The acknowledgement is transferred to the NC.	

5.6   Sequence of the M00, M01, M02, and M30 Function Output

M Functions M00 and M01

Sequence   Irrespective of the programmed sequence in the NC block, the NC transfers the M functions M00 (unconditional stop) and M01 (conditional stop) to the PLC at the end of the movement. The NC stops NC block execution (PxxSRUN = 0) as soon as the auxiliary function concerned has been acknowledged and the NC has processed the remainder of the block.

The NC continues program execution (PxxSRUN = 1) upon the next forward or backward start (PxxCADV, PxxCREV).

After the NC block has been terminated, the programmed M00 or M01 function appears in the status display until the program is restarted.
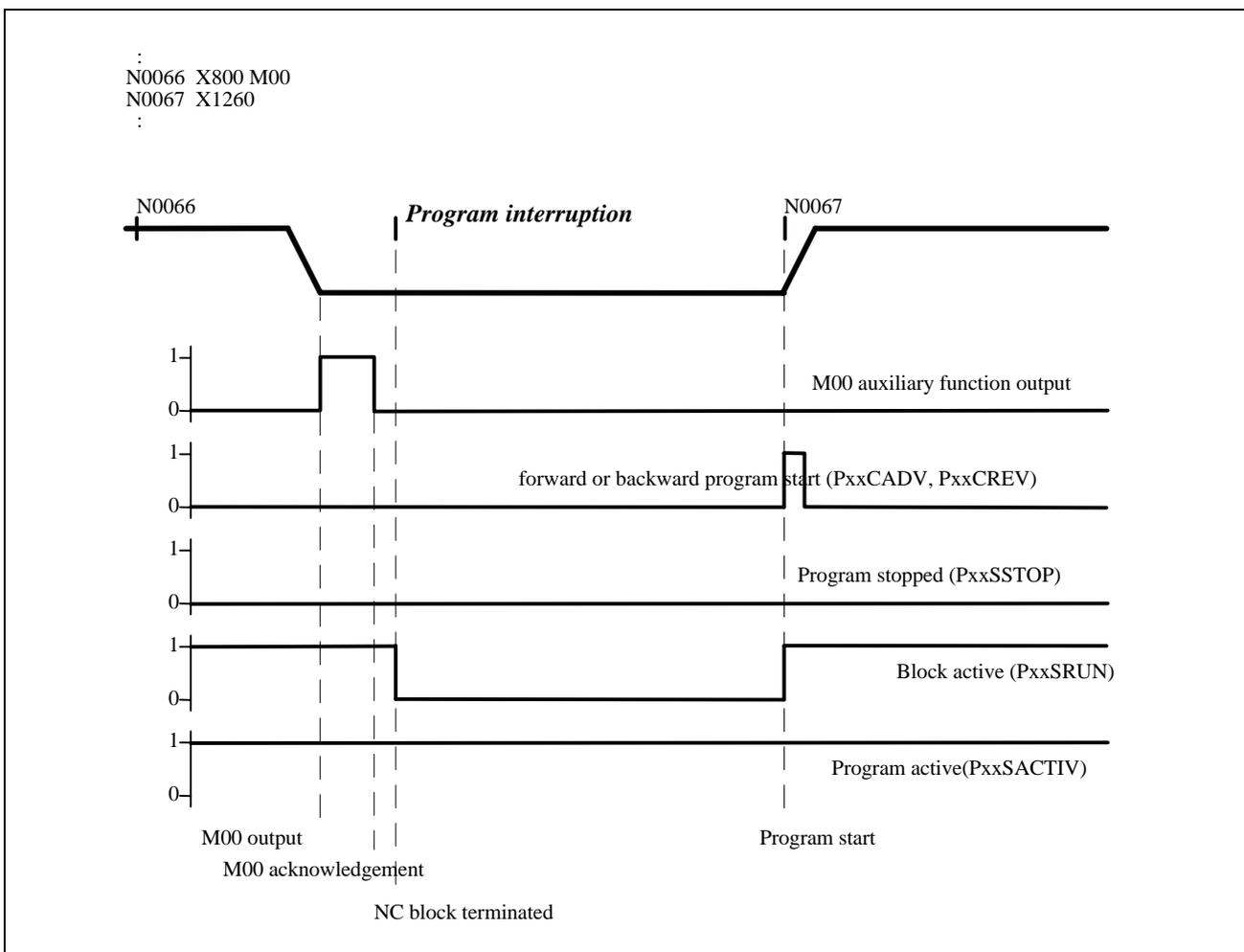
Interface signals

Fig. 5-5: Interface signals for the transfer of the M00 and M01 auxiliary functions

---

Instruction: In the case of the M00 and M01 functions and with the HLT command, the NC does not set the 'Program halted' (PxxSSTOP) status signal.

