SIEMENS

# SINUMERIK

# SINUMERIK 840D sl
# Tool Management

Function Manual


Preface

Introduction 1

Overview 2

Description of functions 3

Commissioning 4

Programming 5

Machine data 6

Signal description of the PLC interface 7

Alarms 8

Appendix A


Valid for

*Control*
SINUMERIK 840D sl / 840DE sl

| *Software* | *Version* |
|---|---|
| CNC software | 4.5 |


02/2012
6FC5397-6BP40-3BA0

## Legal information

### Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

**⚠ DANGER**

indicates that death or severe personal injury **will** result if proper precautions are not taken.

**⚠ WARNING**

indicates that death or severe personal injury **may** result if proper precautions are not taken.

**⚠ CAUTION**

indicates that minor personal injury can result if proper precautions are not taken.

**NOTICE**

indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

### Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

### Proper use of Siemens products

Note the following:

**⚠ WARNING**

Siemens products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by Siemens. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

### Trademarks

All names identified by ® are registered trademarks of Siemens AG. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

### Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

Siemens AG
Industry Sector
Postfach 48 48
90026 NÜRNBERG
GERMANY

Order number: 6FC5397-6BP40-3BA0
℗ 08/2012 Technical data subject to change

Copyright © Siemens AG 2012.
All rights reserved

# Preface

## SINUMERIK documentation

The SINUMERIK documentation is organized in the following categories:

- General documentation
- User documentation
- Manufacturer/service documentation

## Additional information

You can find information on the following topics at www.siemens.com/motioncontrol/docu:

- Ordering documentation/overview of documentation
- Additional links to download documents
- Using documentation online (find and search in manuals/information)

Please send any questions about the technical documentation (e.g. suggestions for improvement, corrections) to the following address:

docu.motioncontrol@siemens.com

## My Documentation Manager (MDM)

Under the following link you will find information to individually compile OEM-specific machine documentation based on the Siemens content:

www.siemens.com/mdm

## Training

For information about the range of training courses, refer under:

- www.siemens.com/sitrain

  SITRAIN - Siemens training for products, systems and solutions in automation technology
- www.siemens.com/sinutrain

  SinuTrain - training software for SINUMERIK

## FAQs

You can find Frequently Asked Questions in the Service&Support pages under Product Support. http://support.automation.siemens.com

## SINUMERIK

You can find information on SINUMERIK under the following link:

www.siemens.com/sinumerik

## Target group

This publication is intended for:

- Project engineers
- Technologists (from machine manufacturers)
- System commissioning engineers (who commission systems/machines)
- Programmers

## Benefits

The function manual describes the functions so that the target group knows them and can select them. It provides the target group with the information required to implement the functions.

## Standard scope

This documentation describes the functionality of the standard scope. Additions or changes made by the machine manufacturer are documented by the machine manufacturer.

Other functions not described in this documentation might be executable in the control. This does not, however, represent an obligation to supply such functions with a new control or when servicing.

Furthermore, for the sake of clarity, this documentation does not contain all detailed information about all types of the product and cannot cover every conceivable case of installation, operation or maintenance.

## Technical Support

You will find telephone numbers for other countries for technical support in the Internet under http://www.siemens.com/automation/service&support

# Table of contents


**Preface** ..... **3**

**1 Introduction** ..... **11**

1.1 Overview ..... 11

**2 Overview** ..... **19**

2.1 Function structure of tool management ..... 19

2.2 HMI/PLC - NCK data structure (OPI) ..... 20

2.3 PLC – NCK interfaces ..... 22

2.4 Magazine configuration ..... 24

2.5 Access protection, protection levels ..... 25

**3 Description of functions** ..... **27**

3.1 Magazines ..... 27
3.1.1 Buffer ..... 27
3.1.2 Loading magazine ..... 28
3.1.3 Box-type and chain magazines ..... 28
3.1.4 Circular magazine ..... 30
3.1.5 Other magazine types ..... 31
3.1.6 Wear group ..... 31
3.1.7 Background magazine ..... 33
3.1.8 Consider adjacent location ..... 34

3.2 Several tools at a magazine location (multitool) ..... 36
3.2.1 Short description ..... 36
3.2.2 Programming ..... 41
3.2.3 $TC_MTP - multitool data ..... 41
3.2.4 Tool change with a tool from a multitool ..... 53

3.3 Tool change box-type, chain, circular magazines ..... 66
3.3.1 Prepare a tool change ..... 66
3.3.2 General tool change sequence ..... 68
3.3.3 Monitoring the maximum speed of a tool ..... 73
3.3.4 Selecting a tool and a cutting edge ..... 79
3.3.5 Predecoding (preprocessing) and block execution (main run) ..... 81
3.3.6 Traverse axes while tool is being changed ..... 83
3.3.7 Tool change in the spindle for chain and box-type magazines ..... 84
3.3.8 Special cases "T0", empty spindle, multiple T selection ..... 88
3.3.9 Tool change with turret ..... 88
3.3.10 Number of replacement tools ..... 89
3.3.11 Tool changing errors ..... 90
3.3.12 Manual tools (adding tools during machining) ..... 91
3.3.13 Tool changes in the NCK using synchronized actions ..... 99
3.3.14 Function replacement ..... 103
3.3.15 Block search ..... 108

3.3.16 Block search (SSL) in conjunction with active tool management ..... 110
3.3.17 Program test ..... 113
3.3.18 Several spindles in one channel or TO unit ..... 115
3.3.19 Decoupling the tool management from the spindle number ..... 116
3.3.20 Several spindles/toolholders ..... 123
3.3.21 Several magazines in one channel or one TO unit ..... 124
3.3.22 Reset and start mode ..... 125
3.3.23 Repeating a tool change with the same tool identifier ..... 133

3.4 Search for tool ..... 137
3.4.1 Strategies for tool searches ..... 137

3.5 Empty location search ..... 139
3.5.1 Empty location search for a tool – from spindle to magazine ..... 139
3.5.2 Search strategy for empty locations ..... 140
3.5.3 Assigning a hierarchy to the location types ..... 141
3.5.4 New type of location type hierarchy ..... 142
3.5.5 Search procedure for empty locations ..... 144
3.5.6 Search strategy, 1:1 exchange (old for new) ..... 144
3.5.7 Tool search in wear group ..... 146

3.6 Loading ..... 150
3.6.1 Loading sequence ..... 150
3.6.2 Function of the PLC when loading? ..... 150
3.6.3 Loading by directly assigning the T number ..... 152
3.6.4 Load tools via a part program ..... 152
3.6.5 Retroload tool data ..... 153

3.7 Unloading ..... 156
3.7.1 Overview ..... 156
3.7.2 PLC function when unloading ..... 156
3.7.3 Unloading by deleting the T number from the magazine location ..... 158

3.8 Relocating tools and positioning the magazine ..... 159
3.8.1 Relocate (task from TM system) ..... 159
3.8.2 Relocation by the PLC ..... 159
3.8.3 Positioning the magazine ..... 162

3.9 Tool monitoring (workpiece count, tool life, wear) ..... 163
3.9.1 Monitoring types ..... 163
3.9.2 Tool life monitoring ..... 166
3.9.3 Workpiece count monitoring ..... 167
3.9.4 Wear monitoring ..... 168
3.9.5 Signals to and from the PLC ..... 171

3.10 Tool monitoring without active tool management ..... 174
3.10.1 Tool monitoring overview ..... 174
3.10.2 Tool life monitoring ..... 176
3.10.3 Workpiece count monitoring ..... 177
3.10.4 Wear monitoring ..... 177
3.10.5 Monitoring the additive offset ..... 177
3.10.6 Working with replacement tools ..... 178
3.10.7 Examples ..... 178
3.10.8 NC language commands ..... 179

3.11 Variants of D-number assignments ..... 180

3.11.1 Relative D No. for each T - standard ..... 180
3.11.2 Absolute D No. without reference to the T number (flat D No.) ..... 181
3.11.3 Free selection of D numbers for every T ..... 182
3.11.4 Location-dependent offsets (additive offsets) ..... 185

3.12 Adapter data ..... 188
3.12.1 Overview ..... 188
3.12.2 Description of function ..... 189
3.12.3 Activation ..... 189
3.12.4 Transformed data of the active tool $P_ADT[n] ..... 199

3.13 Power failure while tool command is in progress ..... 200

3.14 PLC description ..... 201
3.14.1 Interfaces ..... 201
3.14.2 Definitions of acknowledgement status ..... 207
3.14.3 Simplified acknowledgement of tool management commands ..... 211
3.14.4 Diagnostics for communication between NC and PLC ..... 212
3.14.5 Function blocks ..... 215

**4 Commissioning ..... 217**

4.1 Input of the machine data ..... 217
4.1.1 Input of the machine data ..... 217

4.2 Load the machine manufacturer PLC blocks ..... 221
4.2.1 Overview ..... 221
4.2.2 Create PLC data ..... 222
4.2.3 Description of the test blocks ..... 224
4.2.4 Delete pending tasks ..... 228

**5 Programming ..... 229**

5.1 Overview of OPI and system variables ..... 229

5.2 Cutting edge data ..... 232
5.2.1 Cutting edge data ..... 232
5.2.2 Cutting edge parameters ..... 232
5.2.3 User cutting edge data ..... 235
5.2.4 Cutting edge-related tool monitoring ..... 235
5.2.5 User cutting-edge monitoring ..... 236
5.2.6 Location-dependent offsets, fine (additive offsets) ..... 237
5.2.7 Location-dependent offsets, coarse (setting-up offsets) ..... 238

5.3 Tool data ..... 239
5.3.1 Overview ..... 239
5.3.2 Tool-related data ..... 239
5.3.3 Tool-related grinding data ..... 245
5.3.4 Tool-related user data ..... 246

5.4 Magazine data ..... 247
5.4.1 Overview of magazine data ..... 247
5.4.2 Magazine description data ..... 247
5.4.3 Magazine user data ..... 250
5.4.4 Magazine location data ..... 250
5.4.5 Magazine location user data ..... 254
5.4.6 Magazine location type hierarchy ..... 255
5.4.7 Distance to change position ..... 256

5.4.8 Magazine blocks ... 259
5.4.9 Assigning buffers to spindles ... 268
5.5 Adapter data ... 270
5.6 Toolholder data ... 271
5.7 User-definable variables ... 274
5.8 NC language commands ... 276
5.8.1 CHKDNO - Uniqueness check for D number ... 276
5.8.2 CHKDM - Uniqueness check within a magazine ... 277
5.8.3 GETACTTD - Determining the T No. for a unique D No. ... 278
5.8.4 GETDNO - Rename D numbers ... 278
5.8.5 SETDNO - Rename D numbers ... 279
5.8.6 DZERO - Invalidate D numbers ... 279
5.8.7 DELDL - Delete additive offsets ... 279
5.8.8 NEWT - Create a new tool ... 280
5.8.9 NEWMT - create new multitool ... 281
5.8.10 DELT - Delete tool ... 282
5.8.11 DELMT - deleting a multitool ... 282
5.8.12 GETT - Read T No. ... 282
5.8.13 SETPIECE - decrementing the workpiece counter ... 283
5.8.14 GETSELT - Read the selected T No. ... 286
5.8.15 GETEXET - Reading of the loaded T number ... 286
5.8.16 GETACTT - Read the active internal T No. ... 287
5.8.17 SETMS - Spindle can be declared a master spindle ... 288
5.8.18 SETMTH - Set master toolholder number ... 289
5.8.19 POSM - Positioning the magazine ... 291
5.8.20 POSMT - positioning a multitool on a toolholder to the location number ... 293
5.8.21 MVTOOL - Language command to move tool ... 297
5.8.22 SETTIA - Deactivate tool from wear group ... 300
5.8.23 SETTA - Activate tool from wear group ... 302
5.8.24 RESETMON - Language command for setpoint activation ... 303
5.8.25 DELTC - Delete toolholder data record ... 306
5.8.26 TCA - Tool selection/tool change irrespective of tool status ... 308
5.8.27 Replacement of the TCA command ... 310
5.8.28 TCI - Change tool from buffer into magazine ... 313
5.8.29 GETFREELOC - Search for empty location ... 315
5.8.30 DELMLRES - Delete location status "reserved for tool in the buffer" ... 318
5.8.31 DELMLOWNER - Delete owner magazine location of the tool ... 319
5.8.32 $P_USEKT - Tool change only with tools of subgroup ... 321
5.8.33 TOOLGNT/TOOLGT - Tool groups ... 323
5.8.34 $P_TMNOIS - is a number, T number, magazine number or MT number ... 324
5.8.35 $P_TOOLEXIST - define the existence of a tool ... 324
5.8.36 $A_TOOLMN - Read magazine No. of tool ... 325
5.8.37 $P_MTOOLN / $P_MTOOLMT - determine the number of multitools/MT number ... 325
5.8.38 $P_MTOOLNT / $P_MTOOLT - number of tools in the multitool ... 326
5.8.39 $A_TOOLMLN - Read magazine location No. of tool ... 327
5.8.40 $P_TOOLND - Read number of cutting edges for tool ... 328
5.8.41 $A_MONIFACT - Factor for reading tool life monitoring ... 328
5.8.42 $AC_MONMIN - Factor for tool search ... 330
5.8.43 $P_TOOLNG - Number of tool groups ... 333
5.8.44 $A_MYMN / $A_MYMLN - Owner magazine/location of the tool ... 334

5.8.45 $A_MYMTN / $A_MYMTLN - $A_TOOLMTN / $A_TOOLMTLN - tools in the multitool ..... 335
5.8.46 $P_TOOLNT / $P_TOOLT - T numbers ..... 336
5.8.47 $P_TOOLD - D numbers ..... 337
5.8.48 $P_TOOLNDL - Number of defined DL offsets ..... 337
5.8.49 $A_USEDND - Workpiece counting ..... 338
5.8.50 $A_USEDT - Workpiece counting ..... 339
5.8.51 $A_USEDD - Workpiece count ..... 341
5.8.52 $P_MAGN / $P_MAG - Magazine ..... 342
5.8.53 $P_MAGNDIS / $P_MAGDISS / $P_MAGDISL - magazine distance tables ..... 343
5.8.54 $P_MAGNS / $P_MAGS - Toolholder ..... 344
5.8.55 $P_MAGNREL / $P_MAGREL - Assigned buffer ..... 345
5.8.56 Example of magazine configuration system variables ..... 346
5.8.57 $P_MAGNH / $P_MAGNHLT / $P_MAGHLT - Location type hierarchies ..... 349
5.8.58 $P_MAGNA / $P_MAGA - Tool adapter ..... 351
5.8.59 Additional language commands ..... 351
5.8.60 Variables for subroutine replacement technique ..... 358
5.8.61 Variables for tool change in synchronized action ..... 358

5.9 Definitions when programming data ..... 360
5.9.1 Tool and cutting edge data ..... 360
5.9.2 Magazine data ..... 362
5.9.3 Tool change ..... 364
5.9.4 Cutting edge selection ..... 365
5.9.5 Tool transfer from program test ..... 366

5.10 Programming T=location number ..... 367

5.11 Call multiple turrets with "T=location number" ..... 369

5.12 Programming examples ..... 370
5.12.1 Programming examples ..... 370

5.13 Overview of the remaining OPI blocks of tool management ..... 371
5.13.1 Magazine data, directory ..... 371
5.13.2 Tool data, directory ..... 371
5.13.3 Parameterization, return parameters _N_TMGETT, _N_TSEARC ..... 372
5.13.4 Working offsets ..... 373
5.13.5 PI services and language commands for tool management ..... 373

**6 Machine data ..... 379**

6.1 NC-specific machine data ..... 379

6.2 Channel-specific machine data ..... 404

6.3 Machine data for function replacement ..... 423

6.4 Machine data for the Siemens user data ..... 427

**7 Signal description of the PLC interface ..... 429**

7.1 Overview of data blocks ..... 429

7.2 Interface for loading/unloading magazine ..... 431

7.3 Interface for spindle as change position ..... 436

7.4 Interface for turrets as change position ..... 444

7.5 Interface for loading/unloading magazine (multitool) (DB 1071) ..... 450

7.6 Interface for spindle (multitool) (DB 1072) ..... 452
7.7 Interface for revolver (multitool) (DB 1073) ..... 457
7.8 Interface NC channels ..... 462
7.9 Interface magazine configuration ..... 464
**8 Alarms ..... 465**
8.1 Overview ..... 465
8.2 Alarm description ..... 468
**A Appendix ..... 503**
A.1 List of abbreviations ..... 503
A.2 Documentation overview ..... 505
**Glossary ..... 507**
**Index ..... 519**

# 1 Introduction

## 1.1 Overview

### General

The tool management function (TOOLMAN) ensures that at any given time, the correct tool is in the correct location and that the data assigned to the tool is up to date. The function is used on machine tools with circular magazines, chain magazines or box magazines. It also allows fast tool changes and avoids both scrap by monitoring the tool service life and machine downtimes by using spare tools.

### Tool-management functions

There are 4 different function versions when handling tools:

- **TMBF**: **T**ool **M**anagement (**B**ase **F**unctions)
  Default setting in the NCK
  (TMBF)
- **TMFD: T**ool **M**anagement **F**lat **D** numbers
  (TMFD)
- **TMMO: T**ool **M**anagement Tool (**Mo**nitoring)
  (TMMO)
- **TMMG: T**ool **M**anagement **Mag**azines
  (TMMG)

Included in the basic version of SINUMERIK 840D sl are:

- TMBF or:
- TMBF + TMFD + TMMG

The function is capable of managing up to 30 real magazines with a total of 600 magazine locations and 1500 tools, and up to 12 edges per tool (max. 1500 tool edges). The maximum number of edges per tool depends on the software version and machine data settings.

## Structure

The structure is as follows:

TMBF
Tool management base functions (available even when tool management is not active)

TMMO
Tool monitoring

TMMG
Tool magazine management (only available when tool management is active)

TMFD
Tool management with flat D numbers (only without active tool management)

| Main tool management functions (standard) | HMI-Advanced | SINUMERIK Operate |
|---|---|---|
| System diagrams in the standard software | X | X |
| Options for configuring screen forms and softkeys | X | X |
| User-friendly commissioning via system displays | X | X |
| Editing tool data | X | X |
| Magazine and tool list | X | X |
| Empty location search and location positioning | X | X |
| Loading and unloading of tools | X | X |
| Easy search for empty locations using softkeys | X | X |
| Several real magazines are possible | X | X |
| Several loading and unloading points per magazine | X | X |
| "Relative" D numbers that can be freely numbered | X | - |
| Adapter data | X | - |
| Location-dependent offsets | X | - |
| Data backup via USB | X | X |
| Data backup on hard disk | X | - |
| Data backup via CF Card | | X |

This document describes the scope of the tool management functions. Tool management functions are included in SINUMERIK Operate, NCK and PLC. The appropriate functions are shown in the function structure (see Fig. 2-1). Tool Management is sub-divided into several sub-areas.

## Basic functions

The basic functions are generally available, even in systems without an active TM system. Basic functions include, for example, creating and deleting tools, entering offsets and tool changes. On the basic function level, a specific number (max. 12) of tool edges (D numbers) is assigned to each T number (tool identification).

Alternatively, the function TMFD or "Flat D numbers" (freely selectable D number independently of the T number) can be activated in systems without active tool management. You can select any number of tool edges per tool; the number of edges per tool is not limited to 12. With "Flat D Numbers", the user is responsible for management and assignment of T numbers to D numbers.

**Note**

SINUMERIK Operate does not support the function "flat D numbers".

## Special functions

The miscellaneous functions of tool management are magazine management, tool and empty location search and monitoring the tool life, workpiece numbers or wear values. These additional functions are only available when tool management is active.

Magazine management functions must be implemented by the machine manufacturer in systems without active tool management. These will generally be executed via the PLC.

## Magazine management

Magazine management administers magazine locations. These locations might be empty, loaded with tools or assigned to oversized tools in adjacent locations.

Empty locations can be "loaded" with other tools. The tool management provides the machine manufacturer with optimized management of tools and magazine locations.

Magazine management provides extended functions such as load, unload or position tools. It also includes searches for tools, magazine locations and search strategies for replacement tools. For the tool monitoring functions, while the activated monitoring is running, tools are disabled and no longer used. For further machining, if a similar tool (duplo tool) is present which is not disabled, then this tool is used automatically.

In the simplest case scenario, all that needs to be configured when tool management is activated are magazines, loading magazines, spindles, grippers, etc. Furthermore, the interfaces (DB 71 to DB 73) must be processed in the PLC.

Task-related tool motions (e.g. position chain, swivel gripper) are derived from the interface processing. On completion of tool motion, the positions and task status should be acknowledged via basic program blocks (FC 6, FC 7 and FC 8). A detailed description of the acknowledgements is provided under the index entries "Acknowledgement: simplified", "Acknowledgement status" and "Changing acknowledgement data".

If necessary, create another cycle (or ASUB) for the NC program where tool changing is programmed with the required travel motions. An identifier is programmed for the tool change or tool preselection when the TM system is active. A duplo number is also available to support unique identification of replacement tools. Tool identifier and duplo numbers are always mapped on an internally assigned T number. This internally assigned T number is used for addressing the variables described in the following.

### OPI variables

Additional functions are available using OPI variables on the PLC or HMI side. The NC program (e.g. cycle, ASUB) provides corresponding language commands to achieve optimum adaptation of the tool management to the machine environment. You can obtain a clear overview from the data structures that form the basis of the tool management. They are represented in the form of NC data blocks.

### Operator panels

The following operator panels can be used for tool management (TOOLMAN):

- HMI-Advanced
- OP177, e.g. for loading magazines
- OP8T, e.g. for box-type magazines

### Data

Data storage and management is carried out in the NC and SINUMERIK Operate. All data can be read and written manually, via the NC program or by data transfer.

### Operator input

Operation is performed via system screens. These include screens for start-up (HMI Advanced) and screens for tool management operation (magazine lists, tool lists, loading/unloading).

## Programming in the NC part program

The tool management function makes it possible to call a tool in the part program using a name (identifier), e.g. T = "end mill 120 mm".

Tool call is still possible via the T no. (tool number). The T No. is then the name of the tool (e.g. T=12345678).

A tool is uniquely defined by its name and duplo number. Furthermore, each tool can be uniquely identified by its "internal" T number. The internal T number is as a rule assigned by NCK and is not used for programming a tool change in the main program.

Using a machine data, it can be set as to whether the change is realized using the T command (typical for lathes) or whether the tool is prepared using T programming and then it is first changed with M06. This machine data setting is independent of the magazine type.

The following characters are permitted for the identifier:

[ _ ] [ a...z ] [ A...Z ] [ 0...9 ] ; [ + - . , ]

Identifiers are case-sensitive, i.e. differentiate between uppercase and lowercase characters.

## PLC

There are data blocks (DB 71-73) as well as DB 1071-1073 for receiving tool management commands and function blocks (FC 6, 7, 8) for acknowledging the tool management commands. A "fast acknowledgement" is implemented for simple applications in data blocks DB71...73.

Another block, FC 22, is used as a direction selection for magazines.

Tool management data can also be read and written via FB 2, 3. Complex tool management services can be initiated by FB 4.

## Magazine types

Circular, chain magazines and box magazines can be managed. Other magazine types, e.g. pick-up magazine, are mapped onto these.

Real magazines can be defined as a circular, chain or box-type. Loading points or loading stations shall be used as the magazine type for loading and unloading.

A magazine buffer combines all other locations in which tools can be placed (spindle, gripper, ...).

### Location coding

Fixed location coding as well as variable location coding are supported for the tools.

### Location type

The location type defines the type and shape of the location. By assigning location types to magazine locations it is possible to subdivide a magazine into areas. This means that different types of special tools, e.g. "especially_large, "especially_heavy can be assigned to specific locations.

The location types can be placed in ascending order - a so called hierarchy. This order determines that a tool that is supposed to be inserted in a "small" location type can also be placed in a "larger" location type if no "smaller" location type is vacant.

### Monitoring functions

In tool management, it is possible to select either workpiece counts or tool life monitoring (with reference to the cutting edges). Further, a wear monitoring function is available. Replacement tools (duplo tools) are differentiated by means of a duplo number.

### Search strategy

Various strategies are possible for tool search and to search for the empty location of the "old tool".

The empty location search strategy is used for loading tools.

## Excerpt from TM basic data

| Term | Data/Range |
|---|---|
| Magazine configuration per channel | 1 |
| Total number of magazines | Max. 32 |
| Total number of magazine locations | Max. 600 |
| Total number of tools | Max. 600 per TO unit / max. 1500 across all TO units |
| Programming tools (names) in the NC program using 32 alphanumeric characters | e.g. T="angled miller_32" |
| Duplo number | 1 – 32000 |
| Total number of cutting edges | Max. 1500 |
| Location type definition | Yes |
| Viewing adjacent locations in half locations | 2dimensional |
| Location coding | Fixed or variable |
| Strategy for tool search | can be set (programmable) via system variables |
| Strategy for empty location search | can be set (programmable) via system variables |
| M06 command for tool change | M code, settable via MD, channel-specific |
| Tool change with M06 or T command | settable via MD, channel-specific |
| Wear monitoring | For every cutting edge |
| Wear monitoring according to tool life | Resolution ms |
| Wear monitoring according to number of workpieces | Counters |
| Access to tool management data via NC program | System variables |
| Automatic decoding stop until tool is selected. | Yes |
| T=Location No. | settable via MD |

## Option

Tool management with more than one real magazine (if more than 3 magazines, e.g. pick-up tool change in a spindle with loading magazine, then a buffer is required) is an OPTION.

# 2 Overview

## 2.1 Function structure of tool management

**HMI**

- Tool list
- Tool wear list
- OEM tool list
- Magazine list

**NCK**

- Manage tool data
  State
  Monitoring
  Offsets
- Manage magazine data
  Magazine
  Magazine locations
- Tool management
  Search for tool
  Search for empty location
  Change tool
  Load, unload

**PLC**

- Magazine control
- Gripper control
- Spindle control
- Safety interlocks
- Execute tool change
- Calculation of position, if necessary
- Own change strategy, if required

# 2.2 HMI/PLC - NCK data structure (OPI)

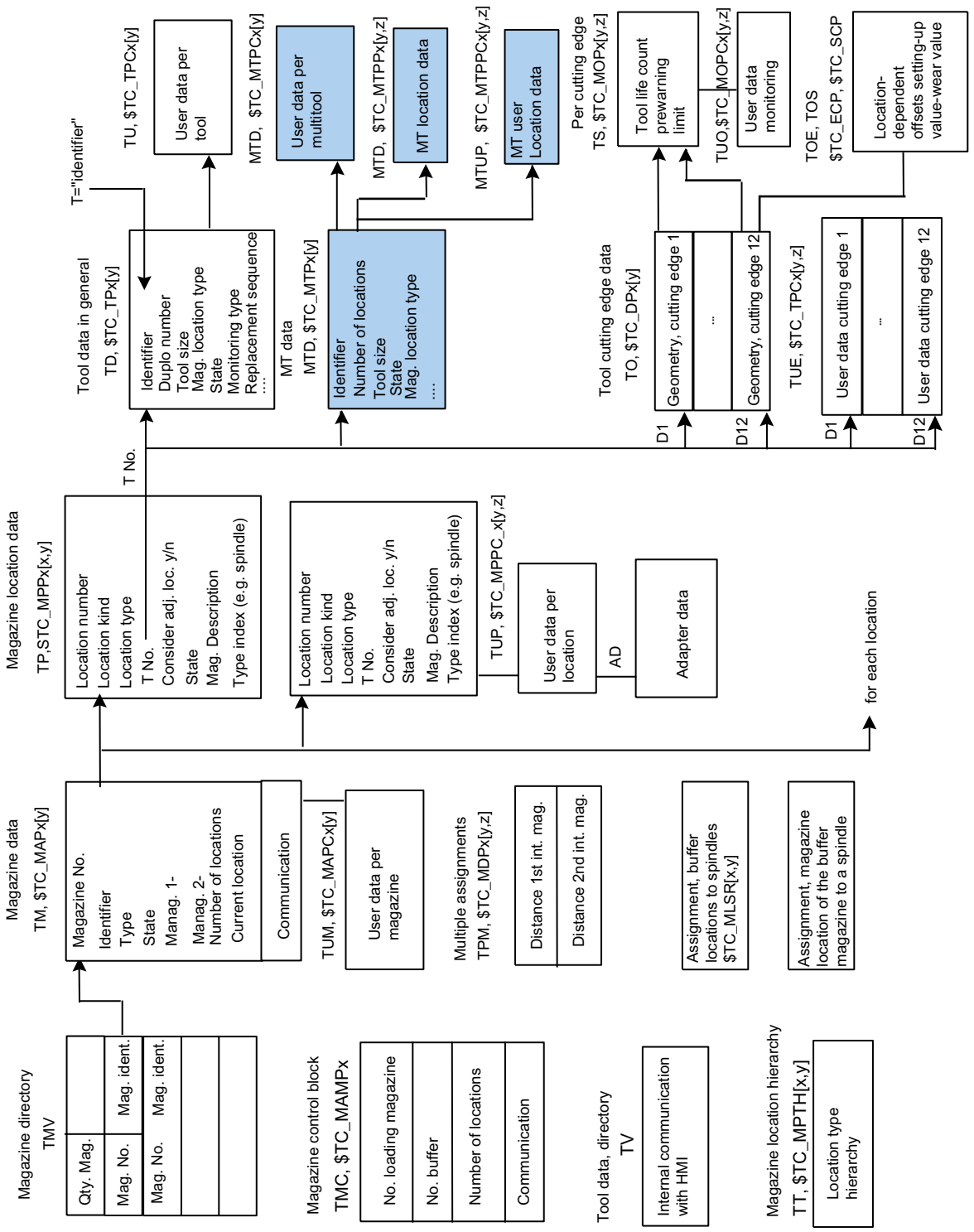



Figure 2-1 Structure of magazine data and tool data

Unchecked boxes mark the previous data of the tool management. Checked boxes show the user data.

New data blocks are displayed as checked and grayed boxes.

## TOA area

A TOA area constitutes and independent group in tool management. There is no link existing to other TOA areas.

Up to 10 independent TOA areas may be created depending on the number of channels available. Several channels can be assigned to one TOA area but one channel cannot be assigned to more than one TOA area. A subset of magazines, buffer locations and loading magazines can be assigned to one TOA area.

# 2.3 PLC – NCK interfaces

## Overview

The heart of the SINUMERIK 840D sl tool management system is located on the NCK. The PLC merely contains the interfaces for the machine-specific part (see Fig. 2-2).

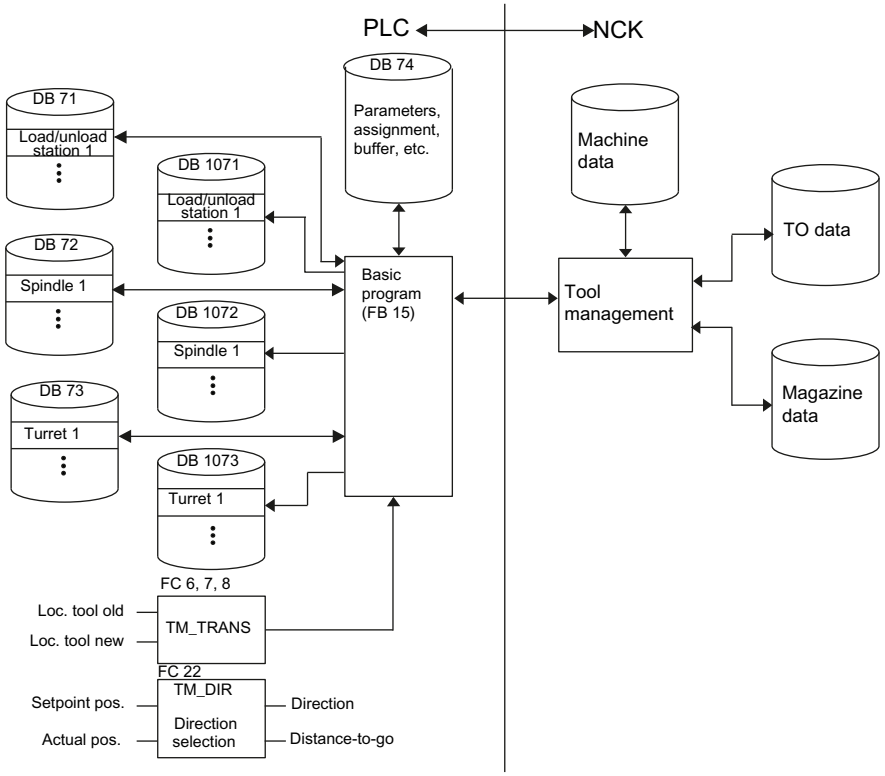



Figure 2-2 Data structure and PLC - NCK interface

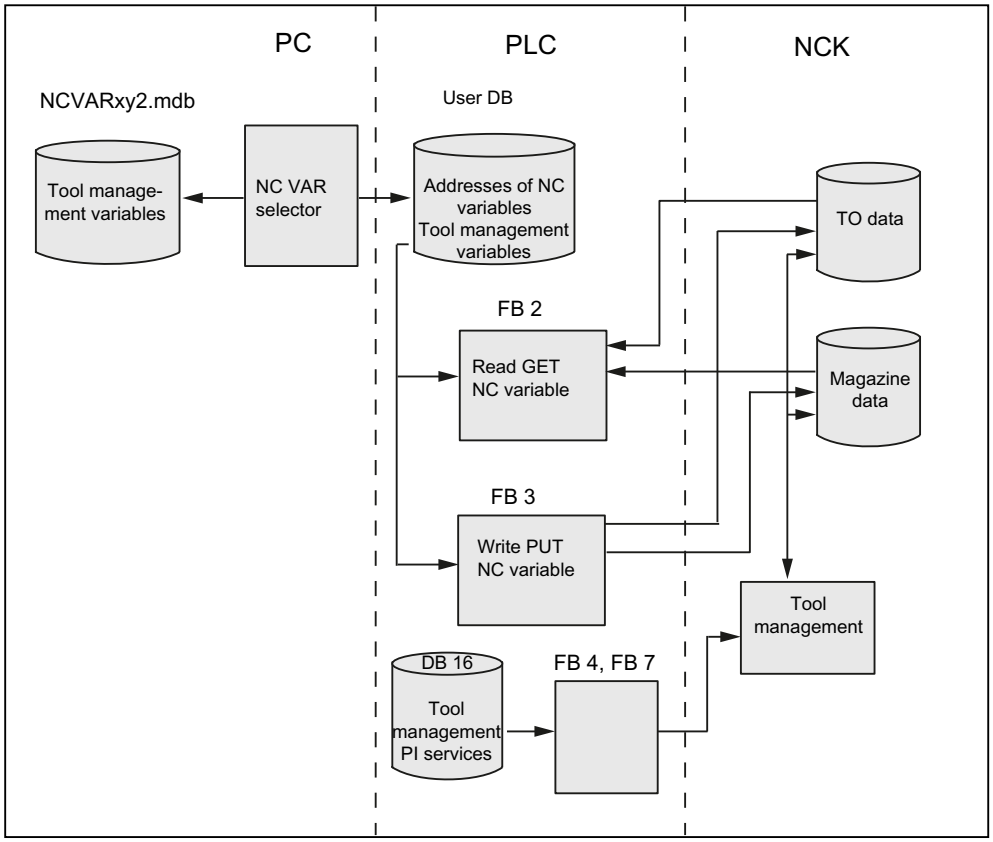



Figure 2-3 Extended interface for tool management between PLC and NCK

# 2.4 Magazine configuration

## Magazine configuration

In a configuring process, (HMI or NC program) one or several real (actual magazine to store tools, NCK can manage several magazines), magazines can be combined on the HMI to form a magazine configuration. All the magazines of one configuration can be operated simultaneously in one channel. Several magazine configurations can be defined but only one configuration can be active in one channel at one time.

Magazine and tool data are stored in the NC in the so-called TO area. The TO area can in turn be sub-divided by machine data into individual TO units. It must further be defined by machine data, which channel works or which channels work on which TO units. Only one magazine configuration can be active at any one time per TO unit. If several channels are assigned to a TO unit, then the magazine configuration applies for all assigned channels.

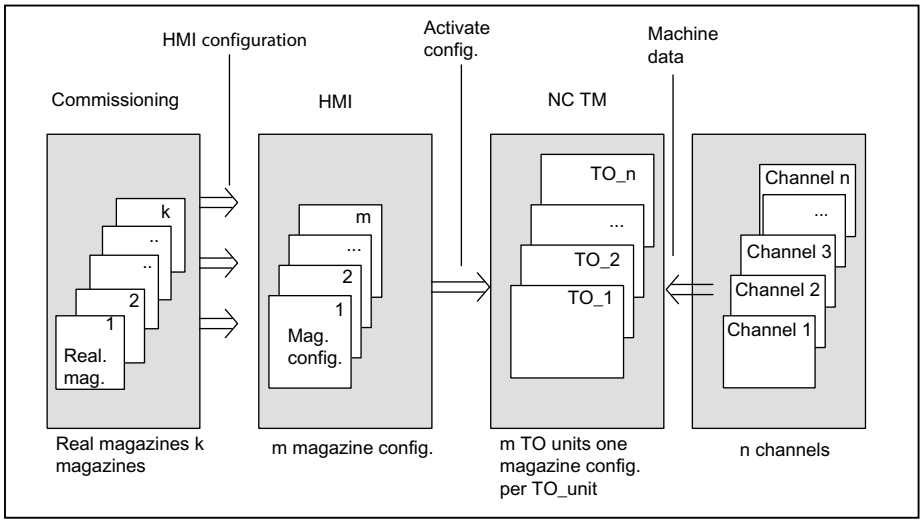



Figure 2-4 Assignment of magazines to channels

## 2.5 Access protection, protection levels

The access to programs, data and functions is protected via 8 hierarchical levels according to customer requirements. These are divided into

- 4 password levels for Siemens, machine manufacturers and end users
- 4 keyswitch positions for end users

| Protection level | Locked by: | User |
|---|---|---|
| 0 | Password | Siemens |
| 1 | Password | Machine manufacturer: Development |
| 2 | Password | Machine manufacturer: Commissioning engineer |
| 3 | Password | End user: Service |
| 4 | Keyswitch, position 3 | End user: Programmer, machine setter |
| 5 | Keyswitch, position 2 | End user: Qualified operator, who does not program |
| 6 | Keyswitch, position 1 | End user: Selected operator, who does not program |
| 7 | Keyswitch, position 0 | End user: Semi-skilled operator |

Examples of functions that can be disabled using HMI-Advanced:

- Loading
- Unloading
- Magazine list, tool list display
- Tool cabinet, tool catalog
- Loading the magazine configuration

# Description of functions

# 3

## 3.1 Magazines

### 3.1.1 Buffer

A buffer involves the 2nd internal magazine. The magazine number is always 9998. The buffer includes the spindle, toolholder, gripper, loader and transfer location. The locations are numbered, just like a real magazine, ascending from 1-n. Every location has a location index. Here, it is assigned as to which is the 1st spindle or the 1st gripper. Any numbering can be used. However, transparency is improved if the locations of a location type (all spindles, all grippers,...) are numbered in an ascending sequence. Also refer to Chapter 5.4.4.

The NCK only makes a differentiation between spindles or toolholders and grippers. Other "location types" such as loaders or the transfer location are mapped on the gripper.

Example: Assigning the locations in the buffer magazine

| No. | Name | Type | Index | Assignment to spindles | Distances to magazine |
|---|---|---|---|---|---|
| 1 | Spindle_1 | Spindle | 1 | | 0 |
| 2 | Gripper_1 | Gripper | 1 | | 0 |
| 3 | Gripper_2 | Gripper | 2 | | 0 |
| 4 | Loader_1 | Loader | 3 | | 0 |
| 5 | Loader_2 | Loader | 4 | | 0 |
| 6 | Transfer_1 | Transfer location | 5 | | 0 |

## 3.1.2 Loading magazine

The loading magazine is the 1st internal magazine and always has magazine number 9999.
The loading magazine contains loading locations.
These are sub-divided into

- Loading points and
- Loading stations

Loading points and stations are provided for loading and unloading tools. The allocation of locations is fixed, all other locations can be assigned freely. Location 1 in the loading magazine is used for the fixed assignment.

Location 1 is reserved for loading/unloading in all spindles/toolholders, as well as to load and remove manual tools (see Manual tools (adding tools during machining) (Page 91). A loading point is an open entry to the magazine where tools can be **manually** put into and taken directly from the magazine.

A loading station is viewed as an "external magazine location" which a gripper, for example, can access to transport a tool to the magazine during loading.

The difference between a loading point and a loading station is as follows:

When loading a tool at a loading/unloading point, the tool is automatically removed from this location, while when unloading to an unload station, it remains at the loading or unloading location. - it must then be removed from there by the application (HMI, NC cycle or PLC).

## 3.1.3 Box-type and chain magazines

### Fundamentals

Chain and box-type magazines do not as a rule have any additional buffer available for transportation between magazine and spindle. These additional buffers can temporarily contain tools.

The command is distributed in the PLC using the basic program. In this case, DB 72 acts as the user interface. There is a separate interface area for each spindle in the interface. A new command from the NCK is only then entered in the interface once the previous command has been acknowledged with status values 1 ...7 via FC 8/FC 6.

1. The programming function T = identifier is implemented in the PLC in data block DB 72. Bit "Prepare tool" is set in the associated interface.
2. Programming function M06 is also implemented in DB 72. In this instance, bit "Change tool" is set in the activated interface. The bit "Prepare tool" from an earlier T command is not reset here. If the bit "Prepare tool" shall no longer be set for the M06, then it is the task of the user program to reset this bit as part of acknowledging the last T command.
3. Programming functions T and M06 in the same block set the "Prepare tool" and "Change tool" bits simultaneously in the activated DB 72 interface.

Exceptional cases which are emulated in the PLC identically to case 3 above are as follows:

- Initiation of a tool change after block search (last accumulated tool change for the active tool)
- Initiation of a tool change for initialization blocks (reset and start mode), if this was set via the machine data.

**Note**

In these exceptional cases, the subroutine (macro, cycle) in which M06 is normally programmed is not executed.

## Example for machine tools with chain and box-type magazines

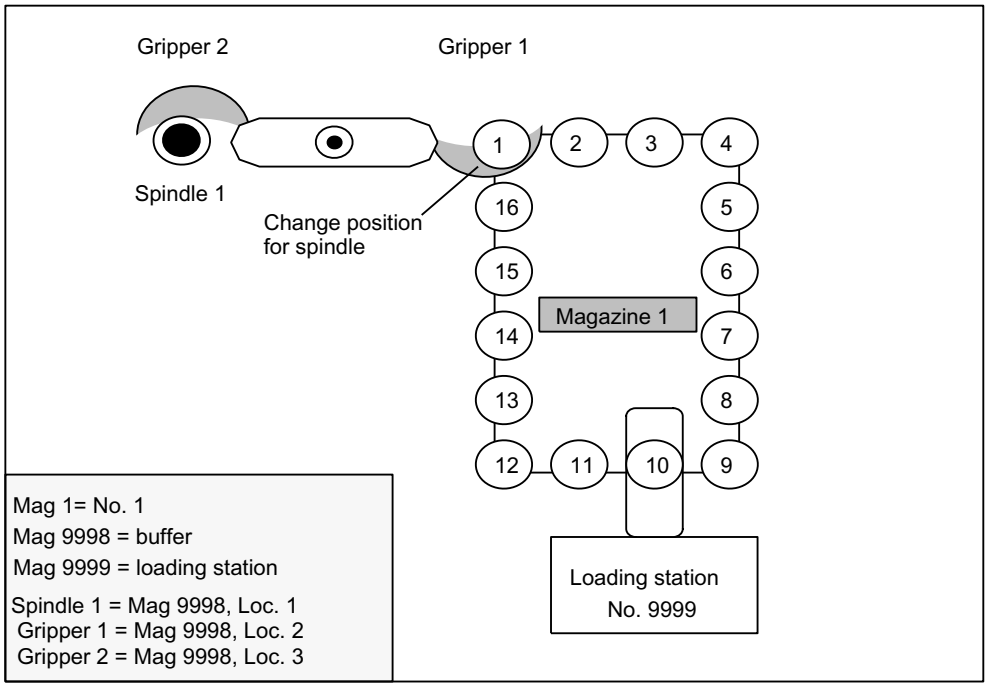



Figure 3-1 Machine tool with chain magazine

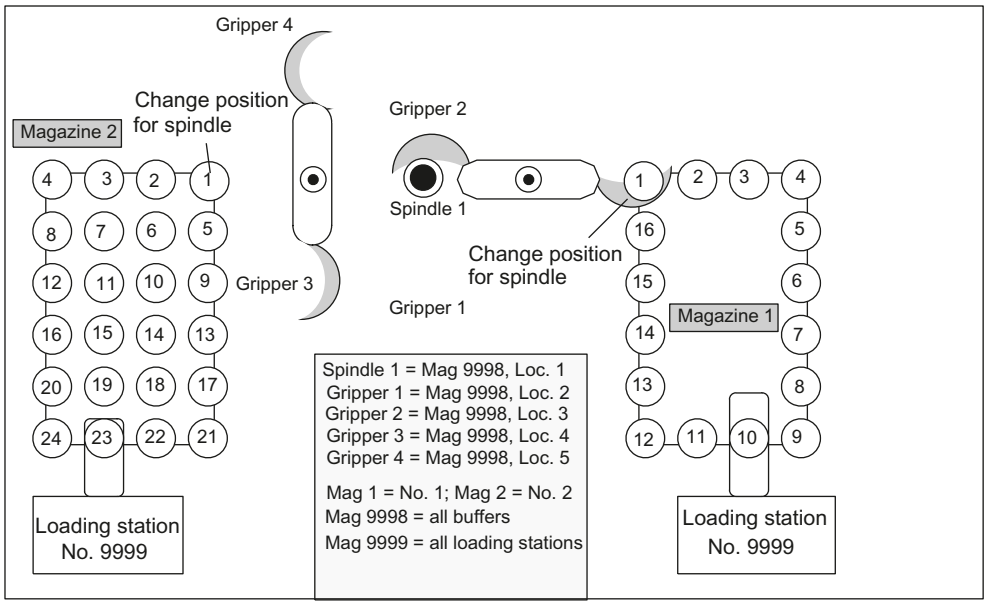



Figure 3-2 Machine tool with chain and box-type magazine

The magazine zero point is defined by $TC_MDP2 (with value assignment of 0). The change position (spindle) is normally assigned on this basis.

## 3.1.4 Circular magazine

Generally, circular magazines do not have any additional buffer with which tools can be transported from the magazine to the spindle. The tools on circular magazines are not physically transported into the spindle, but are moved into a defined position through rotation of the turret so that machining can take place with one particular tool. The tool is only transported to the spindle or holder in the software.

If TOOL_CHANGE_MODE is set to 1 for a turret, then the description above for chain and box magazines applies too.

The programming command T = identifier initiates the tool change. T = location can be programmed as an alternative. When T = location, no tool need actually be stored in the location.

The command is distributed in the PLC using the basic program. In this case, DB 73 is shown as the interface for the user (if TOOL_CHANGE_MODE is set to 0). There is a separate interface area for each turret. The turret numbers are assigned successively in ascending sequence according to magazine numbers during commissioning. The permissible magazine range is 1 ... maximum number of real magazines. A new command from NCK is then entered in the interface once the previous command has been acknowledged using FC 7 (alternatively using FC 8/FC 6 as well).

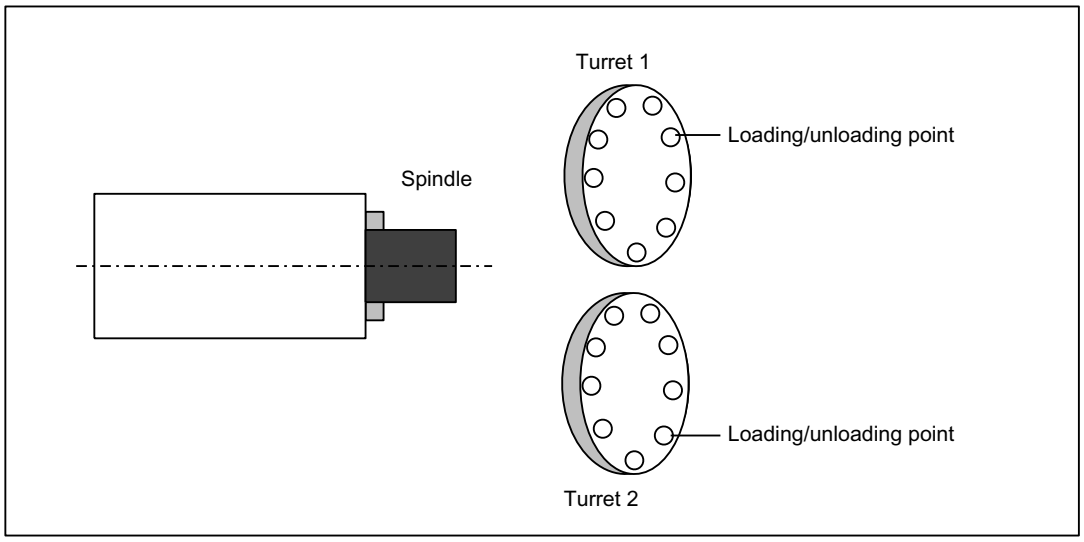



Figure 3-3 Double-slide turning machine with direct loading/unloading point in the turret

## 3.1.5 Other magazine types

In practice, there are other types of magazines in addition to the ones listed above. These are e.g. disk-type, washer, pick-up, rack, cage magazines (and many more). Such types must be mapped to the three types of magazines supported by the tool management.

## 3.1.6 Wear group

### Fundamentals

Locations in a magazine are linked to form an area referred to as the wear group. In this way, locations of a magazine can be reserved for particular machining operations.

A wear group number is assigned to each of these locations and the magazine is thereby divided into several different areas. Only tools from one of the areas are then used for a specific machining operation.

The wear group number for each magazine location is defined via system variable **$TC_MPP5[m,p]** (m: Magazine number, p: Location number).

Values of between -32000 ... +32000 are possible.

**Values > 0:**
The specified number is assigned to the location (e.g. **$TC_MPP5[1,3] = 2** assigns the third location of magazine 1 to wear group number 2).

**Value = 0:**
The location is not assigned to a wear group, as a result the magazine locations are not generally included in tool searches.

**Values < 0:**
The wear group whose number corresponds to the absolute value of this number is disabled (e.g. **$TC_MPP5[1,3] = -2** disables wear group number 2 of the magazine with number 1). This already applies for only one disabled location within the wear group.

**Note**

Wear groups are only available for real magazines. The definitions for $TC_MPP5 do not affect the status of tools.

### Activate wear group

System variable $TC_MAP9 defines which wear group (magazine area) is active. To change the active wear group, the corresponding number is set in this system variable, thereby defining which wear group will be used to start the machining operation.

The default setting is 0.

The wear group can also set active by a tool change or by the user via NC commands/OPI.

### Disable wear group

If there is no longer any tool that is ready for use at the location of an active wear group, then the system switches to the next wear group and the old wear group is disabled.

Machining is continued by activating the next group and searching for a suitable replacement tool.

The wear group is also disabled if one of the locations has been disabled via system variable $TC_MPP5 (negative value).

### Activate (internally)

**Bit 0** of system variable **$TC_MAMP3** can be set to determine how internal activation of a wear group will affect the status of the associated tools.

**Value 0:**
The tool status is not changed (preset).

**Value 1:**
When activated, one tool from each tool group included is set to "active". Tools already set earlier as active are not reset.

### Disable (internally)

Bit 1 of system variable $TC_MAMP3 can be set to determine how internal deactivation of a wear group will affect the status of the associated tools.

**Value 0:**
The tool status is not changed (preset).

**Value 1:**
When a wear group is disabled all active tools are reset.

**Note**

For a tool search in the wear group, refer to the index entry "Tool search in the wear group".

## 3.1.7 Background magazine

Background magazines are not directly supported by the tool management. However, functions for background magazines can be activated by setting the system variable selectively. System variable $TC_7 MAMP2, bit 7 can be used to set whether the tool search begins in the magazine last used for tool replacement (bit 7 = 0) or whether the search is carried out in the order defined by "Spindle to magazine" (bit 7 = 1).

Generally, this system variable is set when configuring the magazine. A change can be made at any time via the part program or OPI.

The assignment of "spindle to magazine" is set via system variable $TC_MDP2[n,m]; the order corresponds to the order in which this variable is written. This is pre-assigned as well by the magazine configuration.

**Example** for 4 magazines and one spindle:

$TC_MAMP2=385 (bits 0, 7 and 8 set).

$TC_MDP2[1,1]=0
$TC_MDP2[2,1]=0
$TC_MDP2[3,1]=0
$TC_MDP2[4,1]=0
...this assigns the first buffer (spindle) to magazines 1 to 4; a tool search would therefore start in magazine 1m, followed by magazine 2, etc. up to magazine 4.

You can modify this search order by setting this system variable as follows:

1. Delete the assignment
   $TC_MDP2[1,0]=9999
   $TC_MDP2[2,0]=9999
   $TC_MDP2[3,0]=9999
   $TC_MDP2[4,0]=9999
2. Re-assign in another sequence
   $TC_MDP2[2,1]=0
   $TC_MDP2[3,1]=0
   $TC_MDP2[4,1]=0
   $TC_MDP2[1,1]=0
   ... this results in a search sequence, magazine 2, 3, 4, 1

The trigger criterion for changing the order of assignment can be the information in the change cycle that the new tool was found in another magazine. This can be read in the program $A_TOOLMN[t], whereby "t" is the internal T number of the tool. The new tool is obtained via GETSELT. You must remember the previous foreground magazine.

## 3.1.8 Consider adjacent location

### Fundamentals

Consider adjacent location is used for oversized tools. When searching for empty locations (loading, relocating, changing) bits 4 to 11 are evaluated in the magazine location parameter $TC_MPP4 (half location occupied/reserved). As this function requires additional memory space, the default setting is 0.

To activate the function, the following must be set:
$MN_TOOL_MANAGEMENT_MASK Bit 3 = 1
$MC_TOOL_MANAGEMENT_MASK bit 3 = 1
In addition, for every magazine location where a consideration should be made, parameter $TC_MPP3 should be set to 1.

Two functions are available when the consider adjacent location is active.

### Overlap disabled magazine locations

The function is activated by setting the magazine location parameter $TC_MPP4 bit 13 = 1. If a location is disabled, it can now be "overlapped" by an oversized tool. This means the consider adjacent location function ignores the disabled state of a magazine location.

Example:
Chain magazine, location 12 is disabled (e.g. tool acceptance is defective). An oversized tool (size 2/2/1/1) is loaded or is positioned in the spindle. The tool can now be stored at location 11 or 13.

The following can be selected as default setting:
As soon as a location is blocked, then "overload active" is automatically set or is reset again as soon as the location is unblocked.
This setting is realized in machine data
$MN_TOOL_DEFAULT_DATA_MASK bit 4 = 1.

### Overlapping magazine edge locations

This function is activated by setting the magazine description parameter $TC_MAP3, bits 8 to 11.

The following definition applies:
(Definition: smallest magazine location number is at the top left, the largest magazine location number is at the bottom right).

Bit 8 **lefthand** edge location must not be exceeded
Bit 9 **righthand** edge location must not be exceeded
Bit 10 edge location **top** must not be exceeded
Bit 11 edge location **bottom** must not be exceeded

The default setting for these bits is 0.

Example:
Box-type magazine
Due to the mechanical arrangements, oversized tools may extend beyond the edge at the top and to the right.
The following must be set:
$TC_MAP3[magazine No.] bit 8 = 1
$TC_MAP3[magazine No.] bit 11 = 1

# 3.2 Several tools at a magazine location (multitool)

## 3.2.1 Short description

### Overview

Using the function TMMG (Magazine management) and when the "multi-tools" function (MT) is activated, so-called multi-tools (mini revolvers) with a number of tools can be loaded into a magazine and unloaded from a magazine.

**Note**

This function is supported in SINUMERIK Operate only.

**Note**

The following functions are not yet implemented in the current version:

- T=location
- Manual tool (a multitool cannot be a manual tool)
- Magazine location adapter (a multitool cannot sit on an adapter and cannot have itself an adapter on any of its locations)

The T selection in the part program also detects and checks the tools of a multitool when searching for a tool.

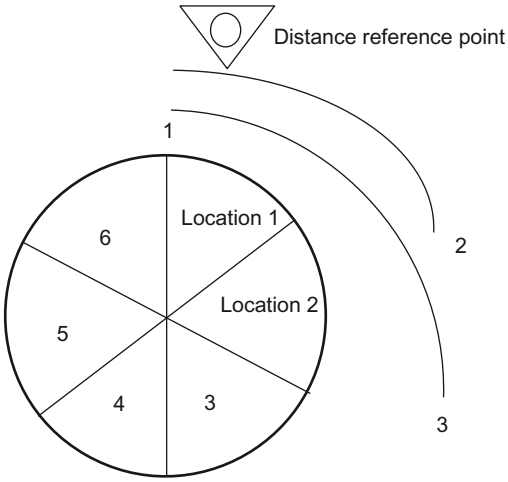
A multitool has a definable number of MT locations, where tools can be located. The geometrical arrangement of the MT locations can either be defined using the MT location number, an angle or using a distance.