M Functions M02 and M30

Sequence   Irrespective of the programmed sequence in the NC block, the NC transfers the M functions M02 and M30 to the PLC at the end of the movement. The NC terminates program execution and resets the program (PxxSACTIV = 0 and PxxSRUN = 0) as soon as the auxiliary function concerned has been acknowledged and the NC has processed the remainder of the block.

     The NC restarts program execution upon the next forward or backward start (PxxCADV, PxxCREV).

     After the NC program has been terminated, the programmed M30 or M02 function appears in the status display until the program is restarted.

Interface signals


```
:
N0486  X67
N0487  X800 M30
:
```

N0487   *Program end*   N0000

M30 auxiliary function output

Forward or backward program start (PxxCADV, PxxCREV)

Program stopped(PxxSSTOP)

Block active(PxxSRUN)

Program active (PxxSACTIV)

M30 output   Program start

M30 acknowledgement

NC block and NC program terminated
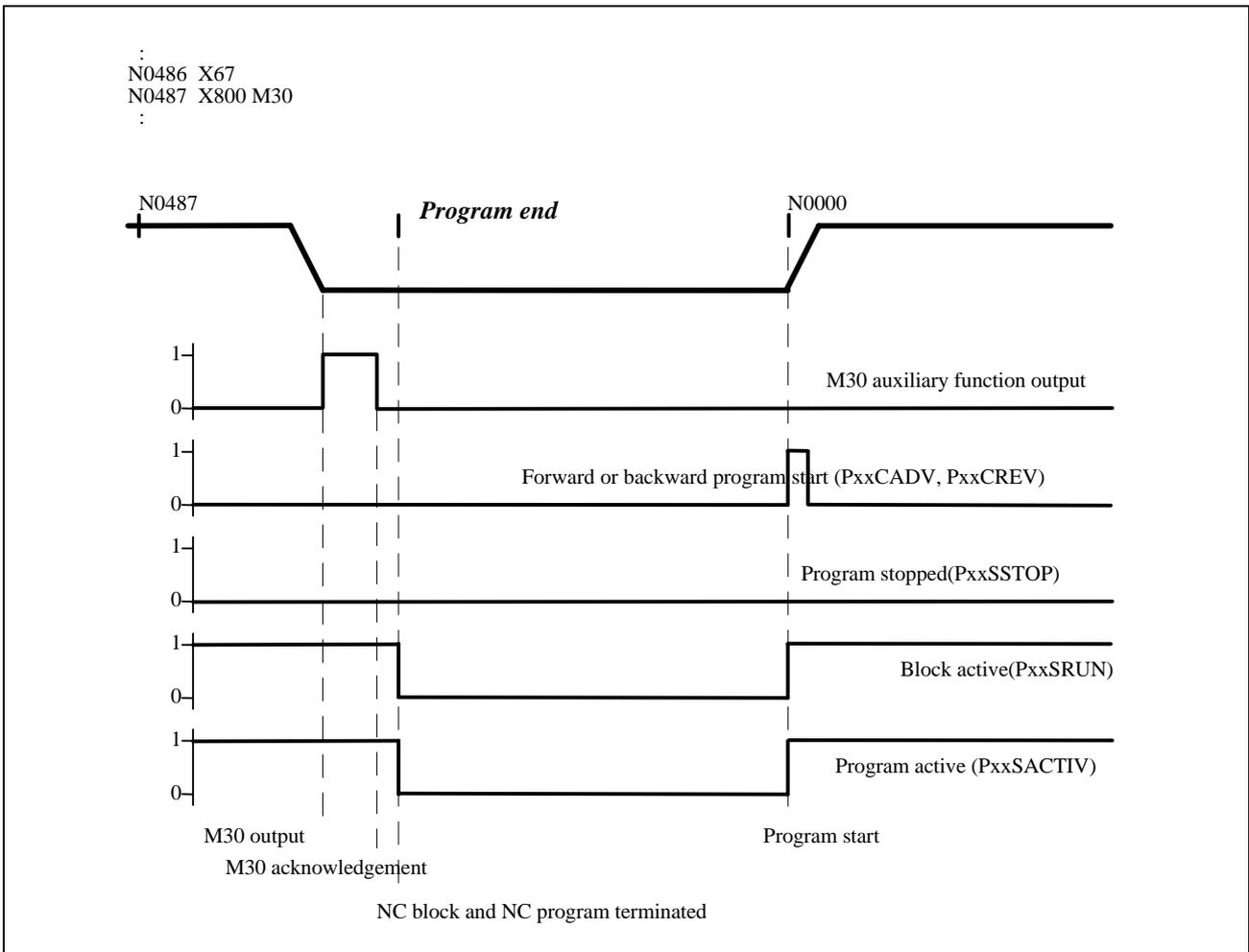
Fig. 5-6: Interface signals for the transfer of the M02 and M30 auxiliary functions