The commands to select a tool and to change a tool sent to the PLC have additional information regarding the distance reference point and/or the machining position:

- MT location number of the tool in the multitool, or
- Angle, or
- Distance of the tool within the multitool

This type of distance coding can be defined using MT. The PLC then initiates the corresponding machine handling, e.g. moving a positioning axis.

A new acknowledgment block is available in the basic PLC program, the FC6. The block corresponds to the already known FC8. It only has one additional parameter "MultitoolPosition". The FC6 includes the complete FC8 functionality, so that the FC6 can completely replace the FC8. Further, as user interface, analog to DB 71, DB 72 and DB 73, there are the data blocks DB 1071, DB 1072 and DB 1073. If, for example, a multitool is changed, then the complete information of the "carrier tool" is contained in DB 72, and all of the information about the individual tool in DB 1072.




Location number definition for the MT location distance:
MT location 1 = 1, MT location 2 = 2, ...MT location 6 = 6

Figure 3-4 Location number

The diagram shows the distance coding of the locations in the multitool, i.e. the MT location number of the particular MT location itself. This distance coding is especially suitable for machines that operate with similar multitool geometries, e.g. only mini revolvers.

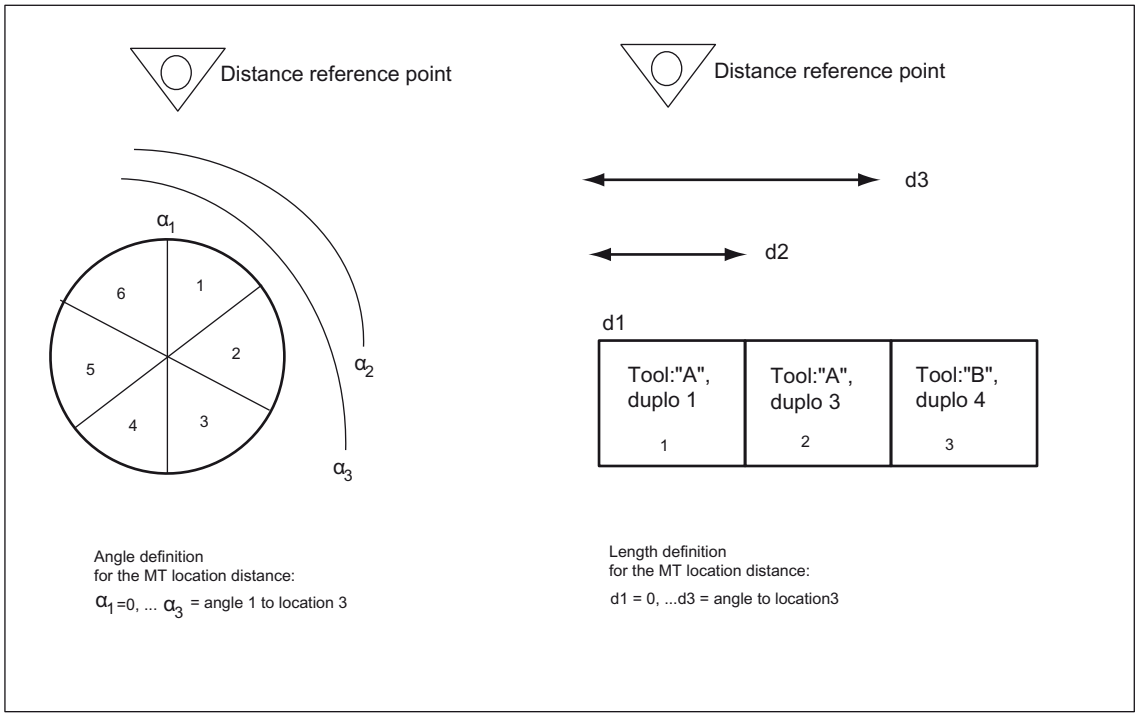



Figure 3-5 Angle and length

Typical geometries can be seen in this diagram. Angle α and the lengths are output to the PLC. This means for example that multi-tools can be used at a machine and handled by the PLC, which have different geometries (MT locations are not symmetrically arranged: Although multi-tools are inherently symmetrical, different multi-tools have different distances between the MT locations).

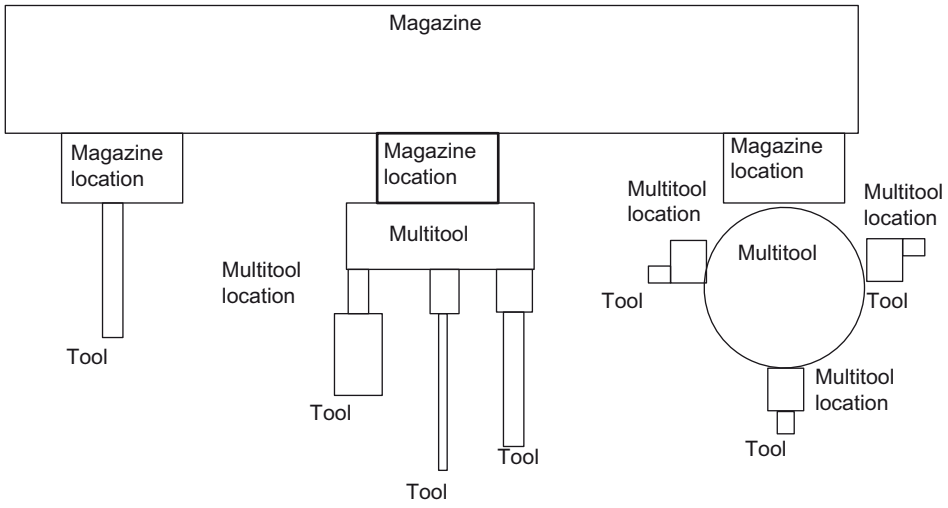
The distance reference point or the machining position is defined on a machine-for-machine basis. The allocation of the MT location numbers to the multitool locations must correspond to the mechanical machine design.

A multitool can include tools from different tool groups, i.e. the names can be different.

Nothing changes when programming a tool change in the part program. Formally, the commands are identical with existing commands; i.e. the tool change is programmed using T and/or M06.

**Note**

Presently, SINUMERIK Operate supports the distance coding "angle" and "location number".




Magazine: $TC_MAP ..
Magazine location: $TC_MAPP...
Tool: $TC_TP.../$TC_DP...
Multitool: $TC_MTP...
Multitool location: $TC_MTPP...

Figure 3-6 Multitool shown in the magazine

Further, there is a display of the multitool in the magazine with additional magazine location adapters. Both a magazine location as well as an MT location can have a magazine location adapter.

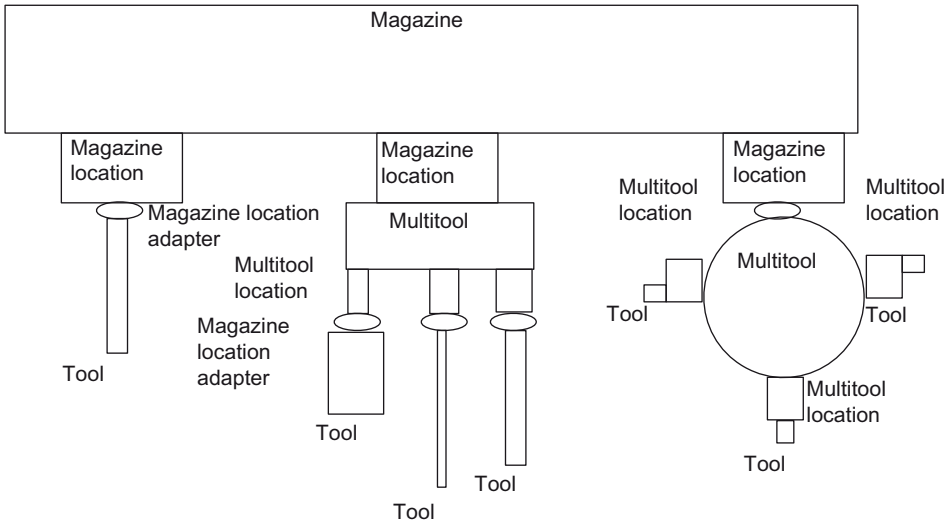



Figure 3-7 Shown with additional adapter data

The following machine data and language commands are available for the "multitool" function (see there for more detailed information).

Machine data

- $MN_MM_TOOL_MANAGEMENT_MASK, bit 10

  Activating the MT function
- $MN_MM_NUM_MULTITOOL

  Number of defined MT (limit values: 0-1500; max. 600 per channel)
- $MN_MAX_TOOLS_PER_MULTITOOL

  Max.number of tool locations per MT (limit values: 2-32)

Language commands/system parameters

- $TC_MTP, $TC_MTPP

  Data definition for MT and MT location
- $TC_MTPC, $TC_MTPPC

  MT OEM data for tool management
- $TC_MTPCS, $TC_MTPPCS

  MT OEM data for Siemens
- NEWMT, DELMT

  Generating, deleting
- POSMT

  Positioning MT to toolholder MT location number
- $P_TMNOIS

  What type does the number refer to: Magazine, tool or MT

- $P_MTOOLN, $P_MTOOLMT

  Number of multi-tools, MT number is the i-th MT
- $P_MTOOLNT, $P_MTOOLT

  Number of tools in the multitool, T number of the i-th tool
- $A_TOOLMTN, $A_TOOLMTLN

  Location of the tool in the multitool, MT number/MT location number
- Synchronized action access in the tool management PLC command

  $AC_TC_MTTN, $AC_TC_MTLTN, $AC_TC_MTNLOC, $AC_TC_TOOLIS, $AC_TC_MTDIST

NC commands

- RESETMON

  Can reset the tool monitoring data of the tools in an MT to its setpoints
- GETT

  Determines T No., MT No. to the name
- DELMLOWNER

  Deletes the magazine owner location on the tool or MT
- MVTOOL

  Moves tool or MT
- GETFREELOC

  Searches for an empty location in the magazine for tool or MT, searches for an empty location in the MT for tool

## 3.2.2 Programming

### MT numbers

The multitool numbers originate from the same number space as the T numbers and the magazine numbers.

Numbers 1-32000 are permitted for the T and magazine numbers. This allows multitools to be handled just like simple tools (T number at the magazine location, T number as parameter in the OPI PI service to load and unload tools, ...). In addition, in some instances MT numbers can be handled just like magazine numbers.

Users can explicitly enter T or MT numbers in the NC programming, if they initiate that a tool or multitool is created by programming $TC_TPx or $TC_MTPx. Explicitly programmed MT numbers must not collide with already defined T numbers or magazine numbers. Programming is then canceled with an alarm. However, if users newly create a tool using the language command NEWT – or for multitools using NEWMT – then the NCK automatically allocates the T or MT numbers. When automatically allocating an MT number, it is ensured that this is neither an already defined tool nor an already defined magazine.

NC language commands or system parameters, which have a tool T number or magazine number as parameter or index, and which are called using an MT number, generate an alarm if the associated functionality for multitool is not explicitly defined.

### MT names

Multitool names come from the same name space as the tool names and magazine names. Various multitools must have different names, i.e. a duplo number is not defined.

## 3.2.3 $TC_MTP - multitool data

### Overview

A multitool is a combination of several tools to form a unit. The following parameters allow a multitool to be described so that it fits into the systemology of the tool magazine function.

All of the parameters in the following table have no physical units. The default access right is "key-operated switch position 0" - both for access operations from the NC program as well as for access operations from the OPI. Access rights can be restricted using the REDEF command.

$TC_MTPx[y]
x: Parameters 1 …8, …PROTA
y: = Multitool number MT = 1 …32000

| NCK identifier | Description | Format | Pre-assigned limit values |
|---|---|---|---|
| $TC_MTPN | The number of locations is defined as delete command | INT | 0<br>0-<br>$MN_MAX_TOOLS_PER_MULTITOOL |
| $TC_MTP2 | Identifiers | STRING | MT number |
| $TC_MTP3 | Size to the left in half locations (= towards a lower location number) | INT | 1<br>1 - 7 |
| $TC_MTP4 | Size to the right in half locations (= towards a higher location number) | INT | 1<br>1 - 7 |
| $TC_MTP5 | Size upwards in half locations (= towards a lower location number) | INT | 1<br>1 - 7 |
| $TC_MTP6 | Size downwards in half locations (= towards a higher location number) | INT | 1<br>1 - 7 |
| $TC_MTP7 | Magazine location type | INT | 9999 (not defined)<br>0 - 32000 |
| $TC_MTP8 | Multitool status; bit-coded | INT | 0 (not released)<br>0 - "4000" |
| $TC_MTP_POS | MT position. The following applies: Position 1 is defined as "location 1 in the machining position" | INT | 0 (not defined)<br>0-<br>$MN_MAX_TOOLS_PER_MULTITOOL |
| $TC_MTP_KD | Type of distance coding | INT | 1 (= location number)<br>2 (= length)<br>3 (= angle) |
| $TC_MTP_PROTA | Name of the protection zone or name of the file, which contains the description of the protection zone. | STRING | (= not defined) |

## $TC_MTPN - number of MT locations

The multitool does not have a duplo number like the tool. The parameter $TC_MTPN contains the number of locations, which the multitool offers to accept tools. In addition, by programming $TC_MTPN[mtNr] = 0 the multitool is deleted. After MT locations have been generated, the parameters can no longer be changed to a value greater than zero.

## $TC_MTP2 - MT name

Multitools can be assigned names, so that a multitool can be uniquely defined by its name or by its number. The rules that apply when assigning names are the same as those that apply to tool names. Multitool names must be different from tool names and magazine names within a TO unit.

### $TC_MTTP3 $TC_MTP6 - MT size

The size data of a multitool is essentially the same as the size data of a tool - and is used to find an optimally suitable magazine location for the multitool when loading into the magazine (empty location search) when the adjacent location evaluation is active. The rules that apply when changing the multitool size correspond to the rules that apply when changing the tool size.

The MT size of a multitool can be changed, as long as the MT is not assigned to an owner location.

### $TC_MTP7

The magazine location type of the multitool is essentially the same as the magazine location type of a simple tool and is required for the empty location search, empty location check (loading operations into the magazine, tool change). The permitted values and rules to change data correspond to those that apply for the corresponding data in the tool. The value cannot be changed if the multitool is loaded in the magazine.

For multitools, which are contained in the loading magazines or buffer magazines, and still do not have an owner location (i.e. that are logically valid as unloaded – $A_MYMN=0, $A_MYMLN=0), then the magazine location type can be changed. The magazine location type of a multitool can be changed, as long as the multitool is still not assigned to an owner location.

### $TC_MTP8 - MT state

The state of a multitool corresponds to the state of an individual tool. The defined states are the same as those of an individual tool as defined under $TC_TP.

The following additional definitions apply:

| Bit | Meaning | Comment |
|---|---|---|
| 0 | Active | Reserved<br>Multitools do not have the "active" state defined. Only tools contained in them can assume the state. |
| 1 | **released** | Equipped multitools have this state, so that a tool in them can be selected. |
| 2 | **locked** | Multitool can be locked. Independent of the state of the tools contained in it, the selection of these tools can be prevented. The PLC signal "ignore locked state" also ignores the locked state of the multitool. The tool change command TCA for a tool ignores the locked state of the multitool. |
| 3 | measured | Reserved<br>Multitools cannot be measured. Only tools contained in them can assume the state. |
| 4 | Prewarning limit reached | Reserved<br>Multitools cannot be monitored. Only tools contained in them can assume the state. |

| Bit | Meaning | Comment |
|---|---|---|
| 5 | **Is being changed** | Protect the multitool during tool selection from competing additional tool selection/MT motion. This means that it is not possible to select a tool within the MT, as long as this state is set due to the selection of a tool in the MT.<br>If the state is set, it is permitted to select another tool from the MT, if this selection regarding the same toolholder is realized just like the selection, that had set the state of the MT. In this case, there is no competing tool selection, but instead a replacing one. If the state is set, then a tool in this MT also has this state set. The state is reset again together with that of the tool. Bit 21 from $TC_TOOL_MANAGEMENT_MASK refers to the tool and the MT.<br>For power on, the state is reset. |
| 6 | **Fixed-location-coded** | Multitools can be fixed-location-coded |
| 7 | **was in use** | The state of multitools is defined analog to that of the tool |
| 8 | **Autom. return transport** | Regarding the tool transport, multitools behave just the same as basic tools. $TC_TOOL_MANAGEMENT_MASK, bit15 also refers to this state. |
| 9 | **ignore locked** | The state is internally set and reset. The rules are essentially the same as the rules for the tool. |
| 10 | **MT is to be unloaded** | Multitools can be selected for unloading |
| 11 | **MT is to be loaded** | Multitool can be selected for loading |
| 12 | **Master tool** | Multitool can be selected as master tool |
| 13 | Reserved | Reserved |
| 14 | **For 1:1 exchange** | Multitool is selected for the pending 1:1 exchange. The rules as for a tool apply |
| 15 | **Manual tool** | Identifier, manual tool, analog to individual tools. Is set for the T selection (see Chapter 3.3.12). |
| 16 | **MT is locked, if a tool in the MT is locked** | If a tool contained in the MT has made the state transition to "locked", then the MT also assumes this state (bit 2). After a tool has made the state transition to "not locked", and then there is no longer any tool in the multitool that has the "locked" state, then the MT itself also loses the "locked"state.<br>Equipping/removing a locked/not locked tool in the MT or from the MT cannot change the MT state "locked/not locked". |

**Note**

Reserved or non-defined MT status bits cannot be written to. Writing to such a bit results in Alarm 17050 "illegal value".

## Interdependencies between the tool and multitool states

Tools, which are loaded in the multitool, can influence the state of the multitool and for MT transport operations, the MT can influence the tool status of the loaded tool.

| Bit | Meaning | Comment |
|---|---|---|
| 1 | **released** | Users allocate tools and multitools a status independent of one another. (Released tools can be loaded into a multitool that has not been released. Tools that have not been released can be loaded into a released MT.) |
| 2 | **locked** | Changing this state is initiated from the tool as part of the tool monitoring and the command RESETMON . Examples 1 to 4 at the end of this table show how the state of loaded tools can influence that of the multitool.<br>User-specific changes to the MT state are not transferred to the loaded tools. |
| 5 | **Is being changed** | The state is set and reset again for the MT as part of the tool selection. The tool to be selected and its MT change the state synchronously. The tools not involved with the tool selection do not experience a state change.<br>The state is always reset at POWER ON. |
| 6 | **Fixed-location-coded** | Tools loaded in the MT are implicitly fixed-location-coded, i.e. the state has no significance for the tool in the MT. For the MT itself, the state is defined; however, this has no influence on the loaded tools. If the tool state changes, this has no effect on the state of the multitool. |
| 7 | **was in use** | The state is automatically set as part of the tool change for the MT and the tool in the MT involved in the change. Tools in the MT, not involved in the tool change, do not change the status.<br>The user can also manually set the state. The same rule applies as for automatic setting. The user is responsible for the reset. If the last tool contained in the MT loses this state, then the MT also loses this state. If the user deletes the multitool state, then the states of all of the tools contained in it are also deleted. |
| 8 | **Autom. return transport** | At the tool change, the state is automatically set and reset for the MT only, however not for the tools contained in the MT. |
| 9 | **ignore locked** | The state is set and reset for the tool to be loaded and for the MT in which this tool is loaded. For the other loaded tools not involved in the tool change, the state remains unchanged. |
| 10 | **MT is to be unloaded** | When unloading from the magazine, the MT and the<br>tools loaded in it lose this state.<br>If a tool that has this state set is removed from the MT, then the state in the tool that has been removed is reset. |
| 11 | **MT is to be loaded** | When loaded to a magazine location, the MT and the tools loaded in it lose this state. If a tool that has this state set is loaded into an MT, then the tool state:<br>– is not changed, if the MT has the state set<br>– is reset, if the MT does not have this state set. |
| 12 | **Master tool** | The user allocates the state. The tool state does not influence the MT – and vice versa. |

| Bit | Meaning | Comment |
|---|---|---|
| 14 | **selected for 1:1 exchange** | This state is not required for tools loaded in the MT. As part of the empty location search, it is only automatically set for the MT and reset again at the end of the command. |
| 15 | **Manual tool** | Unique identifier for a manual tool. If, for a tool selection, the tool is found in a multitool that is not loaded, then this status is set for the tool and also the multitool and when replacing to loading location 9999/1 is reset again. |
| 16 | **MT is locked, if a tool in the MT is locked** | See the following examples |

**Example1:**
**Bit 2 = 0** and **Bit 16 = 1**
The MT has 3 tools that are not locked and have been released. The MT itself is also not locked and has been released. Bit 16 is set to 1. If the "locked" state of any tool in this MT is set (either manually or automatically), then in addition, the "locked" state is set in the MT, although there are still two tools where the "locked" state has not been set (i.e. these tools can still be used).

**Example 2:**
**Bit 2 = 1** and **Bit 16 = 1**
The MT contains 3 locked tools that have been released. The MT itself is also locked and has been released. Bit 15 is set to 1. If the "locked" state of two of the three tools is deleted in the MT, then the "locked" state of the multitool itself remains unchanged. If, for the last tool with the "locked" state, the "locked" state is deleted (either manually or automatically), then the "locked" state is also deleted in the MT.

**Example 3:**
**Bit 2 = 0** and **Bit 16 = 0**
The MT contains three tools that are not locked and are ready for use. The MT itself is also not locked and has been released. Bit 15 is set to 0. If the "locked" state of two of the three tools is set in the MT (either manually or automatically), then the status value of bits 2 in the MT remain unchanged. This means that the last "not locked" tool of the multitool can still be loaded. The MT is only set into the "locked" state when this tool – as the last tool – also assumes the "locked" state.

**Example 4:**
**Bit 2 = 1** and **Bit 16 = 0**
The MT contains three locked tools that are ready for use. The MT itself is also locked and has been released. Bit 15 is set to 0. If the "locked" state of a tool in the MT is deleted (either manually or automatically), then in addition, the "locked" state in the MT is also deleted, independent of the state of the other tools in the MT.

Bit 16 = 0 is advantageous, for example, if the MT only contains identical tools. All tools can then be used until their relevant monitoring limit has been reached.

Bit 16 = 1 is advantageous, for example, if an MT is to be loaded and the tools it contains are different and have to perform various machining operations. If one of these tools is now locked due to the monitoring function, then another MT must be loaded, which contains a complete set of tools that are ready for use for this particular machining operation.

A graphic representation of the "locked" state coupling is again shown in the following two diagrams:

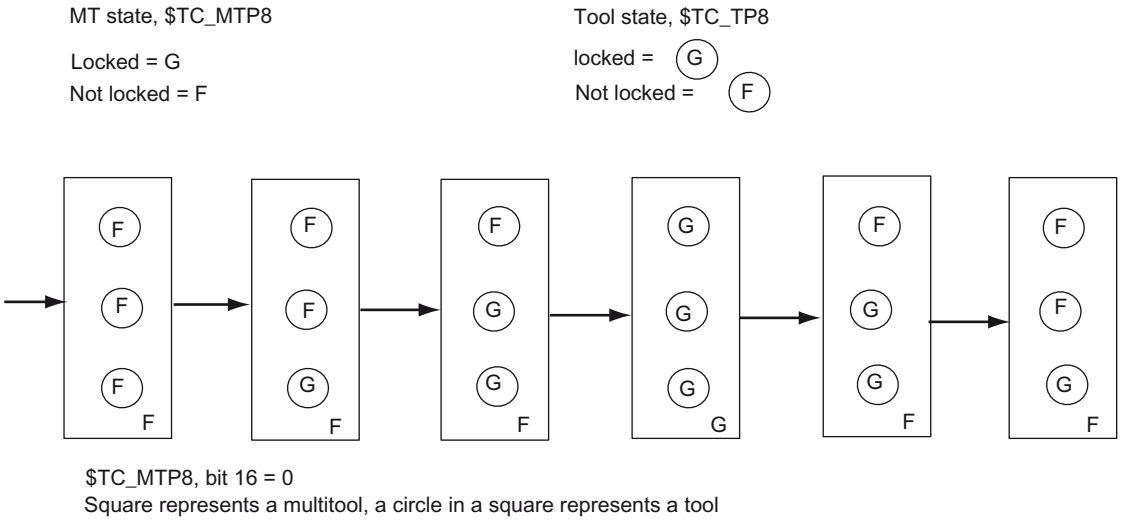



Figure 3-8 Automatic state change of the multitool depending on the state of the loaded tools and bit 16 of $TC_MTP8

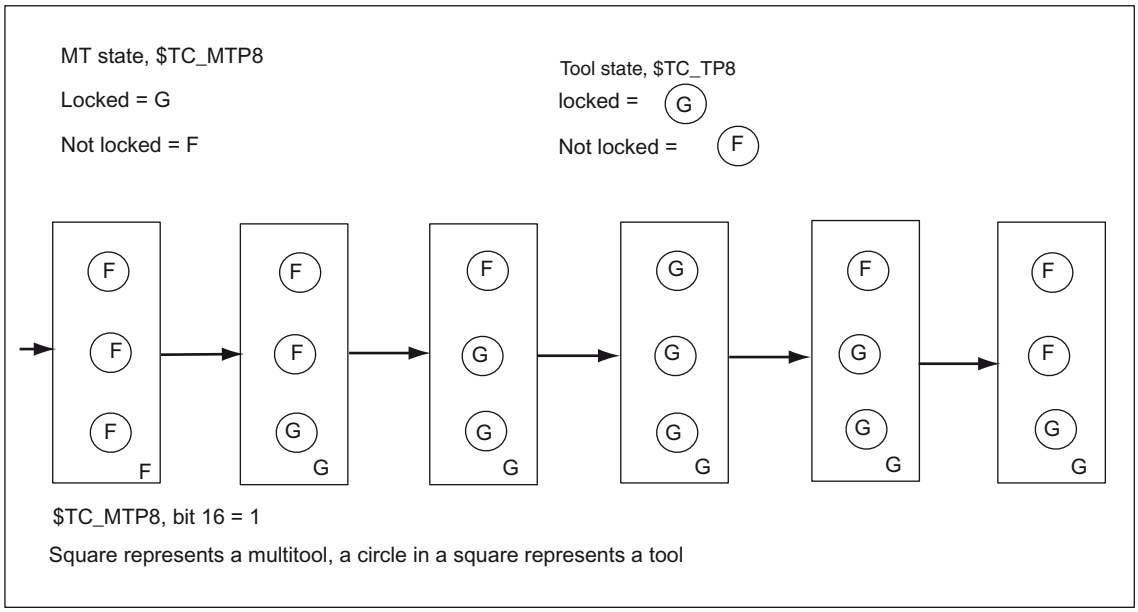



Figure 3-9 Automatic state change of the multitool depending on the state of the loaded tools and bit 16 of $TC_MTP8

### $TC_MTP_POS - MT position

The position of the multitool is the MT location number of the location, which is in the machining position, and which contains the machining (active) tool; see the next diagram.

With the final acknowledgment (PLC acknowledgment with the status_1) of a tool change command for a tool in the MT, the MT position is set to the value of the MT location number of the MT location, which contains the tool that was loaded. The other PLC status values (e.g. status_105) do not change the MT position value.

With the end acknowledgment (PLC acknowledgment with the status_1) of an MT positioning command (POSMT, _N_POSMT), the MT position is set to the value of the programmed MT location number. The other PLC status values are not permitted for the MT positioning command and are rejected with Alarm 6405 "incorrect acknowledgment data".

The PLC itself can initiate position synchronization with a non-synchronous transfer (PLC acknowledgment with status_4).

If a command output to the PLC is not acknowledged with "end" (e.g. cancel, status_3), then the MT position in the NCK is not updated (even if the positioning has already been mechanically carried out).

The MT position of a multitool, which is not located in a toolholder, has no further significance. The exception is programming T="magazine location number", which is typically used for revolvers.

If a multitool is loaded directly onto the spindle, and then relocated there, e.g. from the HMI user interface or using the MVTOOL language command, then with the final acknowledgment of this tool transport, position synchronization is also initiated. There are two possibilities to do this.

1. The real position is acknowledged. The NCK synchronizes to this value. If a reset is now made (assuming the corresponding machine data settings), the init blocks activate the tool at this location. This means that the command data are output to the PLC and the lowest D number of this tool is selected.
2. The position value is acknowledged with "0". "0" is a permitted value and means that the multitool is not positioned; the position has not been synchronized. Now, init blocks do not activate any tool (although under certain circumstances the multitool has been mechanically positioned).

### $TC_MTP_KD - type of distance coding for the MT locations

The location distances (KindOfDistanc) within the multitool can be defined in a variety of ways:

| | |
|---|---|
| $TC_MTP_KD[y] = 1 | The distance coding uses the MT location number. The location number is automatically allocated when creating the MT locations. $TC_MTPPL, $TC_MTPPA cannot be written to. |
| $TC_MTP_KD[y] = 2 | Distance coding is realized using the length data. $TC_MTPPL can be written to, $TC_MTPPA cannot be written to. |
| $TC_MTP_KD[y] = 3 | Distance coding is realized using the angle data. $TC_MTPPA can be written to. $TC_MTPPL cannot be written to. |

The type of distance coding can only be changed as long as no MT locations have been created. Otherwise Alarm 6438 "Inconsistent data modification is not permitted" is generated.

Example:
If, for distance coding, the location number has been defined ($TC_MTP_KD[ y ] = 1), then writing to $TC_MTPPL, $TC_MTPPA results in Alarm 6464 "Command cannot be programmed for the actual multitool distance coding".

Example:
The multitool is defined. Although the number of MT locations has been defined, they have still not been created.

```
$TC_MTP_KD[200] = 1     ;subsequently writing to $TC_MTPPL or $TC_MTPPA results in
                        ;Alarm "Command cannot be programmed for the defined
                        multitool distance coding"
$TC_MTP_KD[300] = 2     ;subsequently writing to $TC_MTPPL is permitted.
                        ;subsequently writing to $TC_MTPPA results in Alarm
                        ;"Command cannot be programmed for the defined
                        ;multitool distance coding"
```

The MT locations are now created, e.g. by writing to the system of parameters:

```
$TC_MTPPL[300, 1] = 30.0      ; all MT locations are implicitly created using the command
```

Then an attempt is made to change the distance type (that was previously defined using $TC_MTP_KD[300] = 2):

```
$TC_MTPPL[300, 1] = 3   ;After the MT locations have been created, the type of
                        ;distance coding must no longer be changed:
                        ;Alarm "Inconsistent data change not permitted"
```

## Multitool location data

| NCK identifier | Description | Format | Physical unit | Pre-assigned limit values |
|---|---|---|---|---|
| $TC_MTPP2 | Multitool location type (corresponds to the significance of the magazine location type) | INT | None | 0 (=every tool fits the location)<br>0 - 32000 |
| $TC_MTPP4 | MT location state | INT | None | 0 (=every tool fits the location)<br>0 - 3 |
| $TC_MTPP6 | T number of the tool contained | INT | None | 0<br>0 - 32000 |
| $TC_MTPP7 | Adapter number of the magazine location adapter contained | INT | None | 0<br>0 - 32000 |

| NCK identifier | Description | Format | Physical unit | Pre-assigned limit values |
|---|---|---|---|---|
| $TC_MTPPL | Distance from the reference location; unit "length" (L stands for length) | REAL | Length [mm/inch] | 0<br>0 - 1000 |
| $TC_MTPPA | Distance from the reference location; unit "angle" (A stands for angle) | REAL | Angle [Degrees] | 0<br>0 - 360 |

### Example:
### Transporting a multitool (loading into the magazine or onto the spindle

Multitool "Multitool_2" has been created (T-No.25), with 6 locations and distance coding "location".
The multitool is directly loaded onto the spindle, e.g. via the user interface. As a consequence positioning is not involved.

The NCK generates a transport job (CMD1)
ID:00000/00000 ------ CMD:00001
NewTool: from M: 09999 P: 00001 to M: 09998 P: 00001 TNo: 00025 TMMVTL-chan: 00000
isMultitool: 00001 MTPN: 00006 MT-Dist: 00000/0.00
OldTool: from M: 00000 P: 00000 to M: 00000 P: 00000

The multitool is loaded just like an individual tool.
Additional information is contained in the command: Multitool, distance coding "location"

The user interface looks like this:

| | | | |
|---|---|---|---|
| DB 71 | DBB0 | 00000001 | Interface 1 active |
| | DBBn | 00000001 | Loading |
| | DBB(n+1) | 10000000 | Data available in the extended range, i.e. it involves a multitool |
| | DBW(n+20) | 0 | Magazine No. (source) |
| | DBW(n+22) | 0 | Location No. (source) |
| | DBW(n+24) | 9998 | Magazine No. (target) |
| | DBW(n+26) | 1 | Location No. (target) |
| DB 1071 | DBW(n+0) | 1 | Multitool, distance coding "location" |
| | .... | | |

All of the data are "0" – there is no additional information from the NCK

There are now 2 options for acknowledging:

- The multitool position remains undetermined, i.e. the init blocks do not output a command and no offset is selected. This option makes sense if the tool is loaded into the magazine (the multitool position is not evaluated) or if the tool is loaded via the spindle. The multitool must be positioned if a tool in the multitool is now to be brought into the machining position (from a data perspective).
- The PLC specifies a position. This means that the NCK synchronizes to the acknowledged position. An init block can activate the tool that is at this location.

The FC6 can be parameterized as follows:

| FC 6 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 1 | DB 71 interface |
| TaskIdentNo | 1 | No. of active interface |
| NewToolMag | 9998 | Target for new tool: Magazine DB71.DBW(n+24) – |
| NewToolLoc | 1 | Target for new tool: Location DB71.DBW(n+26) |
| OldToolMag | 0 | Source for old tool: Magazine= "0"" there is no old tool |
| OldToolLoc | 0 | Source for old tool: Location= "0" there is no old tool |
| Status | 1 | Operation completed |
| MultitoolLoc | 0/x | In case_1, a "0" should be entered here. The multitool position remains undetermined, alternatively "-1"<br>In case_2, the multitool location, which is in the machining position, is entered here. |
| Ready | | Checkback signal from FC 6 |
| Error | | Checkback signal from FC 6 |

## Positioning a multitool

It is only possible to position a multitool, if

a) It is located on a toolholder
b) No offset is active. This means that none of the tools in this multitool may be active.
Positioning can be realized using the language command POSMT or the analog PI service (POSMT).

The multitool loaded on the spindle in the previous example is now positioned to location_5 using a part program.

N10 POSMT(state 5,1) ;position the multitool to toolholder_1 at position 5

NCK generates a command 1

ID:00001/00000 ------ CMD:00001
NewTool: from M: 09998 P: 00001 to M: 09998 P: 00001 TNo: 00025 Spindle: 00001
isMultitool: 00001 MTPN: 00006 MT-Dist: 00005/5.00
OldTool: from M: 00000 P: 00000 to M: 00000 P: 00000

New tool from spindle to spindle, i.e. it is already located on the spindle. T-No=25, spindle=1
Multitool with distance coding "location", number of locations of the multitool=6, target position=5.
There is no old tool.

The user interface looks like this:

| | | | |
|---|---|---|---|
| DB 71 | DBB0 | 00000001 | Interface 1 active |
| | DBBn | 00110000 | Positioning the multitool / command comes from the part program |
| | DBB(n+1) | 10000000 | Data available in the extended range, i.e. it involves a multitool |
| | DBW(n+20) | 9998 | Magazine No. (source) |
| | DBW(n+22) | 1 | Location No. (source) |
| | DBW(n+24) | 9998 | Magazine No. (target) |
| | DBW(n+26) | 1 | Location No. (target) |
| DB 1071 | DBW(n+0) | 1 | Multitool, distance coding "location" |
| | DBW(n+2) | 6 | Number of locations of the multitool |
| | DBD(n+4) | 5.0 | Location distance |
| | DBW(n+8) | 25 | T-No. of the multitool |
| | DBW(n+10) | 5 | Location No. in the multitool |
| | .... | | |

All other data are "0"

The FC6 can be parameterized as follows:

| FC 6 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 1 | DB 71 interface |
| TaskIdentNo | 1 | No. of active interface |
| NewToolMag | 9998 | Target for new tool: Magazine DB71.DBW(n+24) – |
| NewToolLoc | 1 | Target for new tool: Location DB71.DBW(n+26) |
| OldToolMag | 0 | Source for old tool: Magazine = "0" there is no old tool |
| OldToolLoc | 0 | Source for old tool: Location= "0" there is no old tool |
| Status | 1 | Operation completed |
| MultitoolLoc | 5 | Multitool position - DB 1071.DBW(n+10) |
| Ready | | Checkback signal from FC 6 |
| Error | | Checkback signal from FC 6 |

## 3.2.4 Tool change with a tool from a multitool

### Overview

Programming tool change commands remains unchanged. The programming

T= "Miller_150"
M06
D1

selects an appropriate tool from the tool group "Miller_150" and loads this. If, corresponding to the tool search strategy, the tool found is located in a multitool, then this does not play a role regarding activating the offset. The multitool is only involved when the data for the tool change command have been compiled. The NCK determines the distance value (–>MT location number or $TC_MTPPL/$TC_MTPPA) and adds this to the PLC command. For the tool change itself, the multitool (with its individual tools) is moved from the magazine to the toolholder. Using the data "Multitool location distance" that the NCK sends with the tool change data to the PLC, the PLC program must appropriately initiate the machine so that the active tool within the multitool can machine the workpiece.

The state of tools within the multitool in question, which are not involved in an MT motion operation, tool selection, tool change, does not change.

If programmed

T="name"' M06 D1

and the name is that of a multitool, then Alarm 6404 "Tool change not possible" is generated.

### Tool change from a multitool to a toolholder

**Example 1:**

A multitool with four locations is in magazine 1, location 10, and has the TNo = 23. Angle distance coding has been selected for the multitool; i.e. $TC_MTP_KD[23] = 3

The setting is $MC_TOOL_CHANGE_MODE=1, i.e. change with M06.

The data of the defined and loaded multitool look like this:

| | |
|---|---|
| $TC_MTPN[23]=4 | Number of locations |
| $TC_MTP2[23]="Multitool_0" | Identifiers |
| $TC_MTP3[23]=2 | Number of half locations (right) i.e. the multitool is oversized |
| $TC_MTP4[23]=2 | Number of half locations (left) |
| $TC_MTP5[23]=2 | Number of half locations (top) |
| $TC_MTP6[23]=2 | Number of half locations (bottom) |
| $TC_MTP7[23]=1 | Location type |
| $TC_MTP8[23]=130 | Tool status (released, was in use) |

| | |
|---|---|
| $TC_MTP_POS[23]=2 | MT position (is not evaluated, if the tool is located in the magazine) |
| $TC_MTP_KD[23]=3 | Distance coding (3 = angle) |
| $TC_MTP_PROTA[23]="" | Data for protection zone |
| $TC_MTPP2[23,1]=0 | Location_1 - location type |
| $TC_MTPP4[23,1]=0 | Location_1 - location state (occupied) |
| $TC_MTPP6[23,1]=1 | Location_1 - equipped with T-No.1 ("Tool1") |
| $TC_MTPP7[23,1]=0 | Location_1 - adapter No. |
| $TC_MTPPA[23,1]=0 | Distance-angular value |
| $TC_MTPP2[23,2]=0 | Location_2 ... |
| $TC_MTPP4[23,2]=0 | |
| $TC_MTPP6[23,2]=2 | equipped with T-No.2 ("Tool2") |
| $TC_MTPP7[23,2]=0 | |
| $TC_MTPPA[23,2]=90 | |
| $TC_MTPP2[23,3]=0 | Location_3 ... |
| $TC_MTPP4[23,3]=0 | |
| $TC_MTPP6[23,3]=3 | equipped with T-No.3 ("Tool3") |
| $TC_MTPP7[23,3]=0 | |
| $TC_MTPPA[23,3]=180 | |
| $TC_MTPP2[23,4]=0 | Location_4 |
| $TC_MTPP4[23,4]=0 | |
| $TC_MTPP6[23,4]=4 | equipped with T-No.4 ("Tool4") |
| $TC_MTPP7[23,4]=0 | |
| $TC_MTPPA[23,4]=270 | |

The following is programmed:

**T="Tool3"** ; generates the PLC command = 2 with data

ID:00002/00000 --------- CMD:00002
NewTool: from M: 00001 P: 00010 to M: 09998 P: 00001 TNo: 00023/00003 spindle: 00001
isMultitool: 00003 MTPN: 00004 MT–Dist: 00003/180.00
OldTool: from M: 00000 P: 00000 to M: 00000 P: 00000

change tool or multitool from location 1/10 to toolholder 9998/1
both T number 23 of the multitool is output,
as well as the T number 3 of the tool selected in the multitool
isMultitool = 3 tool is contained in the multitool; distance has the unit angle

MT dist = 3/180 - with this data the PLC must bring the tool with T-No. = 3 in multitool T-No. = 23 to location=3 and distance180 degrees into the machining position

The PLC user interface looks like this:

| | | | |
|---|---|---|---|
| DB 72 | DBB0 | 00000001 | Interface 1 active |
| | DBB(n+4) | 00000100 | Prepare change |
| | DBB(n+5) | 10000000 | Data available in the extended range (DB 1072) |
| | ... | | |
| | DBW(n+20) | 1 | Source new tool (magazine) |
| | DBW(n+22) | 10 | Source new tool (location) |
| | DBW(n+24) | 0 | Target old tool (magazine) |
| | DBW(n+26) | 0 | Target old tool (location) |
| | DBW(n+28) | 1 | New tool: Location type |
| | DBW(n+30) | 2 | New tool: Size left |
| | ... | | |
| | DBW(n+36) | 2 | New tool: Size bottom |
| | DBW(n+38) | 162 | New tool: Status (released, was in use, being changed) |
| | DBW(n+40) | 23 | New tool: T number |

Up until now, data in the usual form. "Carrier tool" is transported in which the preselected tool is loaded. That it now involves a multitool is indicated by setting DB72.DBB(n+1), bit7 "extended data available (DB1072)".

The data of the specifically preselected tool ("Tool3") are now in DB1072.

| | | | |
|---|---|---|---|
| DB 1072 | DBW(n+0) | 3 | Distance coding (angle) |
| | DBW(n+2) | 4 | Number of locations in the multitool |
| | DBD(n+4) | 180 | Location distance (3rd location, corresponds to 180 degrees) |
| | DBW(n+8) | 23 | New tool: Multitool number |
| | DBW(n+10) | 3 | New tool: Location number in the multitool -> it is mandatory that the PLC acknowledges this position |
| | DBW(n+12) | 0 | Old tool: Multitool number |
| | DBW(n+14) | 0 | Old tool: Location number in the multitool |
| | DBW(n+16) | 1 | New tool: Location type |
| | DBW(n+18) | 1 | New tool: Size left |
| | ... | | |
| | DBW(n+24) | 1 | New tool: Size bottom |
| | DBW(n+26) | 42 | New tool: Status |
| | DBW(n+28) | 3 | New tool: T number |
| | DBW(n+30) | 1 | New tool: Toolholder or spindle number |

| | | |
|---|---|---|
| DBW(n+32) | 1 | New tool: Original magazine (is identical with DB72.DBW(n+44) |
| DBW(n+34) | 10 | New tool: Original location (is identical with DB72.DBW(n+46) |

The FC6 can be parameterized as follows.
Assumption: the prepared tool or multitool is not moved and remains in the magazine

| FC 6 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 2 | DB 72 interface |
| TaskIdentNo | 1 | No. of active interface |
| NewToolMag | 1 | Source for new tool: Magazine DB72.DBW(n+20) – |
| NewToolLoc | 10 | Source for new tool: Location DB72.DBW(n+22) |
| OldToolMag | 0 | Target for old tool: Magazine = "0" there is no old tool |
| OldToolLoc | 0 | Target for old tool: Location= "0" there is no old tool |
| Status | 1 | Exit operation |
| MultitoolLoc | xx | Multitool position - DB1072.DBW(n+10) The position, in this case (tool remains in the magazine), has no significance. It can be acknowledged with the position from DBW(n+10), but also with "0" or "-1"<br>This also applies to intermediate acknowledgments. The NCK only evaluates the multitool position with the final acknowledgment of the change. |
| Ready | | Checkback signal from FC 6 |
| Error | | Checkback signal from FC 6 |

M06 ; generates the PLC command = 3 with the data

ID:00003/00002 ------ CMD:00003
NewTool: from M: 00001 P: 00010 to M: 09998 P: 00001 TNo: 00023/00003 spindle: 00001
isMultitool: 00003 MTPN: 00004 MT-dist: 00003/180.00
OldTool: from M: 00000 P: 00000 to M: 00000 P: 00000

Just as in all previous versions, this means that the user interface is no longer updated. Only DB72.DBB(n+0)bit1 "perform change" is set

The FC6 can be parameterized as follows.
Assumption: The prepared tool or multitool was already transported and here, in the example, only the final acknowledgment is programmed.

| FC 6 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 2 | DB 72 interface |
| TaskIdentNo | 1 | No. of active interface |
| NewToolMag | 9998 | Target for new tool: Magazine = buffer |
| NewToolLoc | 10 | Target for new tool: Location = spindle |
| OldToolMag | 0 | Target for old tool: Magazine = "0" there is no old tool |
| OldToolLoc | 0 | Target for old tool: Location= "0" there is no old tool |
| Status | 1 | Exit operation |
| MultitoolLoc | 3 | Multitool position - DB1072.DBW(n+10) must now be forcibly acknowledged with the correct position from DBW(n+10). |
| Ready | | Checkback signal from FC 6 |
| Error | | Checkback signal from FC 6 |

**D2** ; activate the offset of the tool with T–No. = 3

A new tool is now programmed, which is located in the same multitool.

**T="Tool1"** ; generates the PLC command = 2 with data
ID:00004/00004 ------ CMD:00002
NewTool: from M: 09998 P: 00001 to M: 09998 P: 00001 TNo: 00023/00001 spindle: 00001 myM: 00001 myP: 00010 isMultitool: 00003 MTPN: 00004 MT-dist: 00001/0.00
OldTool: from M: 00000 P: 00000 to M: 00000 P: 00000

The tool/multitool is already on the toolholder. NCK detects the situation and sets 0/0—>0/0 to remove the old tool - there is no old tool to transport. The old tool is removed implicitly by positioning the new tool (rigid coupling of the new and old tool in the multitool)

For the user interface this means

- No transport job for the "carrier tool".

| | | | |
|---|---|---|---|
| DB 72 | DBB0 | 00000001 | Interface 1 active |
| | DBB(n+4) | 00000100 | Prepare change |
| | DBB(n+5) | 10000000 | Data in the extended range (DB 1072) |
| | ... | | |
| | DBW(n+20) | 9998 | Source new tool (magazine) |
| | DBW(n+22) | 1 | Source new tool (location) |
| | DBW(n+24) | 0 | Target old tool (magazine) |
| | DBW(n+26) | 0 | Target old tool (location) |
| | DBW(n+28) | 1 | New tool: Location type |
| | DBW(n+30) | 2 | New tool: Size left |
| | ... | | |
| | DBW(n+36) | 2 | New tool: Size bottom |
| | DBW(n+38) | 162 | New tool: Status (released, was in use, being changed |
| | DBW(n+40) | 23 | New tool: T number |

- The relevant data for the new tool are located in DB 1072.

| | | | |
|---|---|---|---|
| DB 1072 | DBW(n+0) | 3 | Distance coding (angle) |
| | DBW(n+2) | 4 | Number of locations in the multitool |
| | DBD(n+4) | 0 | Location distance (1st location, corresponds to 0 degrees) |
| | DBW(n+8) | 23 | New tool: Multitool number |
| | DBW(n+10) | 1 | New tool: Location number in the multitool -> it is mandatory that the PLC acknowledges this position |
| | DBW(n+12) | 23 | Old tool: Multitool number |
| | DBW(n+14) | 3 | Old tool: Location number in the multitool |
| | DBW(n+16) | 1 | New tool: Location type |
| | DBW(n+18) | 1 | New tool: Size left |
| | ... | | |
| | DBW(n+24) | 1 | New tool: Size bottom |
| | DBW(n+26) | 42 | New tool: Status |
| | DBW(n+28) | 1 | New tool: T number |
| | DBW(n+30) | 1 | New tool: Toolholder or spindle number |
| | DBW(n+32) | 1 | New tool: Original magazine (is identical with DB72.DBW(n+44) |
| | DBW(n+34) | 10 | New tool: Original location (is identical with DB72.DBW(n+46) |

M06 ; generates the PLC command = 3 with the data

ID:00005/00005 ------ CMD:00003
NewTool: from M: 09998 P: 00001 to M: 09998 P: 00001 TNo: 00023/00001 spindle: 00001
myM: 00001 myP: 00010 isMultitool: 00003 MTPN: 00004 MT-dist: 00001/0.00
OldTool: from M: 00000 P: 00000 to M: 00000 P: 00000

The FC6 can be parameterized as follows.

| FC 6 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 2 | DB 72 interface |
| TaskIdentNo | 1 | No. of active interface |
| NewToolMag | 9998 | Target for new tool: Magazine = buffer |
| NewToolLoc | 1 | Target for new tool: Location = spindle |
| OldToolMag | 0 | Target for old tool: Magazine = "0" there is no old tool |
| OldToolLoc | 0 | Target for old tool: Location= "0" there is no old tool |
| Status | 1 | Operation completed |
| MultitoolLoc | 1 | Multitool position - DB1072.DBW(n+10) must now be forcibly acknowledged with the correct position from DBW(n+10) |
| Ready | | Checkback signal from FC 6 |
| Error | | Checkback signal from FC 6 |

D1 ; activate the offset of the tool with T-No. = 17

## Tx - Tx programmed: Configuration of the tool selection

$MC_TOOL_MANAGEMENT_MASK, bit 11 makes it possible to adjust the behavior when repeatedly programming Tx – Tx. The setting is valid, just as before for the tool to be selected, however also for the MC itself.

**Example:**

The following has been set: Tool selection with T, tool change with M code. The following is programmed:

T="Tool5"
T="Tool5"

The second tool preparation command is a "superfluous" command, which as default setting does not result in a command being output to the PLC. If "Tool5" is a tool belonging to a multitool, then with the command, generally

a) a transport job of the MT "from the magazine to the toolholder" is generated, and
b) a positioning command of the MT location with the programmed tool.

If "Tool5" is in an MT, then two basic situations can exist for the MT:

1 the MT is already located on the toolholder

1.1 the programmed tool has already been positioned

1.2 the programmed tool is a different tool than the tool that was positioned

2 the MT is still not located on the toolholder

For case 1.1, the data for a) "MT from toolholder to toolholder"
b) "Position to the already positioned location of the tool "Tool5""

For case 1.2, the data for a) "MT from toolholder to toolholder"

b) "Position to the location of the tool that has still not been positioned "Tool5""

For case 2, the data for a) "MT from magazine to toolholder"

b) "Position to the location of the tool "Tool5""

The general criterion as to whether the second program command is a "superfluous" command is whether the generated command data for the PLC are identical to that of the first command. The second command is then not output to the PLC.

This command output can be forced using the bit value 1 of bit 11 from $MC_TOOL_MANAGEMENT_MASK.

### Tool change command canceled before the final acknowledgment

If, within the scope of a tool change, the MT has already been mechanically loaded, but the MT has not been positioned, and the operation is interrupted in this state (fault, RESET, EMERGENCY STOP, power off, power failure...), then before continuing, the PLC must ensure that the previously pending MT positioning is carried out. The PLC must then make sure that the NCK is informed about the MT change (e.g. using an asynchronous transfer with acknowledgment status 4 or 5. In so doing, the NCK synchronizes the MT position with the command data from the PLC). With an asynchronous transfer, the PLC can also communicate the MT position to the NCK.

**Note**

Especially if init blocks for START and/or RESET are generated via MD settings, with the property "activate the tool on the toolholder", and the tool on the toolholder is an MT, then the PLC must ensure that the MT is correctly positioned on the toolholder before the NCK makes the correction selection (i.e. before the RESET command is sent to the NCK, the MT must have been positioned)

### T0 - tool deselection and return transport of the multitool into the magazine

T0 deselects the tool and loads the associated MT back into the magazine.

Continuation of the example of the previous section:

**T0** ; generates the PLC command = 2 with the data

ID:00005/00004 ——— CMD:00002
NewTool: from M: 00000 P: 00000 to M: 00000 P: 00000 TNo: 00000/0000 spindle: 00001
isMultitool: 0 MTPN: 0 MT-dist: 0/0.0
OldTool: from M: 09998 P: 00001 to M: 00001 P: 00010

This means, as usual, a T0 is output at the PLC user interface. The "tool carrier" must be removed from the toolholder. It does not make any difference as to whether it involves an individual tool or a multitool. DB72.DBB(n+1), bit7 is not set, as there are no relevant data.

M06 ; generates the PLC command = 3 with the data

ID:00006/00005 ------ CMD:00003
NewTool: from M: 00000 P: 00000 to M: 00000 P: 00000 TNo: 00000 spindle: 00001
OldTool: from M: 09998 P: 00001 to M: 00001 P: 00010

If a tool from this multitool that has just been changed out is again selected/loaded, then the multitool is again loaded onto the toolholder.

It is not possible to program a T0 with the meaning to deselect the active tool, and at the same time to keep the MT on the toolholder. T0 M06 D0 means, that after successful execution

- the correction is deselected

- there is no active tool

- there is no tool or MT on the toolholder.

### PLC acknowledgment status 2 and 7

The PLC acknowledgment status numbers 2 and 7 refer to the tool within the multitool. This means that it is not the multitool that is rejected, but the tool. If the newly selected tool is in another multitool, then the transport job data for the multitool as well as for the newly selected tool contained in it, are newly determined and output to the PLC.

### Tool change with "T=magazine location number" programming ("T=location")

The following definition applies.

For T = location, the tool at the location of the actual multitool position is selected.

Example:

Multitool with distance coding, location number, $TC_MTP_KD[500]=1, is in revolver 1, location 4 and has the MT No. = 500; $TC_MPP6[1, 4] = 500. The MT position is $TC_MTP_POS[500]=2.

The tool at location 1/1 is loaded onto the toolholder 9998/1. The MT has 3 locations.

The following tools are loaded in the multitool:

"tool_1": $TC_MTPP6[500, 1] =11 MT distance $TC_MTPPA[500, 1] = 1

"tool_2": $TC_MTPP6[500, 1] =22 MT distance $TC_MTPPA[500, 2] = 2

– $TC_MTPP6[500, 1] =0 MT distance $TC_MTPPA[500, 3] = 3

There is no tool at location 3 of the multitool.

The spindle is empty. Tool selection and tool change are programmed with T. The "T=magazine location number" function is used.

The following command is then programmed:

;MT-Position $TC_MTP_POS[500]=2

T4 ;at magazine location 4, in the multitool loaded there, select the tool,
which is loaded at MT-location 2 of the multitool and load the MT - if it is not locked - and activate the tool.
;If the tool at MT location 2 of the multitool is locked, then a search is made for
;another matching tool with the name "tool_2", which under certain circumstances –
;depending on the tool – search strategy, tool equipping – is at some location of
;another multitool or which is contained as individual tool on another
;turret location.

The resulting command to the PLC is as follows:

T4 programming with the result "Multitool 500 is at the programmed magazine location and at the MT location selected (via the MT position), there is tool "tool_2" with the T-No.=22" - supplies the following (essential) data to the PLC:

ID:00000/00000 ——— CMD:00004
NewTool: from M: 00001 P: 00004 to M: 09998 P: 00001 TNo: 00500/00022 spindle: 00001
isMultitool: 1 MTPN: 3 MT-dist: 2/2.0
OldTool: from M: 09998 P: 00001 to M: 00001 P: 00001

## Load/move multitool on toolholder and init block

If a multitool is loaded onto a toolholder other than through a tool change (loading operation, movement command) and for the init block handling (if it is appropriately configured), the active tool must be subsequently determined, then the following applies:

- If necessary: After loading/moving, set the MT position so that the requested tool can be activated – or so that the MT position matches the mechanical MT position
- Under all circumstances, issue a tool change command to the PLC that contains the MT position of the tool to be activated
- Take the MT, which is located on the master toolholder
- Take the tool, which is at the MT location with MT location number = "MT position" (=$TC_MTP_POS), and select this.
- Activate the D offset of this tool with the lowest D number.

**Note**

The MT position of the multitool on the toolholder must be synchronized to the mechanical position of the multitool at the machine itself. If the MT position when loading does not already match the MT loading position, then under certain circumstances the PLC can initiate this synchronization with an asynchronous transfer before the RESET command to the NCK (that generates the init block).

### Not possible to move the tool from or to the MT location

A tool cannot be transported to or from a multitool location. Both PI service as well as a language command or asynchronous transfer are rejected with an error.

The multitool is considered to be an entity in its own right that is manually equipped, and which is loaded, unloaded or transported as a whole (complete entity). Movement of tools in the multitool has not been realized.