6 Index

7 Table of Figure

Customer Service

Germany

Vertriebsgebiet Mitte	Vertriebsgebiet Ost	Vertriebsgebiet West	Vertriebsgebiet Nord
INDRAMAT GmbH D-97816 Lohr am Main Bgm.-Dr.-Nebel-Str. 2 Telefon: 09352/40-0 Telefax: 09352/40-4885	INDRAMAT GmbH D-09120 Chemnitz Beckerstraße 31 Telefon: 0371/3555-0 Telefax: 0371/3555-230	INDRAMAT GmbH D-40849 Ratingen Hansastraße 25 Telefon: 02102/4318-0 Telefax: 02102/41315	INDRAMAT GmbH D-22085 Hamburg Fährhausstraße 11 Telefon: 040/227126-16 Telefax: 040/227126-15
Vertriebsgebiet Süd	Vertriebsgebiet Südwest		INDRAMAT Service-Hotline
INDRAMAT GmbH D-80339 München Ridlerstraße 75 Telefon: 089/540138-30 Telefax: 089/540138-10	INDRAMAT GmbH D-71229 Leonberg Böblinger Straße 25 Telefon: 07152/972-6 Telefax: 07152/972-727		INDRAMAT GmbH Telefon: D-0172/660 040 6 -oder- Telefon: D-0171/333 882 6

Customer Service in Germany

Europe

Austria	Austria	Belgium	Denmark
G.L.Rexroth Ges.m.b.H. Geschäftsbereich INDRAMAT A-1140 Wien Hägelingasse 3 Telefon: 1/9852540-400 Telefax:1/9852540-93	G.L.Rexroth Ges.m.b.H. Geschäftsbereich INDRAMAT A-4061 Pasching Randlstraße 14 Telefon: 07229/4401-36 Telefax: 07229/4401-80	Mannesmann Rexroth N.V.-S.A. Geschäftsbereich INDRAMAT B-1740 Ternat Industrielaan 8 Telefon: 02/5823180 Telefax: 02/5824310	BEC Elektronik AS DK-8900 Randers Zinkvej 6 Telefon: 086/447866 Telefax: 086/447160
England	Finnland	France	France
Mannesmann Rexroth Ltd. INDRAMAT Division Cirencester, Glos GL7 1YG 4 Esland Place, Love Lane Telefon: 01285/658671 Telefax: 01285/654991	Rexroth Mecman OY SF-01720 Vantaa Riihimiehentie 3 Telefon: 0/848511 Telefax: 0/846387	Rexroth - Sigma S.A. Division INDRAMAT F-92632 Gennevilliers Cedex Parc des Barbanniers 4, Place du Village Telefon: 1/41475430 Telefax: 1/47946941	Rexroth - Sigma S.A. Division INDRAMAT F-69634 Venissieux - Cx 91, Bd 1 Joliot Curie Telefon: 78785256 Telefax: 78785231
France	Italy	Italy	Netherlands
Rexroth - Sigma S.A. Division INDRAMAT F-31100 Toulouse 270, Avenue de lardenne Telefon: 61499519 Telefax: 61310041	Rexroth S.p.A. Divisione INDRAMAT I-20063 Cernusco S/N.MI Via G. Di Vittoria, 1 Telefon: 02/92365-270 Telefax: 02/92108069	Rexroth S.p.A. Divisione INDRAMAT Via Borgomanero, 11 I-10145 Torino Telefon: 011/7712230 Telefax: 011/7710190	Hydraudyne Hydrauliek B.V. Kruisbroeksestraat 1a P.O. Box 32 NL-5280 AA Boxtel Telefon: 04116/51951 Telefax: 04116/51483
Spain	Spain	Sweden	Switzerland
Rexroth S.A. Centro Industrial Santiago Obradors s/n E-08130 Santa Perpetua de Mogoda (Barcelona) Telefon: 03/718 68 51 Telex: 591 81 Telefax: 03/718 98 62	Goimendi S.A. División Indramat Jolastokieta (Herrera) Apartado 11 37 San Sebastion, 20017 Telefon: 043/40 01 63 Telex: 361 72 Telefax: 043/39 93 95	AB Rexroth Mecman INDRAMAT Division Varuvägen 7 S-125 81 Stockholm Telefon: 08/727 92 00 Telefax: 08/64 73 277	Rexroth SA Département INDRAMAT Chemin de l`Ecole 6 CH-1036 Sullens Telefon: 021/731 43 77 Telefax: 021/731 46 78
Switzerland	Russia		
Rexroth AG Geeschäftsbereich INDRAMAT Gewerbestraße 3 CH-8500 Frauenfeld Telefon: 052/720 21 00 Telefax: 052/720 21 11	Tschudnenko E.B. Arsenia 22 153000 Ivanovo Rußland Telefon: 093/22 39 633		