### Tool change - tool search

The tool search strategies are described in Chapter 3.3.1. They are essentially also applied to the multitool.

| NCK identifier | Description | Format | Preassignment |
|---|---|---|---|
| $TC_MAMP"<br>$TC_MAP10 | Type of search strategy<br>Bit 0 - 7 tool search strategy | INT | 0 |

Regarding tools in the multitool, the individual tool search strategies behave as follows:

**Bit 0 = 1**: Select the "active" tool.

If there is more than one suitable tool in the multitool with the "active" state, then the first checked tool of these tools is selected.

**Bit 1 = 1:** Select the tool that can be reached through the shortest distance.

Within the multitool there is no "shortest distance" search. With shortest distance, the "shortest distance within the magazine" is always meant. It does not make any difference whether a tool or a multitool is at the particular magazine location.

**Bit 2 = 1:** Select the "active" tool. If there is no active tool available, then select the replacement tool with the lowest number contained in $TC_TP10.

If there is more than one suitable tool in the multitool with the "active" state, then the first checked tool of these tools is selected.

**Bit 3 = 1:** Lowest actual value (remaining value) of the monitoring functions.

If there is more than one suitable tool with "lowest actual value" in the multitool, then the first checked tool of these tools is selected.

**Bit 4 = 1:** Highest actual value (remaining value) of the monitoring functions

If there is more than one suitable tool with "highest actual value" in the multitool, then the first checked tool of these tools is selected.

**Note**

Further, the tool search is tool-oriented, i.e. the tool of a tool group is checked as to whether it can be used corresponding to the actual configuration and search strategy.

### Wear group and multitool

All tools within a multitool belong to the wear group of the multitool itself. The locations within a multitool have the "wear group" property.

### Manual tool and multitool

The manual tool function is also available for multitools. As far as this function is concerned, the MT itself is the manual tool and not the programmed tool. If a tool is programmed, which is in an MT, but this MT is not loaded, then the MT is treated just like a manual tool.

Example:

The name of the multitool is "MT1", the name of the tool - programmed for toolholder 1 - is "Tool4" with duplo number 5.

The following is programmed
T="Tool4" M06 D1.
This is then followed by the request to load with Alarm 17212 "Manual tool %3, duplo No. %2 load to the spindle/toolholder %4

Manual tools (adding tools during machining) (Page 91)

T0 M06 D0
then correspondingly generates Alarm 17214 "Unload manual tool %3 from spindle/toolholder %2"
and correspondingly requests that the manual tool (that is an MT or is located in an MT) is again removed from the toolholder.

### Suppressing alarms 17212, 17214

The manual tool change request alarms can be suppressed using bit 12 in MD $MN_SUPPRESS_ALARM_MASK_2. Then, using the tool change command data, the PLC must correctly load and remove the manual tool.

### Empty location search strategy - "replace old tool by new tool" and multitool

Just like tools, for an empty location search, multitools can use the search strategy - "replace old tool by new tool" (1:1 exchange). The MT has the necessary defined data required for this purpose - such as location type, tool size.

## Tool adapter at MT location/tool adapter at magazine location

Just like a magazine location, an adapter can also be allocated
$TC_MPP7[mag. No., location No.] = "Adapter number"
an adapter can also be allocated to an MT location
$TC_MTPP7[MT No. MT location No.] = "Adapter number"

And MT itself can be at a magazine location, which contains an adapter. The adapter data of the magazine location also has an effect on the offsets of the tools contained in the MT. Adapter transformations cannot be linked. If a magazine location adapter is positioned at the magazine location as well as at the MT location, then only the adapter of the MT location affects the offset calculation of the tool.

It only makes sense to allocate the magazine location adapter to the magazine location or the MT location.

This is supported by the additional configuration option for the magazine location adapter:

– $MN_MM_NUM_TOOL_ADAPTER = –2
A tool adapter is automatically allocated to each MT location.

# 3.3 Tool change box-type, chain, circular magazines

## 3.3.1 Prepare a tool change

### Fundamentals

The tool change type is set using machine data 22550 $MC_TOOL_CHANGE_MODE.

$MC_TOOL_CHANGE_MODE = 0
no separate T preparation, change with the T command.

$MC_TOOL_CHANGE_MODE = 1
separate T preparation, the change is realized with M06 or the M function, which is set in machine data $MC_TOOL_CHANGE_M_CODE.

This setting is independent of the magazine type. This means that also for a turret, T and M06 can be programmed just the same as a chain magazine but only with a T command.

### $MC_TOOL_CHANGE_MODE=0

```
T="Tool identifier"  ;   Tool preparation and tool change with an NC command (=
                     ;   within an NC block)
                     ;   NCK sends a command to the PLC
```

If an error is detected during tool preparation, then machining is stopped when the block T = identifier is read-in.

After correction and NC Start, the block with T = identifier is interpreted again and program processing is continued.

### $MC_TOOL_CHANGE_MODE=1

- Within an NC block

```
T="Tool identifier" M06      ; Tool preparation and tool change. This programming
                             ; line results in a command to the PLC
```

Program tool preparation and tool change in one block (T= "Tool identifier" M06), corresponds to setting TOOL_CHANGE_MODE = 0.

- Distributed over two NC blocks

```
T="Tool identifier"  ;   Tool preparation
                     ;   NCK sends a command to the PLC
M06                  ;   Tool change (the number of the M code is settable),
                     ;   NCK sends a command to the PLC
```

Tool preparation and tool change are typically programmed in different blocks. Two commands are transferred to the PLC.

An alarm is triggered if an error occurs in T="tool identifier". If the MD 22562 TOOL_CHANGE_ERROR_MODE is set accordingly, the alarm is delayed until the associated tool change command M06 is interpreted in the program run. Only then is the alarm output. The operator can make corrections in this block.

**Note**

Offset selection or deselection is automatically made with the tool change command. In so doing, machine data MD20270 CUTTING_EDGE_DEFAULT is evaluated.

## Empty spindle

Program commands T0 and M06 remove the tool from the spindle and return it to the magazine. The spindle is then empty.

## Possible problems when programming T/M06

$MC_TOOL_CHANGE_MODE=0; tool change with T address

The part program is executed through to the block T = "identifier". The following problems can occur and are handled in the manner described:

- The tool data record is in the NCK but not assigned to a magazine location. The tool must be reloaded mechanically, if necessary, e.g. directly onto the spindle. The assignment of the tool to the magazine location/the spindle takes place e.g. with the function "Overstore"; $TC_MPP6[m,p] = T no., or by the HMI operation "Load (onto spindle)".
- The tool data record is not in the NCK: Set up data record in the NCK, e.g. by HMI operation.
- Programming error in part program: Correct NC block with error in the part program.
- Alarm 22067:

  The desired tool change is not possible. The specified tool group does not contain a "ready to use" replacement tool which could be loaded. The tool monitoring function may have set all potentially suitable tools to the "disabled" status.

The Start pushbutton is pressed once the operation has been completed. The NC block T="tool identifier" is interpreted again and program processing is continued provided operator intervention was correct. If not, the alarm will be generated again.

## 3.3.2 General tool change sequence

### Overview

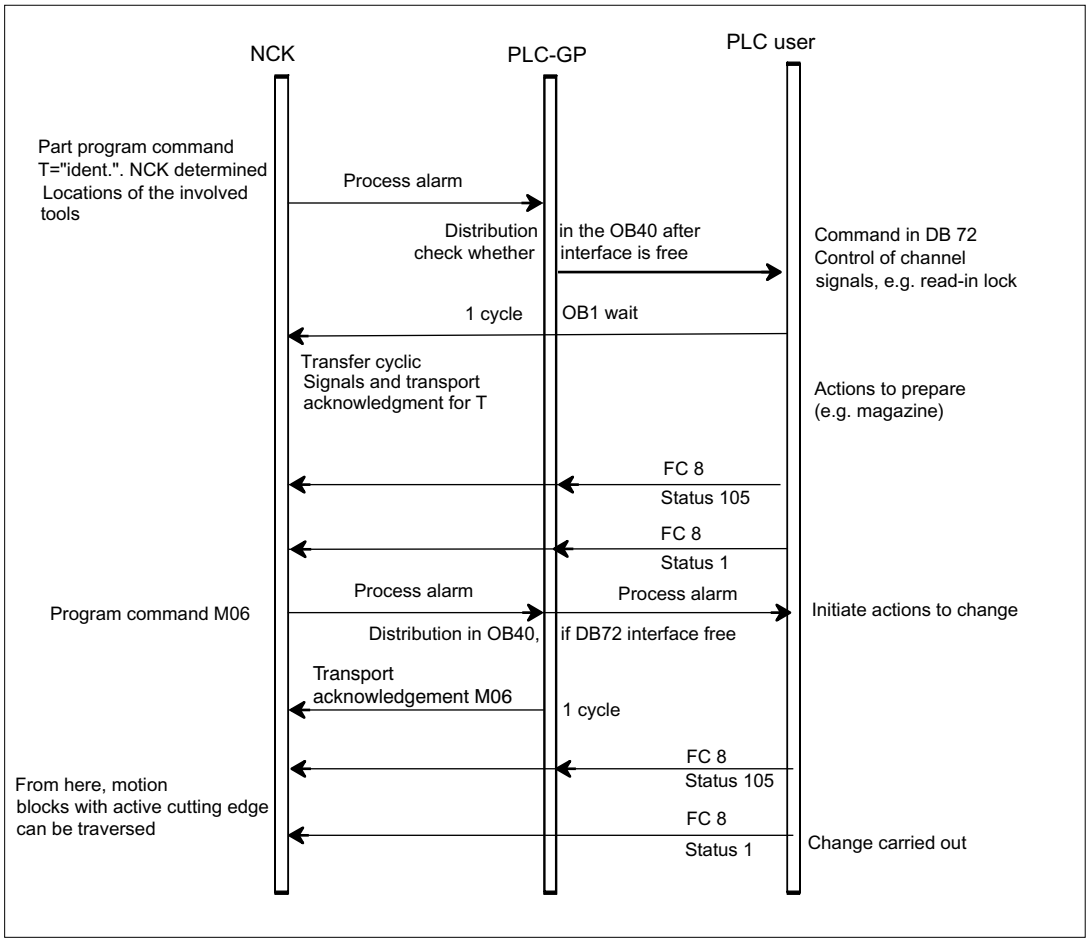



Figure 3-10 Preparing and changing a tool

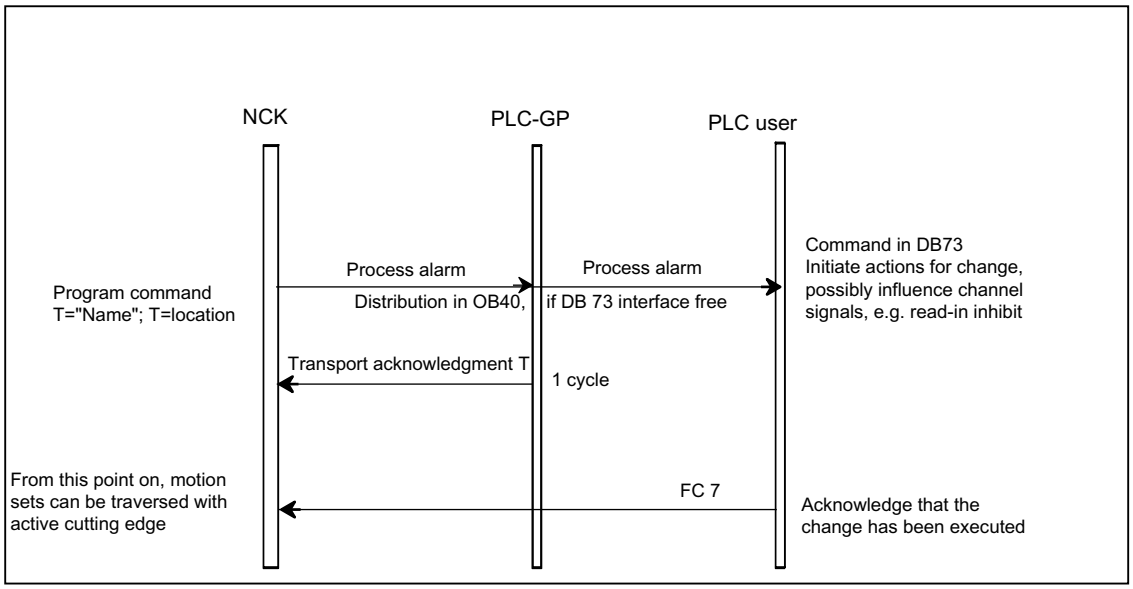



Figure 3-11 Tool changing with T command

The prompt for changing the tool is issued by the part program via T command or M command.

1. The tool-management function in NCK searches in accordance with the tool search strategy for a tool suitable for use (preparation) and, at the same time, searches for an empty location for the tool to be exchanged.
2. The data determined are make available in DB 72/73. The user program must react by making a new tool available.
3. If machine data MD22550 TOOL_CHANGE_MODE is set to 1, with the "M06 command" in the part program, the PLC executes the tool change and signals the end of the change operation.
   If the machine data is set to 0, then the tool is loaded with the programming of T. In both cases, the PLC has the option of applying its own tool change strategy. It can choose its own empty location for storing the old tool.

**Note**

The tool change is an NCK-internal operation that is executed as an interaction with the PLC. The HMI only has the task of displaying data and facilitating data input.

### Spindle and toolholder

Tool management can also be used for machines that have no spindle (e.g. punch presses or turrets). In this case the term "spindle" is replaced by "toolholder";

This is defined in MD20124 TOOL_MANAGEMENT_TOOLHOLDER. If MD > 0, then the spindle numbers $TC_MPP5 are interpreted as toolholder numbers.

### Fixed location coding

If fixed location coding is selected for a tool, the tool will always be returned to the same location when it is replaced.

### Variable location coding

Tools defined with variable location coding can be returned to any location for the appropriate tool size and location type in the magazine.

### Automatic tool return to real magazine

1. An automatic tool return is initiated by the TM only if the tool is transported via several stations (status 105) after a T preparation command from the PLC and the T preparation command is finally acknowledged positively with status 1.
   The return of a preselected tool from the buffer can be suppressed by setting MD20310: TOOL_MANAGEMENT_MASK, bit 15 = 1.
2. If a tool change is interrupted because the control is switched off but the tool is already located in a buffer location (gripper), the next tool change must either return the tool in the buffer to the spindle or to the real magazine.
3. If several tools are located in the buffer the spindle tool is considered first. If there is no tool on the spindle, the order for return is in accordance with system variable $TC_MLSR.

## Example for the time sequence of a tool change

The following example shows a typical cut-to-cut sequence of operations for a tool change with a tool changer and a fixed absolute tool change point on a milling machine.

Machining program

| | | |
|---|---|---|
| N970 G0 X = Y = Z | ; | Retraction from contour |
| N980 T1 | ; | Tool preselection |
| N990 T_CHANGE | ; | Subroutine call without parameters |
| N1000 G90 G0 X= Y= Z= M3 S1000 | ; | Continue machining |

Subroutine for tool change

| | | |
|---|---|---|
| PROC W_WECHSEL | ; | |
| N10 SPOSA= S0 | ; | Spindle positioning |
| N20 G75 FP=2 X1=0 Y1=0 Z1=0; | ; | Approach tool change position |
| N30 M06 | ; | Change tool |
| N40 M17 | ; | |

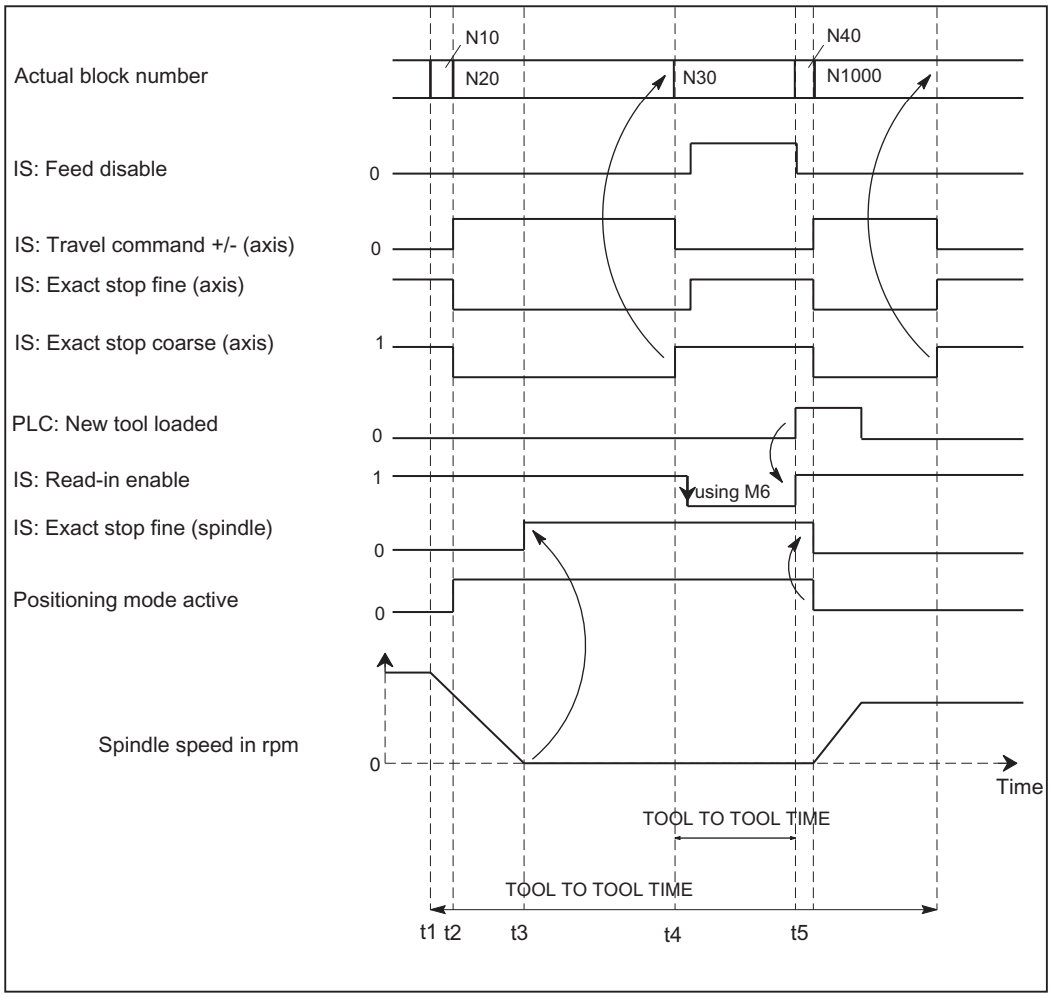



Figure 3-12 Chronological sequence of tool change

t1 axes stationary, spindle rotating, start of the tool change cycle in N10

t2 Traverse axis with G75 in N20 to tool change point

t3 Spindle reaches programmed position from block N10

t4 Axes reach exact stop coarse from N20; N30 now starts:

M06 removes the previous tool from the spindle and loads and clamps the new tool.

t5 Tool changer swivels back to original position.

Then, in N1000 of the calling main program,

- new tool offset can be selected,
- the axes can be returned to the contour, or
- the spindle can be accelerated.

### 3.3.3 Monitoring the maximum speed of a tool

If the maximum speed is exceeded, e.g. for very large tools, then this can represent a danger for man and machine. It is just as important to also monitor the maximum permissible acceleration.

A maximum speed and the maximum rotary acceleration of a tool can be specified, if this is located at a spindle, using two parameters of the tool data ($TC_TP_MAX_VELO and $TC_TP_MAX_ACC).

The speed and/or the acceleration of the corresponding spindle is limited.

The dynamic limiting of the spindle includes

- limiting the speed of a spindle, and
- the rotary acceleration of the spindle

The limits can be separately activated and set.

The dynamic limiting acts on the spindle through a tool

- in the spindle mode
- when tapping using G331/G332
- Synchronous following spindle
- in the spindle positioning mode
- constant cutting rate (G96, G961, G962)
- constant peripheral grinding speed
- spindle jogging

**Note**

The function is only available when magazine management is active.

#### Spindle is also a toolholder

If the spindle number is also the number of the toolholder ($MC_TOOL_MANAGEMENT_TOOLHOLDER = 0) (this is typical for milling machines), then the following applies:

The extension when programming the tool change also refers to the spindle whose dynamics should be limited.

Example with extension = 3:

```
T3="Miller_10" M3=6 S3=4000.
```

A tool with the identifier "Miller_10" is loaded onto spindle S3. The speed of spindle S3 is limited by the tool that is located on it.

**Note**

If an extension has not been programmed, then the tool change - as well as the programmed speed - refers to the actual master spindle.

### The toolholder is not a spindle

If the toolholder is rigid and the toolholder number is not a spindle ($MC_TOOL_MANAGEMENT_TOOLHOLDER > 0) (this is typical for lathes), then there is no assignment to a spindle.

However, for driven tools, it is necessary to assign the toolholder to a spindle. This is realized using the magazine location parameter $TC_MPP_SP[buffermagazine No., location No.]. It is only possible to change this parameter if there is no tool at this buffer magazine location.

If this assignment is not made, then the dynamics are not monitored and are not limited. As a consequence, for example, it is not possible to limit the dynamics of the spindle of a lathe with the fixed turning tool.

Example:

Tool in toolholder 2 is driven by spindle 5:
(buffer magazine No. = 9998, in any location number)

```
$TC_MPP5[9998, location No.]=2
$TC_MPP_SP[9998, location No.]=5
```

Programming:

```
"T2="Drill_8" M2=6 S5=4000.
```

A tool with the identifier "Drill_8" is changed into toolholder 2. The speed of spindle S5 is now limited by the tool in toolholder 2.

**Note**

If an extension has not been programmed (e.g. T="Drill" S=4000), then the tool change refers to the actual master toolholder and the programmed speed on the actual master spindle.

### Activating the speed limiting in the tool

The speed limit for a tool is only effective if tool data $TC_TP_MAX_VELO is set > 0 and the corresponding option is set.

A change to the tool data TC_TP_MAX_VELO only becomes effective the next time that the tool is located in the spindle.

### Activating the rotary acceleration limiting in the tool

The limiting of the rotary acceleration for a tool is only effective if the tool data $TC_TP_MAX_ACC is set > 0 and the corresponding option is set.

A change to the tool data TC_TP_MAX_ACC only becomes effective the next time that the tool is loaded into the spindle.

## Activation of the limiting when the tool is changed

The dynamics limiting by the tool on the spindle is only active if the tool is on the spindle as far as the NCK data is concerned. To do this, the PLC acknowledgements are evaluated.

When the change has taken place on the spindle or the toolholder, the PLC interface signal "tool with dynamic limits active" (DB3x.dbx 85.0) is set.

**Note**

The new PLC user interface signal "tool with dynamic limit active" displays that a tool with dynamic limiting is located in the spindle, and the assignment state of the spindles can be checked, especially if all tools have a maximum tool speed, which under certain circumstances is very high so that there is no effective limiting.

Example of a tool change:

Assumptions:
The tool with the internal T number = 6 is in the spindle, with dynamic limiting.
The tool with the internal T number = 8 is selected from the tool group "Millers", also with dynamic limiting and should be loaded in the spindle ("new tool").

| Step No. | NC program | NC -> PLC | PLC -> NC |
|---|---|---|---|
| 1 | N100 T1="Miller | | |
| 2 | | CMD=2 (tool preparation):<br>New tool T-No=8:<br>Mag./Mag.Loc.1-> Sp1<br>Old tool T-No=6:<br>Sp1 -> Mag./Mag.Loc.2 | |
| 3 | | | CMD=2, Status=1<br>New tool T-No=8:<br>Mag./Mag.Loc.1-> Mag./Mag.Loc.1<br>Old tool T-No=6:<br>Sp1 -> Sp1 |
| 4 | N101 M1=6 | | |
| 5 | | CMD=3 (tool change):<br>New tool T-No=8:<br>Mag./Mag.Loc.1-> Sp1<br>Old tool T-No=6:<br>Sp1 -> Mag./Mag.Loc.2 | |
| 6 | | | CMD=3, Status=105<br>New tool T-No=8:<br>Mag./Mag.Loc.1-> Mag./Mag.Loc.1<br>Old tool T-No=6:<br>Sp1 -> Mag./Mag.Loc.2 |

| Step No. | NC program | NC -> PLC | PLC -> NC |
|---|---|---|---|
| 7 | | | CMD=3, Status=105<br>New tool T-No=8:<br>Mag./Mag.Loc.1-> Sp1<br>Old tool T-No=6:<br>Mag./Mag.Loc.2 -> Mag./Mag.Loc.2 |
| 8 | | | CMD=3, Status=1<br>New tool T-No=8:<br>Sp1-> Sp1<br>Old tool T-No=6:<br>Mag./Mag.Loc.2 -> Mag./Mag.Loc.2 |

Up to step 6, the limits of the old tool are active.

In step 6, the PLC acknowledges the NC that the old tool was taken from spindle 1; this means that there are no limits imposed by the tool.

In step 7, the PLC acknowledges the NC that the new tool has been received at spindle 1, i.e. the limits of the new tool are active.

In step 8, the tool change is formally completed; no tool is moved.

## Behavior when special events occur

The dynamic limiting of a spindle by a tool depends on the tool, which, from the perspective of the NCK machine data, is in the particular spindle. If required, the data in the NC should be aligned with the actual assignment of the spindles. This should be observed for a warm restart or if tool movements are interrupted.

**Note**

When the channel is interchanged, the spindle keeps the dynamic limits. However, it should be observed that the channels in which the spindle can be interchanged also operate with the same TO unit.

## Diagnostic option

The actual reason for a speed limit can be read from the system variable $AC_SMAXVELO_IDX[n] with n = spindle number. The value "12" means that the spindle speed is limited by the tool in the spindle. The maximum speed itself is interrogated in $AC_SMAXVELO[n].

In addition, at a maximum speed of a tool, which is located in the spindle, the PLC user interface signal "tool with dynamic limit active" is set, independent of whether the tool actually limits the speed.

Analog to this, the maximum rotary acceleration is diagnosed. The actual reason for a rotary acceleration limit can be read from the system variable $AC_SMAXACCEL_IDX[n] with n=spindle number. The value "12" means that the rotary acceleration of the spindle is limited by the tool located in the spindle. The maximum acceleration itself is interrogated with $AC_SMAXACCEL_IDX[n].

In addition, for a maximum rotary acceleration of a tool, which is located in the spindle, the PLC user interface signal "tool with dynamic limit active" is set, independent of whether the tool actually limits the speed.

## Commissioning

## Preconditions

The "tool monitoring for maximum speed" option must be active in order to use the function "maximum tool speed".

One TO unit can be assigned to several channels (MD $MC_TOA_UNIT). The spindle number must also be unique across these channels and not only in the channels in which it is configured for axis interchange. This is realized using the magazine location data

- $TC_MPP5[buffer magazine No., location No.] if the MD $MC_TOOL_MANAGEMENT_TOOLHOLDER = 0.
- $TC_MPP_SP[buffer magazine No., location No.], if MD $MC_TOOL_MANAGEMENT_TOOLHOLDER > 0.

## Configuration

The function becomes available when setting the option "Tool monitoring for maximum speed".

If several channels are active, and several channels are "connected with one another" through

- spindles, that can be interchanged between the channels or
- through a TO unit, which is assigned several channels,

then the following must be especially observed:

The spindle numbers must be unique across all "connected channels" and the TO unit must be active in all channels in which the spindles can be interchanged.

**Note**

The application itself must ensure that a spindle interchange in another channel is also correspondingly taken into account for a tool change.

The PLC can check the synchronization of the tool assignment of the spindles with the data management of the NCK. Tools with a maximum tool speed set the PLC user interface signal "Tool with dynamic limiting active". This signal can be compared with the assignment sensors of the spindle.

## Parameterization

If data $TC_TP_MAX_VELO[internal T number] is set > 0, then data $TC_TP_MAX_VELO is evaluated if the tool is brought to a spindle.

Data changes to a tool, which is located in the spindle or toolholder, are not active. They only become active for a new change at the spindle or toolholder.

The same is true for the rotary acceleration:

If data $TC_TP_MAX_ACC[internal T number] is not set to 0, data $TC_TP_MAX_ACC is evaluated if the tool was brought to a spindle.

Data changes to a tool, which is located in the spindle or toolholder, are not active. They only become active for a new change at the spindle or toolholder.

### Data backup

After importing a data backup with tool data, from the data perspective, tools can be on spindles or toolholders. The dynamic limit is correspondingly active. It is the task of the PLC user program to adapt the actual assignment of the spindles to the NCK data

Program example

```
N10 $TC_TP[10]="Miller"
N20
$TC_TP_MAX_VELO[10]=3500
.....
N100 SETMS(1)                ; Master spindle
N110 M5
N120 T="Miller" m6           ; Tool with internal T number =10 is loaded into the
                             ; spindle 1,
                             ; DB31…,DBX85.0 is set to "1"
N130 S5000 M3                ; M3 ; The speed is limited to 3000 rpm
                             ; $AC_SMAXVRLO[1]=3000 and
                             ; $AC_SMAXVELO_IDX[1]=12
```

**Note**

SINUMERIK Operate still does not support the function.

## 3.3.4 Selecting a tool and a cutting edge

### Precondition

**Note**

T number and the M function are no longer transferred to the PLC as an auxiliary function if TOOLMAN is activated.

Numbers are valid tool names as well, e.g. "3" instead of T = "3" can be programmed more simply than T3.

There must be a tool with the T number as the identifier available when working with the T number.

Example: If you want to call a tool using T3, the tool must have the name "3". A tool CANNOT be called with the internal T number managed by NCK only.

### Select/deselect tool offset for Reset

The following machine data can be used to control the behavior for RESET:

- MD20310 TOOL_MANAGEMENT_MASK bit 14
- MD20122 TOOL_RESET_NAME
- MD20110 RESET_MODE_MASK
- MD20130 CUTTING_EDGE_RESET_VALUE
- MD20132 SUMCORR_RESET_VALUE

You can determine whether to:

- deselect the active tool
- keep the active tool selected
- or a particular tool is selected (according to MD20122 TOOL_RESET_NAME).

If, in terms of its data, a new tool is selected that is not yet on the master spindle or the master toolholder (or main spindle, main toolholder), then a tool change is executed for a RESET or the end of the program. With this type of tool change (in a similar manner to block searches), the PLC is not capable of influencing the selection of the tool.

### Select a tool at start of program

The machine data

- MD20310: TOOL_MANAGEMENT_MASK bit 14
- MD20122 TOOL_RESET_NAME
- **MD20112** START_MODE_MASK
- MD20130 CUTTING_EDGE_RESET_VALUE

can be set to define whether:

- the tool on the main spindle or the main toolholder is selected again or remains selected
- or a particular tool is selected (according to MD20122 TOOL_RESET_NAME)

If a new tool is selected which in the data is not yet specified as being on the spindle, a tool change is performed when the program is started. For this type of tool change the PLC cannot influence the selection of the tool, just as for block search.

### Tool rejection by the PLC

For a block search, selection on reset or program start as well as the setting "PrepSelect", then the tool is selected during preprocessing. In this case, the PLC is no longer allowed to reject the tool.

**Note**

If bit 4 of the machine data MD20310 TOOL_MANAGEMENT_MASK is set, then the PLC usually has the possibility to again request preparation for a tool change, yet this time with different parameters, i.e. to reject the tool.

### Communication between PLC and tool management

The communication between PLC and NCK during a tool change is via the VDI interface. Tool change is triggered by the tool management in the NCK. The TM outputs commands to the PLC which acknowledges them either positively or negatively depending on the situation. The PLC also has the possibility of independently (non-synchronously) transferring commands to the NCK, e.g. communicating the magazine position, transport of a tool etc.

## 3.3.5 Predecoding (preprocessing) and block execution (main run)

### Sequence

The cutting edge geometry cannot be calculated until the tool management knows the tool that is actually to be used. Only the identifier is stated in the part program for tool change. Generally, the tool with the status "active" is then used. But if this is disabled, then one of the other twin tools, i.e. the replacement tool, is selected instead. The precoding delays selection of the new offsets until it is clear which tool is to be used. Only then can precalculation of the blocks be restarted.

Tool change must have been completed before the path can be traversed with the tool offset of the new tool.

The block is split if the preprocessing run detects that an edge of a new tool has been selected for the first time and tool preparation has been initiated, but not yet completed.

The following synchronization points exist between predecoding and block execution:

Example:

Programmed NC block:

N1 D1 M06 Txx X100 Y100

Sequential blocks:

N1 Txx M06 end of block

N2 D1 X100 Y100

| | |
|---|---|
| 1. | Interpreter detects an offset selection (D number) |
| 2. | It determines that a tool change was previously programmed which has not yet resulted in selection of a tool. |
| 3. | Interpreter carries out "block splitting". |
| 4. | Output of block N1:<br>Block 1 receives a request from the execution blocks to output their collective blocks, and also if programmed, M06, T numbers, ... |
| 5. | Output of block N2:<br>Block 2 receives the rest, in particular all travel information and any D numbers if programmed. |
| 6. | Tool management stops execution of the block during preprocessing until it is clear which tool is to be used. |
| 7. | After receiving the tool preparation acknowledgement, execution of block 2 is continued, or first the new T number is entered in the block and is used to calculate the contour again. |

### Tool change at the main spindle or master toolholder

The main run waits in synchronism with tool change block for transport acknowledgement.

1. Main run waits in synchronism with tool change block for end of acknowledgement (if bit 5 or bit 6 of MD20310 TOOL_MANAGEMENT_MASK is set), or
2. After a tool change in the main run, the NCK automatically synchronizes with the end of the tool change in the block in which a cutting edge of the new tool was selected for the first time.

**Note**

The transport acknowledgement is an internal acknowledgement of an NCK command. It indicates to the NCK that the output command was accepted. When a new command is output to the PLC, the NCK waits for the acknowledgement of the previous command.

### Tool already in spindle

If the programmed tool is already in the spindle, by default no job is sent to the PLC. (The response can be defined by the MD setting.)

### Tool change at the secondary spindle or secondary toolholder

1. Main run does not wait. There is no synchronization
2. Main run waits in synchronism with tool change block for transport acknowledgement
3. Main run waits in synchronism with tool change block for end of acknowledgement.

### Tool change preparation in a main spindle

1. In the main run, the tool management decides which tool is to be used. Until then, the preprocessor waits at the point in the program at which the offset values of the new tool are to be considered for the first time.
2. The PLC can also decide which tool is to be used. In this case, the PLC can reject the recommended tool with a negative acknowledgement. When rejected by the PLC, the NCK selects a new, different tool (only if MD20300 MC_TOOL_MANAGEMENT_MASK bit 4 = 1, also refer to the FC 8/FC 6 description).
3. Even if the function "GETSELT(...,x)" is programmed, the preprocessor again has to wait until a decision has been made as to which tool is to be used.

### Prepare to change tool in a secondary spindle

1. The main run does not wait. There is no synchronization

**Note**

During a synchronization operation where the new offset is used or allowed for by the preprocessor, "block splitting" must be performed. This ensures that a preprogrammed tool change T or M06 is actually performed and not collected in run blocks.

Unlike the STOPRE command, the preprocessor does not necessarily wait until all blocks have been processed, but only waits if tool selection has not taken place by the appropriate time. The appropriate time is when programming new offsets after tool change or when programming GETSELT.

## 3.3.6 Traverse axes while tool is being changed

After the tool change command M06 the axes can continue travel without having to wait for the tool change acknowledgement and, e.g., execute traversing blocks without tool offset. Travel only stops in a block with an offset selected (D No.) until the PLC signals that a tool change has been completed.

Precondition: MD20270 CUTTING_EDGE_DEFAULT= 0 or = -2

Example: Traversing blocks between tool change and cutting edge selection

```
N10 T="Drill18"           ; Tool change preparation
N15 M06                   ; Tool change
N20 D0                    ; Offset deselection
N25 G00 X100 Z200         ; Traverse machine axes
N30 Y150 M79              ; Traverse machine axes
N35 G01 D1 X10            ; Activating the tool offset.
                          ; Check whether tool has been changed. Preprocessing stop
                          ; until tool change preparations have been completed.
                          ; Main run waits until tool change is acknowledged from
                          ; PLC.
```

The preprocessing stop is maintained until the tool change preparations have been completed. The main run waits at N35 (D1) until the tool change has been executed and acknowledged.

## 3.3.7 Tool change in the spindle for chain and box-type magazines

### Spindle/buffer DB 72

Data block DB 72 is responsible for changing tools in the spindle. This data block also prepares the tool change. This data block has an interface for every spindle.

User data is available at each interface (sequence in accordance with the spindle number) as for the loading and unloading points. Data are additionally available for the new tool to be loaded at change. This data includes location type, sizes, tool status and the T number internally assigned in the NC.

The buffer address of the spindle is contained in DB 72. DBW(n+16) and DBW(n+18) as the destination for the new tool. This position is communicated as the target position of the new tool in parameters "NewToolMag" and "NewToolLoc" when the tool change has been successfully completed. The target position for the old tool (DB72. DBW(n+24) and DBW(n+26)) is transferred to FC 8/FC 6 in parameters "OldToolMag, "OldToolLoc" together with parameter "Status = 1" after the change tool command has been executed.

### Description of tool change operation in spindle

The tool in location 1, magazine 1 is to be loaded to the spindle (magazine no. 9998, location 1) and the tool in the spindle is to be returned to magazine 1 location 8.

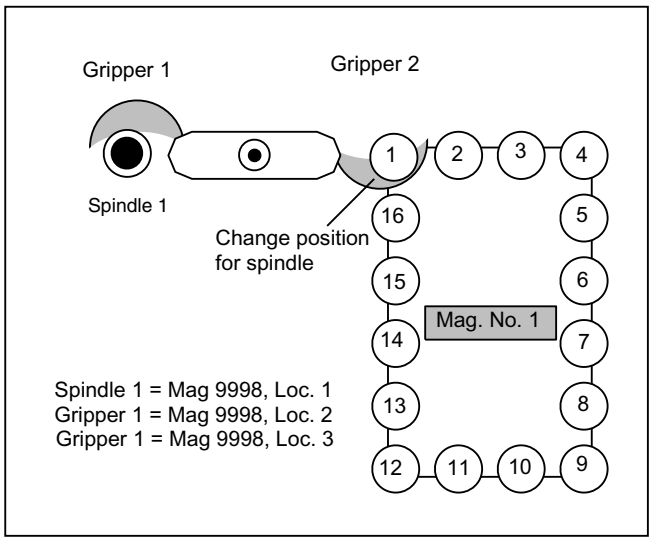



Figure 3-13 Tool change in the spindle

The tool change in the spindle is split into two steps (for TOOL_CHANGE_MODE=1):

1. Prepare change:

   Search for new tool and move to the change position

2. Execute change:

   New tool into the spindle and old tool into the magazine at the correct location

### 1. Prepare change

Bit 2 is set in DB72.DBB n+0. In preparing for the change, the current positions of the tools are communicated to FC 8/FC 6 in the associated parameters once the preparation step has been completed. In this case, "Status" = 1 is parameterized for FC 8. This means that the "old tool" is still in the spindle and that the "new tool" is either still in the source magazine at the same location or has been placed in a buffer.

The following information is passed to FC 8/FC 6:

- The new tool is in the change position, but is still located in magazine (NewToolMag = 1 and NewToolLoc = 1).
- The old tool is still in the spindle (OldToolMag = 9998 and OldToolLoc = 1).

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts task |
| TaskIdent | 2 | DB 72 interface |
| TaskIdentNo | 1 | No. of active interface |
| NewToolMag | 1 | (n+20) Mag No. new tool |
| NewToolLoc | 1 | (n+22) Loc. No. new tool |
| OldToolMag | 9998 | (n+16) Mag No. target new tool |
| OldToolLoc | 1 | (n+18) Loc. No. target new tool |
| Status | 1 | Operation complete |
| Ready | | Checkback signal from FC 8 |
| Error | | Checkback signal from FC 8 |

### 2. Change tool

If the preparation command has been correctly acknowledged with status = 1, the "Change" bit DB72.DBB n+0 bit 1 is set with the M06 command from the part program. The free parameters are also transferred again. All other values remain unaffected by the "Change tool" operation.

Two tools are involved in the tool change procedure. The old tool is in the spindle and the new tool is in the magazine. The tool transport is executed in this example with gripper 1 and gripper 2. Any change in the position of the tools must be communicated to the tool management with FC 8/FC 6. FC 8/FC 6 must be called twice for this purpose.

*FC 8/FC 6 call with status 105 change in progress*

The tool with the dual gripper is withdrawn from the magazine and the spindle. The old tool is now in gripper 2 at location No. 3 and the new tool in gripper 1 in location No. 2. The following FC 8/FC 6 call results:

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts task |
| TaskIdent | 2 | DB 72 interface |
| TaskIdentNo | 1 | No. of active interface |
| NewToolMag | 9998 | (n+16) Mag. No. spindle |
| NewToolLoc | 2 | (n+18) Loc. No. new tool<br>New tool now in gripper 1 |
| OldToolMag | 9998 | Mag. No. old tool |
| OldToolLoc | 3 | Loc. No. old tool<br>Old tool now in gripper 2 |
| Status | 105 | Procedure running |
| Ready | | Checkback signal from FC 8 |
| Error | | Checkback signal from FC 8 |

**Note**

The operator uses FC 8/FC 6 to notify the tool management of the new positions of the exchanged tools.

Tool management knows which is the new (called) tool and which is the old (spindle) tool.

The current positions are also known to the tool management. If these positions change, the tool management is only informed about this through FC 8/FC 6.

**Note**

If T preparation and change signals are simultaneously present, then the tool call and the change command (T and M) are programmed in one block. When calling FC 8/FC 6, in such a case, only the change has to be acknowledged and not the selection.

*FC 8/FC 6 call with status 1 - tool change completed*

While the gripper is moving the tools, the PLC can read the magazine location for the old tool (from the spindle) from DB72.DBW (n+24) and (n+26) and move the magazine to the change position. This position is location 8 in magazine 1 in this example. The tool change can now be mechanically ended by "inserting" the tools. Tool management shall be informed of this change in tool positions by a FC 8/FC 6 call with status = 1. The new tool is placed in the spindle of magazine No. 9998, location No. 1 and the old tool in magazine No. 1 at location 8.

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts task |
| TaskIdent | 2 | DB 72 interface |
| TaskIdentNo | 1 | No. of active interface |
| NewToolMag | 9998 | (n+16) Mag. No. spindle |
| NewToolLoc | 1 | (n+22) Loc. No. spindle |
| OldToolMag | 1 | (n+24) Mag No. old tool |
| OldToolLoc | 8 | (n+26) Loc. No. old tool |
| Status | 1 | Operation complete |
| Ready | | Checkback signal from FC 8 |
| Error | | Checkback signal from FC 8 |

If the dual gripper is to place the spindle tool in the magazine location of the new tool, the user must ensure that the magazine location is of the same size and location type as the spindle tool.

Here too, a 1:1 exchange is supported through appropriate setting of the search strategy by the tool management; in this case, the NCK checks the location type, size, adjacent location allocation,...

If this is the case, the transfer can be performed simultaneously (on the dual gripper in the spindle and in the magazine location at the change position).

FC 8/FC 6 must be parameterized as follows:

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts task |
| TaskIdent | 2 | DB 72 interface |
| TaskIdentNo | 1 | No. of active interface |
| NewToolMag | 9998 | (n+16) Mag No. new tool |
| NewToolLoc | 1 | (n+18) Loc. No. new tool |
| OldToolMag | 1 | (n+20) Mag No. old tool |
| OldToolLoc | 1 | (n+26) Loc. No. old tool |
| Status | 1 | Operation complete |
| Ready | | Checkback signal from FC 8 |
| Error | | Checkback signal from FC 8 |

## 3.3.8 Special cases "T0", empty spindle, multiple T selection

### T0: Empty spindle

DB72.DBX(n+0).3 indicates that T0 has been programmed. If the spindle is to be emptied using T0, this can be identified by the fact that in DB72, DBW (n+20), DBW(n+22) data for new tool have the value "0".

Then, values NewToolMag and NewToolLoc of FC 8/FC 6 must be set to "0".

This applies to the preparation and to the change procedure.

### Spindle is empty

The tool must be loaded. This status is indicated by the fact that parameters OldToolMag and OldToolLoc have the value "0".

In this case, FC 8/FC 6 parameters OldToolMag and NewToolLoc must be set to "0" for tool preparation and change.

### Multiple T selection

It can happen with multiple T selection that the program cannot be aborted by a RESET.

**The interruption response can be enhanced as follows:**

- Cancel the read-in enable to prevent following blocks from being accepted in the main run.
- Then acknowledge with status 3 via FC 8/FC 6 (the tool command is rejected by the PLC).
- When the acknowledgement has been issued, the RESET can be activated for the channel.

## 3.3.9 Tool change with turret

### Turret DB 73

**DB 73** is the block used to "change" tools in the turret (i.e. by rotating the turret so that the required tool is in working position). This data block has an interface for every turret. The turrets are numbered using ascending magazine numbers. User data are available at each interface as for the loading and unloading point. Data are additionally available for the new tool to be loaded at change. This data includes location type, sizes, tool status and the T number internally assigned in the NC.

Following completion of the tool-change operation, loading the new tool shall be acknowledged by FC 7. To this end, the parameter "ChgdRevNo" receives the turret number of the new tool that has been inserted.

| FC 7 parameters | Values | Comment |
|---|---|---|
| Start | | Starts task |
| ChgdRevNo | 1 | 1st turret |
| Ready | | Checkback signal from FC 8/FC 6 |
| Error | | Checkback signal from FC 8/FC 6 |

## 3.3.10 Number of replacement tools

Machine data MD17500 MN_MAXNUM_REPLACEMENT_TOOLS can be set to select the maximum number of replacement tools.

Once the set threshold for the number of replacement tools has been reached it is no longer possible to:

- create a new tool with this ID (alarm) or
- assign a tool by renaming an already fully assigned group (alarm).

### Alarms

For operation via the HMI, alarm 17192 is output as an indication as soon as the defined limit is violated.

If programming via a part program an additional interpreter alarm is triggered (e.g. 14020 if NEWT fails).

For the setting $MN_MAXNUM_REPLACEMENT_TOOLS = 0, the data is not evaluated; this is the default setting.

**Note**

Machine data MD17500 MAXNUM_REPLACEMENT_TOOLS has a maximum input value of "32", i.e. a tool group then contains a maximum of 32 tools.

## 3.3.11 Tool changing errors

If an error is detected by the NCK in the programmed tool preparation (e.g. no tool available, no free position in magazine) program processing is terminated with an alarm.

The operator can assess and rectify various problems without terminating the program.

**The following problems can be solved:**

- The tool data record is not or not entirely in the NCK.
- The part program contains a programming error.
- No more replacement tools of the tool group in question are present or available (only applies when tool management is active).
- Alarm 22067 or 22069 is output. The tool data record has been loaded into the NCK but is not assigned to a magazine location or the magazine of the tool is not accessible to the tool search (only applies when tool management is active). The tool must be reloaded "manually" (e.g. directly onto the spindle).

**Note**

The case of illegal "D number" can occur either if there is an error in the part program or the data record for the D number is not in the NCK.

Programming example

```
N10 ...
N100 T="Drill"            ; NCK detects an error
N110 ...
N200 M06                  ; to the extent that the tool change is not explicitly
                          ; programmed in the same program for tool preparation
N210 ...
```

**Note**

As a rule **M06** is not programmed at the program level of tool preparation but rather in a subroutine, cycle or macro.

Bit 0 of machine data 22562 TOOL_CHANGE_ERROR_MODE is used to set at which block a stop is to be made.

**TOOL_CHANGE_ERROR_MODE, bit 0=0:**

```
N10 ...
N100 T="Drill"            ; NCK detects an error, program stops at this block
N110 ...
N200 M06
N210 ...
```

**TOOL_CHANGE_ERROR_MODE, bit 0=1:**

```
N10 ...
N100 T="Drill"            ; NCK detects an error
N110 ...
N200 M06                  ; Program stops at this block
N210 ...
```

The fault is found during tool preparation yet it is delayed by the NCK. The program continues and stops at M06. Tool preparation has been completed at this point in time for a regular program run. In the event of an error, tool preparation with the correct data can be subsequently repeated. In this situation, the language command GETSELT would supply the value "-1". With this information, e.g. in a change cycle, a branch can be made to fault handling.

The programming error (in block 100 in this example) is corrected by adding the offset to the tool change block:

N200 "T=Drill_1" M06

If a tool change (with M06 programming) is realized by means of a subroutine or cycle program, then the error can be rectified by inserting an overstore block (in the example).

## 3.3.12 Manual tools (adding tools during machining)

Manual tools are tools whose data are completely available in the NCK, but are not loaded into the magazine. The function is set using $MC_TOOL_CHANGE_ERROR_MODE, bit 1=1. The automatically selected tool must be inserted in the machine manually and removed again manually after machining.

## Responsibility of the operator

The user must ensure that

- the data record of the tool positioned on the spindle is actually in the NCK and
- that he or she places the tool that corresponds to the data record in the NCK on the spindle.

Tools which are loaded manually during machining are referred to as **"manual tools"**.

**Note**

The responsibility is on the users themselves to comply with the safety regulations via the PLC program.

## Sequence

Internally, the NCK initiates an automatic sequence until the user can perform the tool change with a manual tool. The NCK searches for the selected tool and detects that a suitable tool is not available in the magazine. After a suitable tool is not found in the magazine, then a search is made in the other tools that are not loaded. The tool with the status active is selected from these. If an active tool does not exist, a replacement tool – corresponding to the selected search strategy – is selected.

If a suitable tool is found, then the manual tool can be loaded. The manual tools are identified in the interface to the PLC (VDI) by the **Magazine location no. 1** in the **magazine 9999**. As a consequence, the basic PLC program interprets this as involving a manual tool and sets the interface signals DB72.DBx(n) bit 5 and bit 6 "Replace or load manual tool". The PLC must ensure that a safe state exists in order that the user can perform the manual tool change.

**Note**

If the manual tool is loaded, alarm 17212: "Channel %1, Manual tool %3, Duplo No. %2, load to toolholder %4" is output. The alarm is confirmed by the tool-change acknowledgement from the PLC

The information alarms can be hidden ($MN_SUPPRESS_ALARM_MASK_2)

**Note**

It is not permissible that the PLC rejects a manual tool preselected from the NCK (tool rejection, also refer to MD20310 TOOL_MANAGEMENT_MASK).

The tool state "CHANGEACTIVE" is taken into account corresponding to the setting in "$MC_TOOL_MANAGEMENT_MASK".

A manual tool is always inserted via the spindle change position in DB 72, also for the setting $MC_TOOL_CHANGE_MODE = 0.

## Magazine location 9999/1 for manual tools

For manual tools, magazine location 1 in Magazine 9999 has a special significance.

Typically, as a result of the magazine configuration that is created on the HMI, the magazine with number 9999 is defined as loading magazine and has at least one magazine location, which has the number 1. As a consequence, in most cases magazine 9999 has a magazine location 1 with the property "loading point".

For the preparation and change command from the NCK or its acknowledgment, normally only locations associated with real magazines and toolholders are involved. However, if magazine location 1 of magazine 9999 is specified as source location of the tool to be loaded or as target location of a tool to be changed out, then it involves a "virtual magazine location address", which under certain circumstances, has nothing to do with the actually available magazine location 1 in magazine 9999. This can then be identified in so much that

- a tool can be loaded into the actual magazine location without an error message being output and
- a tool at magazine location 9999/1 - assuming that magazine 9999 is defined as a loading magazine - is not found when selecting a tool.

## Block search, program test

As regards block searches, there is no difference to a normal tool change. However, the corresponding alarms are not generated.

No change commands are output to the PLC during the block search. If a manual tool needs to be loaded when the NC is first started, then this can be achieved using **magazine location 1** in **magazine 9999** and output of the corresponding alarm.

The data for the tools and magazines have to remain unchanged in the NCK during the **program-test mode** . A manual tool that has been loaded during program-test selection is therefore removed in terms of its data from the toolholder and saved internally. The stored manual tool is loaded back into the toolholder in response to PLC task "Return manual tool from magazine 9999, location 1".

**Note**

Several toolholders and manual tools can exist in the program test mode because of the technology used for the internal storing.

## Boundary conditions

In conjunction with tool selection, tool change and offset selection, only problems associated with the offset block technique can be rectified that have arisen because of programming errors or incorrectly defined data in the NCK.

## Manual tools for circular magazines (change with T command)

Manual tools are loaded and removed via the spindle interface in the DB 72 - with the exception of a special case. The interface number is the number of the spindle / toolholder that was assigned to the turret. The special case occurs if the tool in the spindle is a manual tool. A new tool, which is located in the turret, is programmed. In this case, the command in DB 73 is output in the corresponding turret interface. In this case, the manual tool must first be removed. The tool be loaded into the turret must be swiveled into the machining position. The command then has to be acknowledged.

## Unique identification of manual tools

*Previous behavior:*
A manual tool was solely identified due to the fact that it did not have an owner location. This is then used to derive as to whether (within the scope of a change) it is loaded or removed from the virtual magazine location 9999/1
This also means that a tool, which for example was loaded onto the spindle as a result of an operator action at the HMI, is a manual tool. As a consequence, it cannot be placed in the magazine using T0/M06.

The fact that a tool loses its owner location when being transported can be a legal state. This means that it is no longer possible to reliably identify a manual tool.

*New behavior:*
A manual tool is allocated a unique identifier, $TC_TP8[T_No] bit 15 =1.
If this state is set, a search is not made for an empty location in a magazine for the tool - and this (old) tool is directly transported to the virtual magazine location 9999/1 when the tool is changed. By moving this tool between the locations of the buffer magazine - independent of the motion command that initiated this - the "manual tool" state no longer changes.
(Exception: see Section, resetting the "manual tool" state)

**Note**

As a consequence, a tool that was loaded onto the spindle, e.g. via SINUMERIK Operate, is now not a manual tool. As a consequence, it is placed in the magazine using T0/M06.

**Setting the "manual tool" state**

The "manual tool" state of a tool is set if the following condition are fulfilled:

- machine data $MC_TOOL_CHANGE_ERROR_MODE, bit1 is set
- as part of a tool change, an unloaded tool was selected.

**Resetting the "manual tool" state**

The "manual tool" state of a tool is reset, if

- the tool is unloaded, i.e. the tool no longer has a current magazine location.

  This can especially occur as a result of

  unloading the old tool as part of the tool change

  transporting a manual tool to a loading position (unloading as a result of an HMI operator action)

  writing $TC_MPP6[m,p]=0 to the location of the buffer magazine where the manual tool is currently located. (m=magazine No., p=location No.)
- or the command to select or load a manual tool was interrupted and the tool was still not moved to a magazine location
- or the tool was allocated an owner location. For example, this can be realized with the extended NC language command "GETFREELOC" using a reservation parameter.
- or the tool was brought to a location of a real magazine or the loading magazine.

#### Explicitly writing the state "manual tool" ($TC_TP8, bit 15)

Further, the "manual tool" state of the tool can be set or reset by writing to the system of variables for the tool state ($TC_TP8).

It is not possible to set the "manual tool" tool state, if

- machine data $MC_TOOL_CHANGE_ERROR_MODE, bit1 is not set. Otherwise, Alarm 17242 ( "Channel %1, block %2, manual tool cannot be set as the function is not active") is issued.
- It is not possible to set the "manual tool" tool state, if the tool is located

  - in a real magazine location,

  - in a loading magazine,

  - in a buffer magazine location and has an owner location.

  If this is set, it is rejected with Alarm 17218 ("Channel %1, block %2, tool %3 cannot become a manual tool").

  If a tool, which is located in a magazine location, is to become a manual tool, then it must be transported into the buffer or loading magazine (using asynchronous transfer, PI service or MVTOOL language command). Then, using the NC language command "DELMLOWNER", the reservation and the owner location can be deleted. Only then can the "manual tool" state be set.

If the tool state "manual tool" is explicitly reset, then initially an empty location search is not made for the tool and no reservation is made. It is also not allocated an owner location. Only in subsequent operations can an empty location search be made - and real magazine locations reserved.

The state "manual tool" can also be set and reset via the OPI interface (block T/TD, column 8).

#### Properties of the "manual tool" state

For a manual tool, when the tool is being changed, a search is not made for an empty location, an owner location is not allocated and a reservation is not made. Also for other tool transport types and search operations, for a manual tool, an empty location is not searched for - exception, explicit reservation using the NC language command "GETFREELOC".

The command data set, which the NCK sends to the PLC when a tool is being changed, always contains as target address for a manual tool as old tool, the virtual magazine location 9999/1.

For manual tools, the empty location search strategy "1:1 replacement" is not effective, as the "manual tool" property has priority, i.e.

- If the new tool is a manual tool and the old tool comes from a location in a real magazine, then the transport job sent by the NCK to the PLC is as follows: Old tool back into the real magazine, new tool from virtual magazine location 9999/1.
- and vice versa: If the old tool is a manual tool and the old tool comes from a location in a real magazine, then the transport job sent by the NCK to the PLC is as follows: Old tool to virtual magazine location 9999/1, new tool from the location of the real magazine.