Customer Service in Europe

Outside of Europe

Argentina	Argentina	Australia	Brazil

Mannesmann Rexroth S.A.I.C.
Division INDRAMAT
Acassusso 48 41/7
1605 Munro (Buenos Aires)
Argentina
 	
Telefon: 01/756 01 40
            01/756 02 40
Telex: 262 66 rexro ar
Telefax: 01/756 01 36
	Nakase
	Asesoramiento Tecnico
	Diaz Velez 2929
	1636 Olivos
	(Provincia de Buenos Aires)
	Argentina
	Argentina
	
	Telefon 01/790 52 30
		Australian Industrial Machenery
		Services Pty. Ltd.
		Unit 3/45 Horne ST
		Campbellfield VIC 2061
		Australia
		
		Telefon: 03/93 59 0228
		Telefax: 03/93 59 02886
			Mannesmann Rexroth Automação
			Ltda.
			Divisão INDRAMAT
			Rua Georg Rexroth, 609
			Vila Padre Anchieta
			BR-09.951-250 Diadema-SP
			Caixa Postal 377
			BR-09.901-970 Diadema-SP
			
			Telefon: 011/745 90 65
			            011/745 90 70
			Telefax: 011/745 90 50

Canada	China	China	China
Basic Technologies Corporation Burlington Division 3426 Mainway Drive Burlington, Ontario Canada L7M 1A8 Telefon: 905/335-55 11 Telefax: 905/335-41 84	Rexroth (China) Ldt. Shanghai Office Room 206 Shanghai Intern. Trade Centre 2200 Yanan Xi Lu Shanghai 200335 P.R. China Telefon: 021/627 55 333 Telefax: 021/627 55 666	Rexroth (China) Ldt. Shanghai Parts & Service Centre 199 Wu Cao Road, Hua Cao Minhang District Shanghai 201 103 P.R. China Telefon: 021/622 00 058 Telefax: 021/622 00 068	Rexroth (China) Ldt. 1430 China World Trade Centre 1, Jianguomenwai Avenue Beijing 100004 P.R. China Telefon: 010/50 50 380 Telefax: 010/50 50 379
China	Honkong	India	Japan

Rexroth (China) Ldt.
A-5F., 123 Lian Shan Street
Sha He Kou District
Dalian 116 023
P.R. China
 	
Telefon: 0411/46 78 930
Telefax: 0411/46 78 932
	Rexroth (China) Ldt.
	19 Cheung Shun Street
	1st Floor, Cheung Sha Wan,
	Kowloon, Honkong
	
	Telefon: 741 13 51/-54 und
	            741 14 30
	Telex: 3346 17 GL REX HX
	Telefax: 786 40 19
	            786 07 33
		Mannesmann Rexroth (India) Ltd.
		INDRAMAT Division
		Plot. 96, Phase III
		Peenya Industrial Area
		Bangalore - 560058
		
		Telefon: 80/839 21 01
		            80/839 73 74
		Telex: 845 5028 RexB
		Telefax: 80/839 43 45
			Rexroth Co., Ltd.
			INDRAMAT Division
			I.R. Building
			Nakamachidai 4-26-44
			Tsuzuki-ku, Yokohama 226
			Japan
			
			Telefon: 045/942-72 10
			Telefax: 045/942-03 41

Korea	Korea	Mexico	
Rexroth-Seki Co Ltd. 1500-12 Da-Dae-Dong Saha-Gu, Pusan, 604-050 Telefon: 051/264 90 01 Telefax: 051/264 90 10	Seo Chang Corporation Ltd. Room 903, Jeail Building 44-35 Yoido-Dong Youngdeungpo-Ku Seoul, Korea Telefon: 02/780-82 07 ~9 Telefax: 02/784-54 08	Motorización y Diseño de Controles, S.A. de C.V. Av. Dr. Gustavo Baz No. 288 Col. Parque Industrial la Ioma Apartado Postal No. 318 54060 Tlalnepantla Estado de Mexico Telefon: 5/397 86 44 Telefax: 5/398 98 88	
USA	USA		
Rexroth Corporation INDRAMAT Division 5150 Prairie Stone Parkway Hoffman Estates, Illinois 60192 Telefon: 847/645-36 00 Telefax: 857/645-62 01	Rexroth Corporation INDRAMAT Division 2110 Austin Avenue Rochester Hills, Michigan 48309 Telefon: 810/853-82 90 Telefax: 810/853-82 90		

Customer Service ouside of Europe

Indramat