The "manual tool" state is effective via a power on.

When unloading a tool to the virtual magazine address 9999/1, the settings of MD $MN_TOOL_UNLOAD_MASK are not effective, i.e. the corresponding tool states are kept.

**Note**

Using the NC language command "GETFREELOC" or for the PI service "_N_TMFDPL" or

"_N_TMFPBP", a check is not made as to whether a manual tool is involved. If the NC language command "GETFREE LOC" is parameterized so that also a buffer location is reserved, then as a consequence the tool loses its "manual tool" state.

**Note**

At power on, the "manual tool" state for tools is reset, which

- are at a real magazine location or the loading magazine, or
- are at a buffer magazine location and have an owner location, or
- are not at any magazine location.

**Note**

If, when writing to $TC_MPP6[m,p] a manual tool is set at a magazine location,

the "manual tool" state is deleted, if

- "m" addresses a real magazine or the loading magazine, or
- "m" addresses the buffer magazine and the tool has an owner location.

**Note**

If a manual tool should come to the unloading point magazine location 9999/1 for unloading using an asynchronous transfer, the NC language command "MVTOOL" or the PI service "_N_TMMVTL", then this location must be defined and also free. On the other hand, for unloading operations for a manual tool, magazine location 9999/1 does not have to be defined and does not have to be free.

### Behavior, NC language commands "TCA", "TCI" and return transport for manual tools

If the language command TCA programs a certain tool, which is not located at a magazine location (also not at an internal magazine location), then this tool is selected and changed in as manual tool.

If the language command TCI is applied to a buffer location where there is a manual tool, then the target location for the movement is the virtual magazine location 9999/1 (this means that the TCI instruction does not bring the manual tool into a real magazine corresponding to the definition of TCI for other tools). Alarm 17215 "Channel %1 tool management: Unload manual tool %3 from buffer location %2."

is issued. This alarm is acknowledged by the tool change acknowledgement from the PLC.

Users must themselves ensure that the safety regulations are maintained through their PLC programs, such as when loading a manual tool.

The tool state "BACKTRANSFER" for a manual tool is evaluated in the form so that the virtual magazine location 9999/1 is specified in the PLC command for the manual tool.

Alarm 17215 "Channel %1 tool management: Unload manual tool %3 from buffer location %3." is issued. This alarm is acknowledged by the tool change acknowledgement from the PLC.

Users must themselves ensure that the safety regulations are maintained through their PLC programs, such as when loading a manual tool.

### Suppressing alarms 17212, 17214, 17215, 17216

The manual tool change request alarms can be suppressed using bit 12 in MD $MN_SUPPRESS_ALARM_MASK_2. Then, using the tool change command data, the PLC must correctly load and remove the manual tool.

### Example 1

(milling machine, $MC_TOOL_CHANGE_MODE=1, 1 x spindle, 1 x chain-type magazine, double gripper)

| | | |
|---|---|---|
| T=MILLER_120" | Job to PLC: | new tool from 9999/1 to 9998/1<br>old tool from 9998/1 to 1/10 |
| | "Manual tool" identifier is set | |
| M06 | Information alarm 17212 | "...manual tool "MILLER_120"<br>Duplo number 00001 load onto spindle/toolholder 1" |
| | The information alarm is acknowledged with the final acknowledgment from M06 | |
| ... | | |
| T0 | Job to PLC: | new tool from 0/0 to 0/0<br>old tool from 9998/1 to 9999/1 |

| | | |
|---|---|---|
| M06 | Information alarm 17212 | "...manual tool "FRAESER_120" Duplo number 00001 take from spindle/toolholder 1" |
| | with the final acknowledgment from M06<br>a. the information alarm is acknowledged<br>b. the identifier "manual tool" is deleted | |

**Example 2**

(milling machine, $MC_TOOL_CHANGE_MODE=1, 1 x spindle, 1 x chain-type magazine, double gripper)

The "FACE MILLER_120" tool is loaded directly onto the spindle (e.g. using an HMI operator command) and is then loaded into the magazine using T0/M06.

| | | |
|---|---|---|
| | Job to PLC: | new tool from 9999/1 to 9998/1 |
| | Identifier "manual tool" is **not** set, no information alarm | |
| T0 | Job to PLC: | new tool from 0/0 to 0/0<br>old tool from 9998/1 to 1/x |
| | As this does not involve a manual tool, the NCK performs an empty location search and places the tool in the magazine. | |
| M06 | No information alarm, as it does not involve a manual tool. | |

## 3.3.13 Tool changes in the NCK using synchronized actions

### Overview

At tool change and at loading/unloading it is often necessary to supply the NC cycles with the data for the participating tools.

Usually this is done via the "fast data channel" (dual port RAM) using FC 21.

The PLC user program checks the interface in DB 71/72/73.

If a new command is pending, the data (new location, old location, T_number,...) are read, pre-processed and supplied to the cycles via FC 21. There they are (usually in synchronized actions) read as variable $A_DBB[...] and e.g. magazine movements are derived from them.

To reduce the overhead involved and create simpler mechanisms, most of the data of the tool management interface was mapped onto the NC variables for read access.

This means that all information about the old tool and the new tool can be read directly in the part program or in synchronized actions; the "detour" via the PLC is no longer needed.

The following variables are used for the mapping process:

| | |
|---|---|
| $AC_TC_FCT | Function No. (command No. of the NCK) |
| $AC_TC_STATUS | Acknowledgement status from the PLC |
| $AC_TC_THNO | Toolholder or spindle No. on which the change was executed |
| $AC_TC_TNO | Internal T No. of the tool to be changed or prepared |
| $AC_TC_MFN | Source **new** tool: Magazine number |
| $AC_TC_LFN | Source new tool: Location number |
| $AC_TC_MTN | Target new tool: Magazine number |
| $AC_TC_LTN | Target new tool: Location number |
| $AC_TC_MFO | Source **old** tool: Magazine number |
| $AC_TC_LFO | Source old tool: Location number |
| $AC_TC_MTO | Target old tool: Magazine number |
| $A_TC_LTO | Target old tool: Location number |
| $AC_TC_CMDT | Trigger variable to output command of the NCK (is set for one IPO) |
| $AC_TC_ACKT | Trigger variable for acknowledgement of the PLC (is set for one IPO) |
| $AC_TC_CMDC | Counter for the command output |
| $AC_TC_ACKC | Counter for the acknowledgements |
| $AC_TC_MMYN | Owner magazine of the new tool |
| $AC_TC_LMYN | Owner location of the new tool |
| | Supplementary variables for multitool |
| $AC_TC_TOOLIS | Transported tool, type:<br>0 = basic tool<br>1 = multitool with distance coding "location"<br>2 = multitool with distance coding, "distance"<br>3 = multitool with distance coding, "angle" |
| $AC_TC_MTDIST | Distance of the tool from the reference location |
| $AC_TC_MTNLOC | Number of locations of the multitool |
| $AC_TC_MTTN | Multitool number |
| $AC_TC_MTLTN | Location number of the selected tool in the multitool |

**Note**

The variables are read-only (exception $AC_TC_CMDC and $AC_TC_ACKC). The acknowledgement mechanism remains unaffected (as before, the PLC acknowledges all commands from the NCK via FC 8/FC 6 or FC 7).

## Method of operation

The variables are written:

1. with **each** command from the **NCK** (**CMD**)
2. with **each** acknowledgement from the **PLC** (**ACK**)
3. with **Power On** all are set to value "-1"

The data is retained until it is overwritten by a new command. This means that with commands of the same type, it is not possible to tell from the function number ($AC_TC_FCT) whether a new task is present.

The exceptions are:

$AC_TC_TNO and $AC_TC_THNO

If, for example, the NCK outputs a T preparation, both of these variables are set to "-1" with the first PLC acknowledgement via FC 8/FC 6 (e.g. status 105).

**Note**

Scanning should only take place in synchronized actions. Depending on the application, this can then trigger the variables $AC_TC_CMDT and/or $AC_TC_ACKT.

## Example 1

**Positioning a tool chain onto the old location**

Assumption:

The tool chain has 36 locations, is defined as rotary and indexing axis, increments are 10 degrees therefore each graduation corresponds to one magazine location.

Tool_Change_Mode=1, Tool_Change_M-Mode=6

```
Ids=1 every(($AC_TC_CMDT==1)and(($AC_TC_FCT==2)or($AC_TC_FCT==5))) do
$R10=itor($AC_TC_LTO)
...
if ((R10>0)and($A_DBB[x]==5)) pos[U1]=cdc(R10)
endif
```

The trigger is sent to the command output of the NCK and with command "2" (T preparation) or command "5" (T/M06 in one block) the old location is read out and stored in R10

(itor=IntegerToReal - format conversion if the variable is stored in the R-variable in synchronized actions).

Later in the program, when the enables from the PLC are present (for example as $A_DBB[x]==5), the magazine axis is traversed to the saved position (old location=$AC_TC_LTO).

A magazine movement could also be started as follows (shown here in simplified form):

```
Ids=1 every((((($AC_TC_FCT==2)or(AC_TC_FCT==5))and
($AC_TC_STATUS==105))and(($AC_TC_LTO>0))) do pos[U1]=cdc($AC_TC_LTO)
```

With commands "2" and "5" (T preparation or T/M06), with old location>0 and PLC acknowledgement status "105" (serves as enable), the magazine axis is traversed.

Old location>0: If the spindle was empty, there is no old tool and the old location is 0. Therefore, the magazine axis does not need to move.

## Example 2

### Swiveling a turret

Assumption:

Turret, 6 locations, the turret is defined as an indexing axis, 60 degree increment, corresponds to one tool location, 1xSpindle, Tool_Change_Mode=0

```
Ids=1 every($AC_TC_CMDT==1)and($AC_TC_FCT==4)and($AC_TC_LFN>0) do
$R10=itor($AC_TC_LFN)
...
if ((R10>0)and($A_DBB[x]==5)) pos[B]=cac(R10)
endif
...
```

The NCK is triggered with the command output and with command "4" (change with T command) the new location is read out and saved in R10

(itor= IntegerToReal - format conversion if the variable is stored in the R-variable in synchronized actions).

Later in the program, when the enables from the PLC are present (for example as $A_DBB[x]==5), the turret is traversed to the saved position (new location=$AC_TC_LFN).

The logic operation $AC_TC_LFN>0 prevents a movement from taking place if, for example, T0 was programmed.

## 3.3.14 Function replacement

### Overview

The function allows a T, M or D function to be replaced by a cycle.

The function is available independent of the tool management and is described in detail in the "Function Manual Basic Machine Chapter 2.11 (mode group, channel, program operation)".

The function is set using the following machine data:

| | |
|---|---|
| $MN_M_NO_FCT_CYCLE | Enter the M function that is to be replaced, e.g. "6" |
| $MN_M_NO_FCT_CYCLE_NAME | Name of the cycle that should be executed instead of the M function, e.g. "L6" |
| $MN_T_NO_FCT_CYCLE_NAME | Name of the cycle that should be executed instead of the T function, e.g. "T_cycle" |
| $MN_D_NO_FCT_CYCLE_NAME | Name of the cycle that should be executed instead of the D function, e.g. "offset" |
| $MN_TCA_CYCLE_NAME | Name of the cycle that should be executed instead of the TCA command, e.g. also "T_cycle" |

The mode of operation will now be explained using a T function replacement as an example.

### Example

If one of the auxiliary functions to be replaced is programmed, e.g.
N10 G90 G00 Z-100 S3000 T="Miller_20mm" M65
then the NC executes a so-called block splitting and "splits" this NC block into 2 blocks

a) G90 G00 Z-100 S3000 M65
b) T="Miller_20mm"

The information "Miller_20mm" is transferred as parameter to the cycle.
If the T call is now again programmed in the replacement cycle, then no additional replacement is made.

Machine data $MN_T_NO_FCT_CYCLE_MODE is used to set whether the cycle is executed at the block start or at the block end (or also at the start and end).
The offset handling type is also set: If an offset is programmed (e.g. D3) in the NC block, which is to be split, then it can be set as to whether the offset selection is taken into account or is transferred as parameter to the replacement cycle.

## Transfer variables of the T replacement cycle

| | |
|---|---|
| $C_T | T number of the tool (numerical) |
| $C_T_Prog | Bool variable that shows whether a T word is available in $C_T |
| $C_TS | Tool identifier (string) |
| $C_TS_Prog | Bool variable that shows whether an identifier is available in $C_TS |
| $C_TE | Address extension of the T word |
| $C_TCA | Bool variable that indicates whether the TCA replacement is active |
| $C_DUPLO_PROG | Bool variable that indicates if the Duplo number for the TCA replacement has been programmed |
| $C_DUPLO | For $C_DUPLO_PROG == TRUE, contains the value of the programmed duplo number |
| $C_THNO_PROG | Bool variable that indicates if the toolholder/spindle number for the TCA replacement has been programmed |
| $C_THNO | For $C_THNO_PROG == TRUE, contains the value of the programmed toolholder/spindle number |
| $C_D | Programmed D no. |
| $C_D_Prog | Bool variable that shows whether an offset number is available in $C_D |
| $C_DL | Programmed additive/setup offset |
| $C_DL_Prog | Bool variable that shows whether an offset number is available in $C_DL |

Example of a T replacement cycle

```
;
if(($C_T_PROG==1)or($C_TS_PROG==1)or ($C_TCA==1)) T or TCA has been
programmed
 if $C_T_PROG==1                    ;T numerical
  if $C_T==0                        ;T0 programmed
   if $SC_TE>=1                     ;Extension
    T[$C_TE]=0                      ;yes, programming of T0 with address extension
   else
    T0                              ;Programming of T0 without address extension
   endif
  else
   if $C_TE>=1                      ;Address extension
    T[$C_TE]=$C_T                   ;T programming with address extension
   else
    T=$C_T                          ;T programming without address extension
   endif
  endif
 endif
```

```
;
if $C_TS_PROG==1                    ;T=String
 if $C_TCA==1                       ;TCA
  if $C_DUPLO_PROG==1               ;Duplo-No?
   if $C_THNO_PROG>=1               ;Toolholder No
    TCA($C_TS,$C_DUPLO,$C_THNO      ;Programming of TCA with the identifier, duplo No.
                                    and Toolholder No.
   else
    TCA($C_TS,$C_DUPLO)             ;Programming of TCA with the identifier, duplo No.
                                    without Toolholder No.
    endif
  else
   if $C_THNO_>=1
    TCA($TS,$C_THNO)                ;Programming of TCA with the identifier, Toolholder
                                    No. without duplo No.
   else
    TCA($C_TS)                      ;Programming of TCA only with the identifier
   endif
  endif
 else
   if $C_TE>=1                      ;Extension
    T[$C_TE]=$C_TS                  ;Programming of T=identifiers with address extension
  else
    T=$C_TS                         ;Programming of T=identifiers without address
                                    extension
   endif
  endif
 endif
endif
;
;
;
;-------------------------------------------------------------------------
;--- Continuation of the T preparation---
;-------------------------------------------------------------------------
;
;...
;
msg("")
ret
```

In the cycle, actions can now be easily executed to prepare the tool, scan the gripper, position the magazine data transfer to the PLC, start auxiliary channels,etc.

**Note**

The TCI language command cannot be replaced!

### Transfer variables of the D replacement cycle

| | |
|---|---|
| $C_D | Programmed D no. |
| $C_D_Prog | Bool variable that shows whether an offset number is available in $C_D |
| $C_DL | Programmed additive/setup offset |
| $C_DL_Prog | Bool variable that shows whether an offset number is available in $C_DL |

### Transfer variables of the M replacement cycle

| | |
|---|---|
| $C_T | T number of the tool (numerical) |
| $C_T_Prog | Bool variable that shows whether a T word is available in $C_T |
| $C_TS | Tool identifier (string) |
| $C_TS_Prog | Bool variable that shows whether an identifier is available in $C_TS |
| $C_TE | Address extension of the T word |
| $C_D | Programmed D no. |
| $C_D_Prog | Bool variable that shows whether an offset number is available in $C_D |
| $C_DL | Programmed additive/setup offset |
| $C_DL_Prog | Bool variable that shows whether an offset number is available in $C_DL |
| | |
| $C_ME | Address extension of the M word |
| $C_DL_Prog | Bool variable that shows whether an offset number is available in $C_DL |
| $C_M_PROG | TRUE if M function was programmed for tool change |
| $C_M | Value of substituted address M (integer) |

There are two different cases:

1. The substitution subroutine for the tool change configured with $MN_M_NO_FCT_CYCLE_PAR was called. $C_M contains the value $MN_M_NO_FCT_CYCLE [$MN_M_NO_FCT_CYCLE_PAR].
2. In the case of a tool change with M code, only one substitution subroutine was configured for the T and/or D/DL addresses. If the M code for the tool change is programmed together with one of the addresses to be substituted, the value of $MN_TOOL_CHANGE_M_MODE is transferred to the replacement program in $C_M.

If parameters are to be transferred to the M replacement cycle, then this must be set using $MN_M_NO_FCT_CYCLE_PAR = 1

The default setting is "0", i.e. no parameter is transferred.

The parameter transfer refers exclusively to values, which are programmed in this NC block, i.e. in that block where block splitting is performed.

This application is of interest if Tx M06 is always programmed in an NC block. This means that the T selection, change as well as offset selection and deselection can be included in just one single cycle.

**Note**

Only one function replacement is possible for each NC block.

If, for example, ...T="Miller_20mm" and M06 are programmed in the block, and a replacement cycle applies to both, then this is rejected with an alarm.

**Note**

Parameters $C_T_PROG, $C_TS_PROG, $C_D_PROG; $C_DL_PROG act as trigger. The T No., D No. ... are valid if these parameters have the value "TRUE" - but only then.

**Note**

More detailed information on replacing NC language commands is provided in the "Function Manual Basic Functions".

## 3.3.15 Block search

### Block search with calculation

On a block search, selection on reset or start, the tool is selected during preprocessing. In this case the PLC is not allowed to reject the tool (see bit 4 in MD20310). If it does, an alarm is generated. The block search must then be repeated. Use of the active tool can only be prevented from an external source (HMI, PLC).

In block search with calculation the program is generally put into a state where the selected block can be executed. With respect to the tool management function, this means that the tool that should be located in the spindle when the machining block is reached must now be loaded to it.

If another tool is located in the spindle a "replace" command is initiated. In such a case, the signals "Prepare change" (DB72.DBX(n+0).2 and "Execute change" (DB72.DBX(n+0).1 are present at the same time since the auxiliary functions are output together.

Example: $MC_TOOL_CHANGE_MODE=0

Tool "Drill1" is loaded in the spindle. The new search target has T = "Drilling machine 2" as the momentary tool programming.

NCK initiates the tool change. PLC must not reject.

**Note**

Tool rejection by PLC: If bit 4 of the machine data 20310 TOOL_MANAGEMENT_MASK is set, then the PLC usually has the possibility to again request preparation for a tool change, yet this time with different parameters, i.e. to reject the tool. This is not possible during block search. In this case, the machine data setting is ignored.

**Note**

Because the tool change is frequently performed using cycles, a "replace command" generated by the block search must be executed in an asynchronous subroutine (ASUB). Modal and static motion-synchronization action is retained at the beginning of ASUB and is also effective in the asynchronous subroutine. If the asynchronous subroutine is not continued with Repos, the modified modal and static motion-synchronous actions in the main run remain operative.

Alternatively, execution of the NC part program can be stopped by halting feed and read-in, and a fault message "Wrong tool in spindle after the block search" can be generated.

### Tool cannot be used

Alarm 22068 is output if the tool to be loaded at the search target cannot be used (it is not available, locked, ...), the program must be canceled using a reset.

In order that the block search is not canceled, if the tool involved at the search target is not the tool to be loaded, then an attempt is made to also permit a locked tool (and therefore also an unloaded tool) – assuming that it only has the "released" state and therefore has a defined geometry. This is realized before the alarm is generated.

If an additional tool change is programmed, the tool that is underway that cannot be used is not noticed and does not stop the operation. However, if an attempt is made to precisely load this locked/unloaded/.. tool at the end of the block search after the first START, then this is noticed in the NCK and acknowledged with Alarm 22067; this then no longer allows the program to be continued. The PLC can permit a locked tool to be selected (i.e. by setting the interface signal "Tool lock ineffective" in the channel DB). However, in a specific case, this must be realized during the block search, i.e. before the NCK outputs Alarm 22068 or 22067. If, for a block search, tool programming is initiated in the NCK, and there is neither a tool that can be used, locked nor unloaded, then Alarm 22068 is output, which then exits the block search.

### Example of a search with block splitting effect

```
N100 T="Tool1" M06 D1
N110 SETMTH(1)                  ; Toolholder1 becomes master toolholder
N120 T="ToolZ2" M06 D2          ; Target block: is not yet interpreted
N1000 IF($P_PROG_EVENT ==5)     ; ASUB is started
.............
N1020 SETMTH(2)                 ; Toolholder2 becomes master toolholder
.............
N1040 ENDIF
N1099 REPOSA
N110 SETMTH(1)                  ; The interrupted main program is continued/started
                                ; after the last executable block before the search
                                ; target.
                                ; Toolholder1 becomes master toolholder again.
```

## 3.3.16 Block search (SSL) in conjunction with active tool management

The block search has already been described. Here we shall deal with the specific features in conjunction with active tool management.

The block search establishes the start position of the target block. Auxiliary functions programmed in SSL are collected and output in action blocks at the end of the SSL.

For now this also applies to the T command and M06. This depends on the setting in machine data 20128 $MC_COLLECT_TOOL_CHANGE

0 = Neither T preparation nor M06 are output.

1 = T preparation and M06 are collected and output (and must be acknowledged to end the block search). Default setting.

The following example shows how to proceed with block search.

Configuration: Milling machine, one spindle

Settings:

$MC_Tool_Change_Mode=1, i.e. change with M06

### Block search

Tool change should be subsequently executed:

Situation:

T="Face_80mm" is located in the spindle

Block search to N98 (block search with contour calculation)

Target:

In order to continue in the program:

a. Tool "1537" must be loaded

b. Tool "Drill_6mm" must be prepared

```
...
N10 T="1231"              ; T No. 1
...
N20 M06
...
N30 T="Face_80mm"         ; T No. 2
...
N70 M06
...
N80 T="1537"              ; T No.3
N90 M06
...
N95 T="Drill_6mm"         ; T No. 4
...
N98
```

**Settings:**

$MC_Tool_Change_Mode=1
$MC_Collect_Tool_Change=0
$MN_Search_Run_Mode bit 1=1
$MC_Collect_Tool_Change=0 means: **No output** of T and M06 after block search.

**Procedure:**

- Negative acknowledgement is not required in the PLC.
- The program "Prog_Event.SPF" is started with the last action block.

  The change and preparation must be subsequently carried out.

**Note**

In order to start the Prog_Event after a block search, settings are required in the machine data.

```
Prog_Event.SPF
…
def int T_Vor, T_Spi, T_active
…
 GETEXET(T_active)          The spindle tool is read from NCK view (block N80 and
                            N90) T_active=3
 GETSELT(T_Vor)             T preparation is read from block N95 T_Vor=4
T_Spi=$TC_MAP6[9998,1]      The actual spindle tool is read T_Spi=2
…
;Load correct tool
if ((T_Spi< >T_active)and(T_active>0))
 T=$TC_TP2[T_active]        Preparation of tool "1537"
 L6 ;change cycle           Load tool "1537"
Endif
…
if T_prep< >T_active
 if T_prep>0
 T=$TC_TP2[T_prep]          Preparation of tool "Drill_6mm" from block N95
 Endif
 If t_prep==0
 T0
 Endif
Endif
```

**Note**

If a change is output by the action blocks (in example block N80 and N90), it is always a command "5", i.e. "Prepare change" and "Perform change" are pending in DB 72 at the same time.

If the correct tool is already placed in the spindle (i.e. in the block search example at block N70 and $MC_COLLECT_TOOL_CHANGE=1 is set), the T preparation is issued (from block N30). The setting for bit 12=0/1 in the MD $MC_TOOL_MANAGEMENT_MASK machine data is not evaluated.

Difference between the commands GETEXET and $P_TOOLNO:

GETEXET
Reads the T No. of the spindle tool from the NCK perspective.
Independent of the offset selection.
This has been specifically developed for the block search application.

$P_TOOLNO
Reads the T No. of the active tool.

This does not refer to the "active status" of the tool which is set via the T preparation, instead it refers to the tool whose offset is being calculated. This view of the tools means that a tool doesn't become an active tool until the offset is selected - which is what is read with $P_TOOLNO. This means dependency on MD $MC_CUTTING_EDGE_DEFAULT,

Example:

```
...
N100 T="Countersink"           ;T No. 5
N110 M06
N108 G90 G00 D1 X...
...
N200 T="Drill"                 ;T No. 32
N210 M06
N212 G90 G00 D1 X...
```

Block search to block N200

1. Setting $MC_Cutting_Edge_Default=-2

   GETEXET = 5

   $P_TOOLNO = 5

2. $MC_Cutting_Edge_Default=1

   GETEXET = 5

   $P_TOOLNO = 5

Block search to block N212

1. Setting $MC_Cutting_Edge_Default=-2

   GETEXET = **32**

   $P_TOOLNO = 5

2. $MC_Cutting_Edge_Default=1

   GETEXET = 32

   $P_TOOLNO = 32

## 3.3.17 Program test

### Overview

The "program test" function can be used to traverse a program without axis motion.

All additional data are determined and taken into account. For tool management, this means that the tools are searched and the appropriate values transferred to the PLC interface when the tool is called.

The PLC must acknowledge these jobs without moving the magazine or changing a tool. Special measures are therefore required on the PLC.

The tool management acts in exactly the same way as it would when a program is running. In the case of tools without fixed location codes and acknowledgement, this can result in the PLC data indicating different tool locations to the actual mechanical locations in the magazine. This can be prevented by configuring FC 8 such that a fixed location is simulated for the duration of the program test rather than the calculated empty location applied as a parameter.

The old location of the tool is stored in the function block which handles program testing and returned again to this location in the software (data settings). Any existing spindle tool is also returned to the spindle in the software at the end of the program test or on a reset. This ensures that the magazine assignments in the software match the mechanical assignments after program testing.

For testing programs involving manual tools, see index entry "Manual tools".

### Example of how to adapt the PLC in test mode

The following program example can be used as a template for adapting the PLC to the program test mode. Only the first channel and a spindle are supported as tool change locations.

The tool is always changed directly into the spindle. The spindle is used as the change position (DB 72). Access to the NCK/PLC interface (DB 21, 72) is symbolic. The standard UDTs (UDT 21, 72) are included for this purpose. These are part of the basic program and must be copied into the project and subsequently compiled.

The following must be entered in the symbol table:

| Symbol | Address | Data type | Comment |
|---|---|---|---|
| Channel 1 | DB 21 | UDT 21 | |
| SpChPos | DB 72 | UDT 72 | |
| TC_VAR | DB 119 | DB 119 | For testing the tool change |

All necessary variables are stored in the instance data block.

If program testing mode is **deselected**, no action occurs. The target positions suggested by tool management are confirmed by the PLC.

If program testing mode is **selected**, the target positions are defined by the PLC. These correspond to the source positions of the respective tools. The target position is only confirmed and saved by tool management on the first tool change. It is thus possible to undo the first tool change after program testing mode is selected.

Two asynchronous transfers are required for this purpose. The first one returns any tool present in the spindle to the magazine. The second asynchronous transfer is intended to return a tool which was loaded in the spindle before program testing mode back into the spindle.

**Note**

The corresponding PLC example is stored in the toolbox. The sample file WZV_PROG.AWL is packed in file WZV_BSP:EXE.

## Program test - extended

A setting can be selected with the machine data $MC_TOOL_MANAGEMENT_MASK - bit 20 such that the NCK cannot issue any tool-changing commands to the PLC in the status "Program test active". It outputs its own acknowledgement such there is no further data-related tool motion.

The default setting is that the Tool_change command is not output.

The following applies for the tool used during program test mode:

The tool status "active" can still be set and the tool status "was in use" is set. This does not have any further detrimental effects since tool monitoring is not normally active in the test mode.

If **bit 20**, value **1** is set, generated commands are output to the PLC. Tool / magazine data can be changed in the NCK here depending on the type of acknowledgement by the PLC. If the acknowledgement parameters for the "target magazine" are set to the values of the "source magazine", then the tool is not moved and the data therefore not altered in the NCK.

Exception: The tool status of the tool activated in the test mode can take the status "active".

**Note**

It may not be concluded - if the setting "No tool-change commands to PLC" has been selected - that the tool in the spindle or the toolholder during "Program test active" is the active tool.
The "SERUPRO" (cross-channel block search) is used for the program test.

## 3.3.18 Several spindles in one channel or TO unit

When using tool management and more than one spindle please note the following:

### 2 spindles in one channel

Only one tool offset can be active per channel. Spindle 1 defined as master spindle with $MC_SPIND_DEF_MASTER_SPIND = 1. Spindle 2 is a secondary spindle.

### The master spindle is spindle no. 1 in each case.

2 channels each of which access the same TO memory have been set in the machine data. One spindle is assigned to each channel. Two spindles are assigned to one magazine in the magazine configuration.

The master spindle is spindle No. 1 for both channels In order to change a tool in spindle No. 2 as well, the second spindle must be defined as master spindle in the second channel before the tool is changed. In the TM system, the spindle number is sent to the PLC. This number is determined from the extended address of T. If this is not programmed, the NCK assigns the master spindle number of the channel in which the program is running.

### Each channel has its own master spindle

2 channels each of which access the same TO memory have been set in the machine data. One spindle is assigned to each channel.

Two spindles are assigned to one magazine in the magazine configuration.

In each channel the assigned spindle is defined as the master spindle. Tool change is possible without making any additional definitions in the program.

## 3.3.19 Decoupling the tool management from the spindle number

The program must specify the location (spindle number on milling machines) at which the tool is to be changed before the tool management can insert a tool.

Machine data **MD20124 TOOL_MANAGEMENT_TOOLHOLDER** can be set to determine whether a toolholder number can be assigned to define the location of the tool to be loaded instead of a spindle number. Thus the appropriate designation (spindle number or toolholder number) can be used in the event of use.

The following figures show which variable definitions you require for the following variants:

- Working with two spindles in one channel and one TO unit (standard functionality)
- Working with two spindles in one channel (standard function)
- Working with 2 toolholders in 2 channels (one TO unit)
- Working with two toolholders in one channel

### Working with spindle numbers

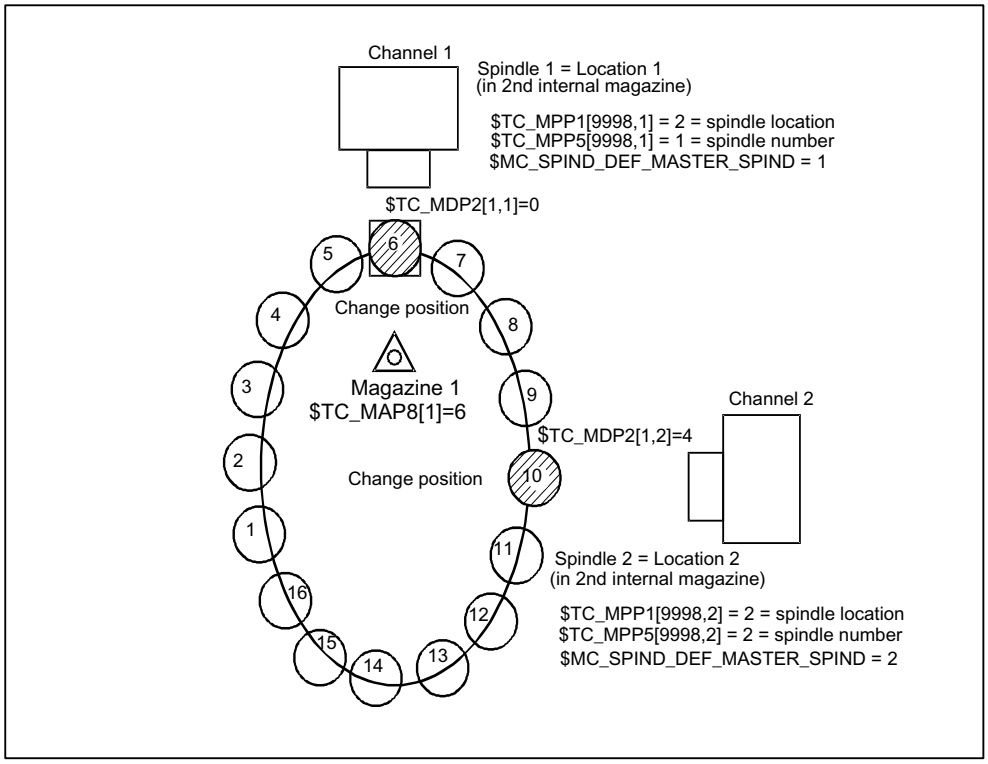



Figure 3-14 2 spindles in 2 channels and 1 TO unit

Two channels operating with the data of one TO unit (with one magazine). One spindle is defined in each channel.

Spindle 1 in channel 1 has been declared the master spindle with MD SPIND_DEF_MASTER_SPIND=1. Spindle 2 on channel 2 is the master spindle.

Both spindles must be assigned different numbers because the assignment of the spindle to the second internal magazine (buffer magazine) must be unique.

This assignment is realized by $TC_MPP1 (spindle location) and by $TC_MPP5 (spindle number).

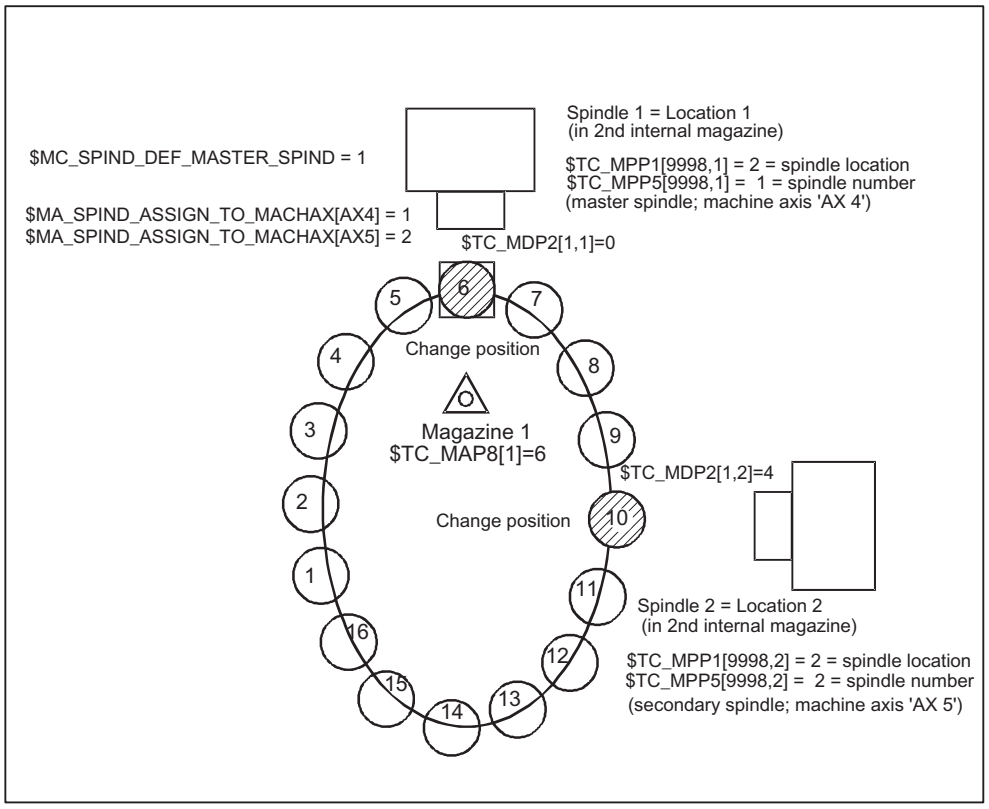



Figure 3-15 2 spindles in one channel

Two spindles of a single channel are operating with one magazine.

Spindle 1 was defined as master spindle with SPIND_DEF_MASTER_SPIND = 1.

Spindle 2 is not a master spindle (secondary spindle).

## Example of a part program (for a channel with two spindles)

(Requirement: CUTTING_EDGE_DEFAULT=1; i.e. D1 is implicitly active with the tool change M06):

| | | |
|---|---|---|
| T="Miller" M06 | ;<br>;<br>;<br>;<br>; | No address extension programmed -> the master spindle is addressed, i.e. spindle 1 = value of machine data $MC_SPIND_DEF_MASTER_SPIND.<br>The tool change takes place in spindle 1.<br>The **path is corrected** with the offsets of the "Miller" tool. |
| ... | | |
| T2="Drill" M2=6 | ;<br>;<br>;<br>; | Address extension for secondary spindle has been programmed. The tool change takes place in the PLC at the tool management interface for spindle 2.<br>The **path is still corrected with the offsets of the "Miller" tool** |
| ... | | |
| SETMS(**2**) | | declares spindle number 2 as **master spindle** |
| T="Miller_2" M06 | ;<br>;<br>;<br>; | No address extension programmed -> the master spindle is addressed (spindle 2).<br>Tool change takes place in spindle 2.<br>The **path is now corrected** with the offsets of the "Miller_2" tool |
| ... | | |
| T**1**="Drill_1" M**1**=6 | ;<br>;<br>;<br>; | Address extension for the actual secondary spindle was programmed.<br>Tool change takes place in spindle 1.<br>The **path is still corrected** with values from tool T="Miller_2". |
| ... | | |
| SETMS | ;<br>; | Declares the spindle defined by $MC_SPIND_DEF_MASTER_SPIND as master spindle |
| T="Miller_3" M06 | ;<br>,<br>;<br>;<br>; | No address extension programmed -> the master spindle is addressed (spindle 1).<br>Value of machine data $MC_SPIND_DEF_MASTER_SPIND). Tool change takes place in spindle 1.<br>The **path is corrected** with the offsets of the "Miller_3" tool. |

## Further example (starting conditions as above)

| | | |
|---|---|---|
| N10 **SETMS** | ; | Declares spindle number 1 as **master spindle** |
| N20 T**2**=3 | | |
| ... | | |
| N50 M**2**=6 | ;<br>;<br>; | Address extension for secondary spindle has been programmed. Tool change takes place on the spindle.<br>The **path is corrected with the offsets of "Miller_3"** |
| ... | | |
| N70 D3 | ;<br>; | The **path is corrected** with the offsets of the active tool (that was activated before block N10 - here in the example, "Miller_3) |
| N80 **SETMS**(**2**) | ; | Declares spindle number 2 as **master spindle** |
| **T3** | | |
| **M06** | | |
| N90 D2 | ; | The **path is corrected** with the offset of tool "T3". |

**Note**

SETMS does not change the active tool. The new master spindle definition cannot be referenced until the subsequently programmed tool change.

The following applies: Offset selection is active for the last tool loaded onto a master spindle.

## Working with toolholder numbers

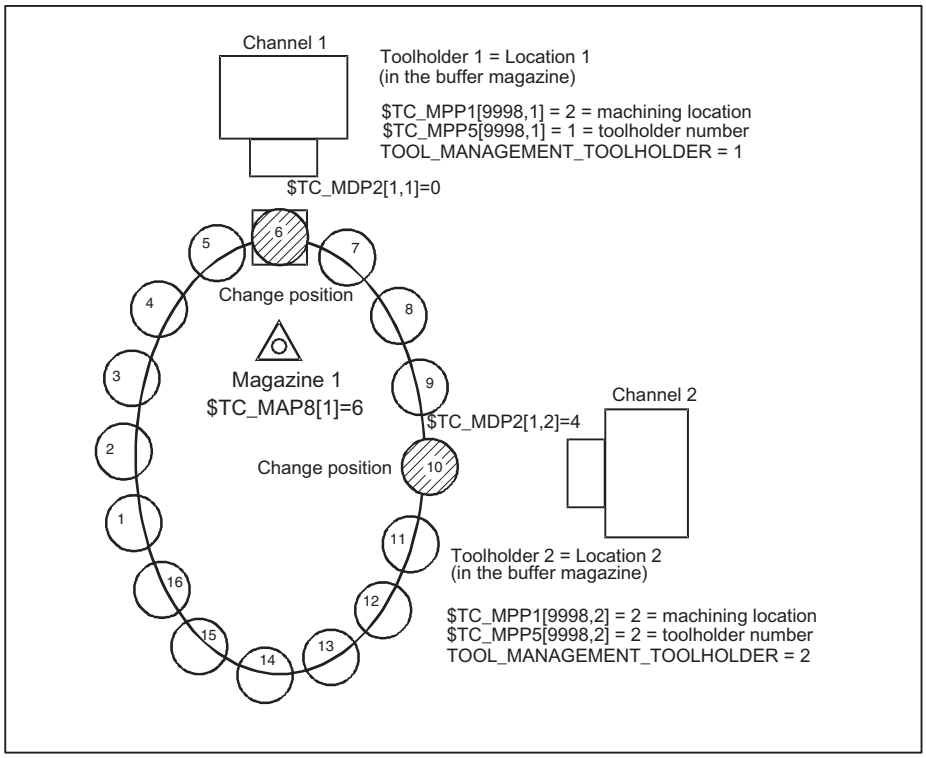



Figure 3-16 2 channels each with one toolholder and one TO unit

(The zero position is located at the change position of the toolholder 1)

Two channels operating with the data of one TO unit (with one magazine). Tool change no longer requires that a spindle number be specified. The address extensions of T and M now refer to the value of machine data MD20124 TOOL_MANAGEMENT_TOOLHOLDER.

Instead of "spindle location" the general term "toolholder" (tool machining location) is used (spindle is standard). If an address extension is not programmed, the address extension is supplemented by the value of MD20124 TOOL_MANAGEMENT_TOOLHOLDER.

**TOOL_MANAGEMENT_TOOLHOLDER = 0**

The previous function remains active (default).

A value greater than zero activates the new function.

**TOOL_MANAGEMENT_TOOLHOLDER > 0**

If a tool change is programmed to a buffer location of the type "Toolholder" with $TC_MPP5 = TOOL_MANAGEMENT_TOOLHOLDER, then the offset data defined for this tool correct the path.

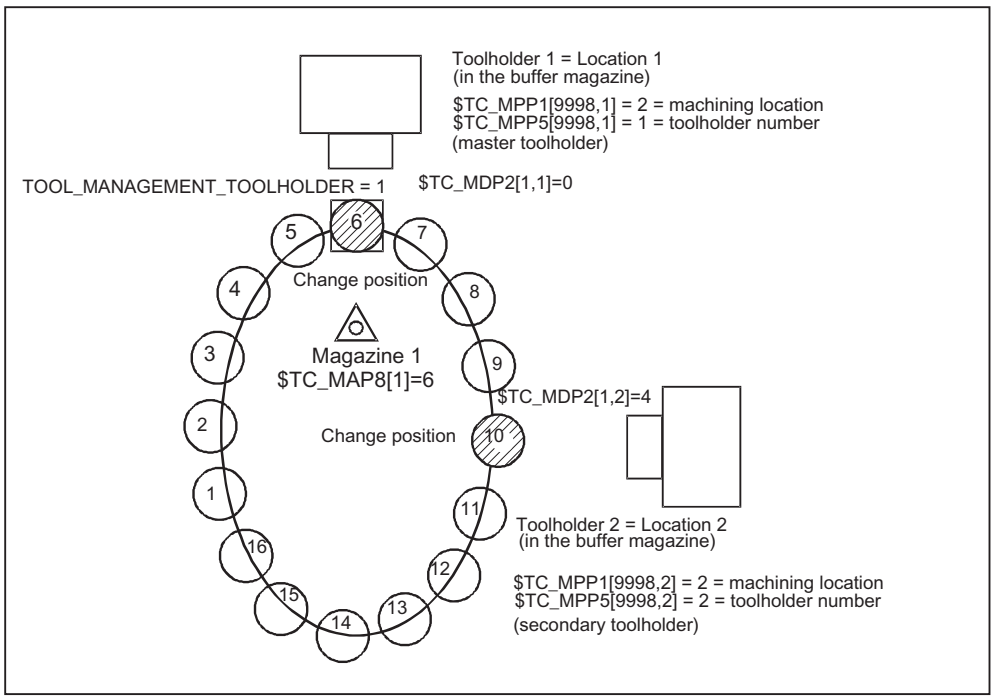



Figure 3-17 1 channel with 2 toolholders

(The zero position is located at the change position of the toolholder 1)

Two toolholders in a channel are operating with one magazine. Toolholder 1 has been declared the master using TOOL_MANAGEMENT_TOOLHOLDER = 1. Toolholder 2 is thus the secondary toolholder.

## Programming example

The language command SETMTH (toolholder number) is used to declare one or several tool holders to the master toolholder.
The initial state after power on is defined using machine data $MC_TOOL_MANAGEMENT_TOOLHOLDER; the behavior at NC start and reset using the machine data $MC_START_MODE_MASK and $MC_RESET_MODE_MASK.

**SETMTH (toolholder number)**,

| | | |
|---|---|---|
| T="Miller" M06 | ;<br>;<br>; | No address extension programmed -> the master toolholder is addressed (toolholder 1 - value of machine data $MC_TOOL_MANAGEMENT_TOOLHOLDER).<br>Tool change is performed at buffer location 1.<br>The **path is corrected** with the offsets of the "Miller" tool. |
| ... | | |
| T2="Drill" M2=6 | ;<br>;<br>; | Address expansion for the secondary toolholder was programmed.<br>Tool change is performed at buffer location 2.<br>The **path is not corrected** |
| ... | | |
| **SETMTH**(2) | ; | declares toolholder 2 to the **master toolholder** |
| T="Miller_2" M06 | ;<br>;<br>; | No address extension programmed -> the master toolholder is addressed (toolholder 2).<br>Tool change is performed at buffer location 2.<br>The path is corrected with the offsets of the "Miller_2" tool |
| ... | | |
| T1="Drill_1" M1=6 | ;<br>;<br>; | Address extension for the secondary toolholder has been programmed.<br>Tool change is performed at buffer location 1.<br>The **path is not corrected**! |
| SETMTH | ;<br>; | Declares the toolholder specified in $MC_TOOL_MANAGEMENT_TOOLHOLDER as the master toolholder |
| T="Miller_3" M06 | ;<br>;<br>;<br>;<br>; | No address extension programmed -> the master toolholder is addressed (toolholder 1 - value of machine data $MC_TOOL_MANAGEMENT_TOOLHOLDER).<br>Tool change is performed at buffer location 1.<br>The path **is corrected** with the offsets of the "Miller_3" tool |

**Note**

SETMTH does not change the active tool. The new master toolholder definition cannot be referenced until the subsequently programmed tool change.

The following applies: Offset selection is active for the last tool changed into the active toolholder.

## 3.3.20 Several spindles/toolholders

### Overview

Tool management can work in one channel with more than one toolholder. If several channels of one TO unit are supplied with data, then make sure that the toolholder numbers have different (= unique) numbers in the magazine configuration ($TC_MPP5 of buffer locations of the type ($TC_MPP1) "Spindle"). The spindle numbers of the channels must then be unique as well (if $MC_TOOL_MANAGEMENT_TOOLHOLDER=0).

### Example

This example shows how to differentiate between an active tool and a programmed tool.

Spindles 1...4 are defined in channel 1; analog to this, spindle locations 1...4 in magazine configuration 4.

```
SETMS (2)
T12                ;   12 is a programmed tool
M06 D3             ;   12 is an active tool, 3 is an active cutting edge
SETMS (4)
T22                ;   12 remains an active tool, 22 becomes the programmed tool
                   ;   with respect to spindle=4
T3=33 M3=6         ;   T33 is loaded onto the adjacent toolholder 3. The tool (T33)
                   ;   is not active.
SETMS (1)          ;   Toolholder=1 becomes master spindle, T12 remains active, T22
                   ;   remains programmed
D5                 ;   D5=active cutting edge; refers to the active tool, i.e. T12
M00
```

The following situation is given:

| Toolholder number | T number | D number |
|---|---|---|
| 1 master spindle | - | - |
| 2 | 12 active | 5 active |
| 3 | 33 - | - |
| 4 | 22 programmed | - |

## 3.3.21 Several magazines in one channel or one TO unit

### Address extension

The NC address T can be programmed with an address extension. The tool management function interprets the programmed address extension as a spindle number or toolholder number. The NC address T without programmed address extension then refers to the main spindle (master spindle).

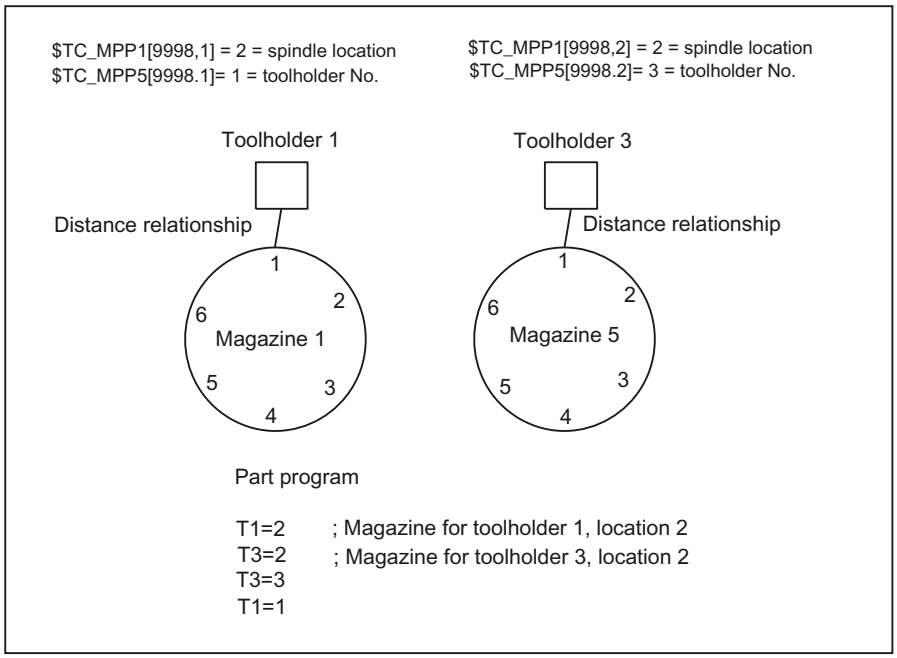



Figure 3-18 T="location" and several magazines in the same channel

The diagram shows the procedure for using more than one magazine in a channel (when programming with T="location" this is usually a turret).

**Note**

The tool offset is only calculated for the toolholder that is assigned at that point in time to the master spindle or the master toolholder.

## 3.3.22 Reset and start mode

### Fundamentals

The tool offset selection/deselection can be set in the machine data for program end or reset as well as for NC Start.

It is also possible to permanently preset the change for a specific tool. e.g. at NC Start.

The settings are made in the following machine data:

MD20310 $MC_TOOL_MANAGEMENT_MASK

MD20110 $MC_RESET_MODE_MASK

MD20112 $MC_START_MODE_MASK

MD20122 $MC_TOOL_RESET_NAME

MD20130 $MC_CUTTING_EDGE_RESET_VALUE

The function and interaction of the machine data are displayed in the following diagram.

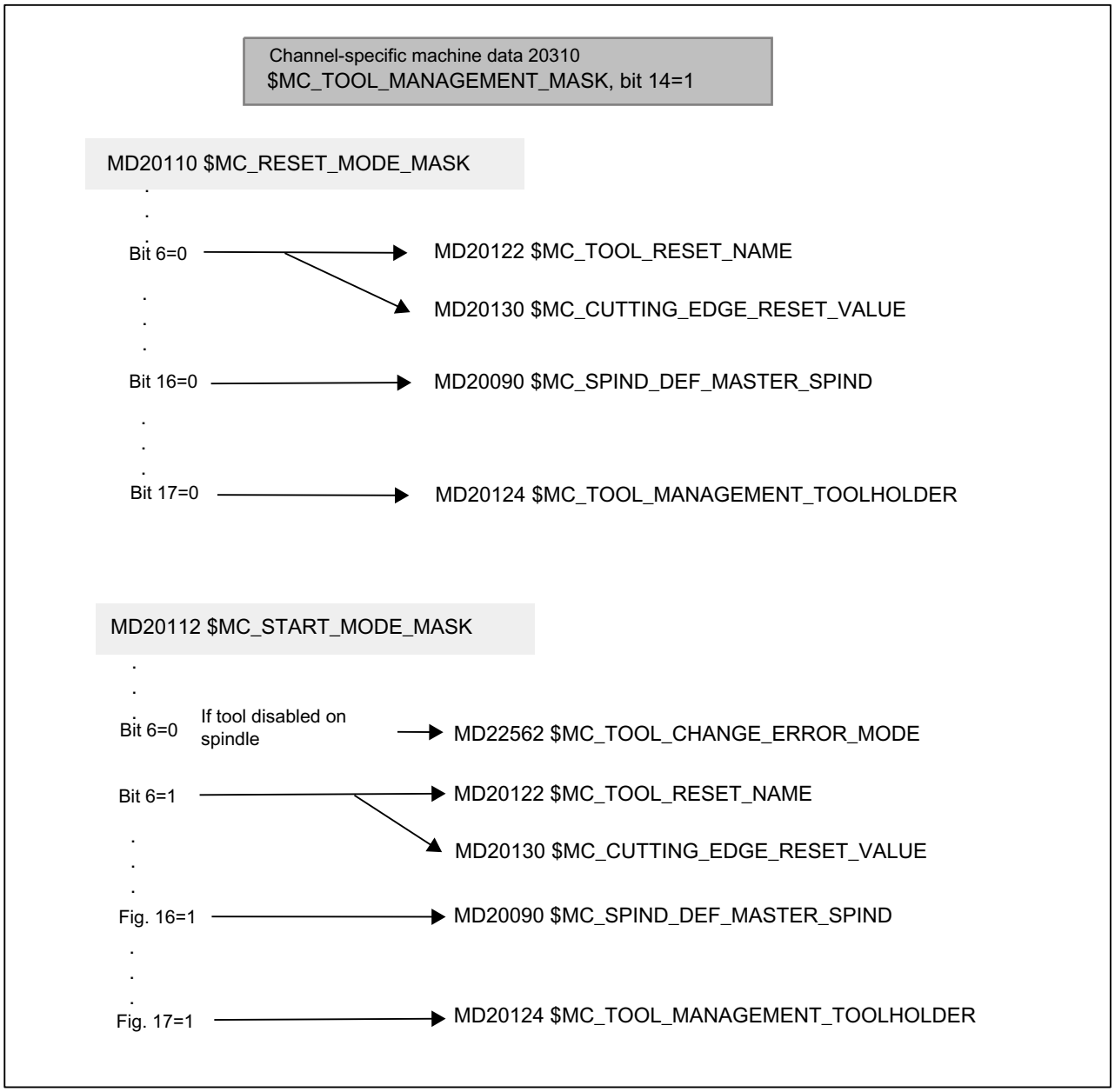



Figure 3-19 Reset and start mode

## MD20110 $MC_RESET_MODE_MASK

**Bit 0=0:**

Significance: leave offset unchanged, i.e. after end of part program and reset, the offset last programmed remains active (behavior as with bit 0 and 6=1).

**Bit 0=1:**

Reset mode, i.e. evaluation of bits 4 ..11

**Bit 2=1:**

Reset behavior (tool offset) with tool management not active. No effect if tool management active

**Bit 6=0:**

Reset behavior corresponds to MD $MC_TOOL_RESET_NAME and $MC_CUTTING_EDGE_RESET_VALUE

**Bit 6=1:**

Current setting for active tool length compensation is retained beyond reset/end of part program.

For active tool management, the tool that is located in the master spindle (general: master toolholder) is selected.

If the tool in the spindle is disabled, this state is ignored, there is no selection of a replacement tool! (Replacement tool with Start_INIT only).

Activation takes place on the master spindle defined in MD $MC_SPIND_DEF_MASTER_SPIND, or on the master toolholder defined in $TC_TOOL_MANAGEMENT_TOOLHOLDER.

The tool in the last programmed master spindle or master toolholder can also be active. Bit 16 or 17 is used for this purpose.

**Reset behavior for spindles**

**Bit 16=0:**

The master spindle is the spindle defined in MD $MC_SPIND_DEF_MASTER_SPIND.

The settings in the machine data below refer to this data

$MC_TOOL_MANAGEMENT_MASK
$MC_RESET_MODE_MASK
$MC_START_MODE_MASK
$MC_TOOL_RESET_NAME
$MC_CUTTING_EDGE_RESET_VALUE

**Bit 16=1:**

The spindle last programmed with SETMS(x) remains the master spindle after end of program and reset, regardless of the machine data setting.

This means that if bits 0/6=1, the offset remains active for the tool which is placed in the spindle.

Power On behavior
The machine data setting is active after Power On.
This means the offset for the tool which is placed in the spindles specified in MD $TC_SPIND_DEF_MASTER_SPIND becomes active; the offset value is that of the smallest available D number No. for this tool.

**Reset behavior for toolholder**

**Bit 17=0:**

The master toolholder is the toolholder specified in MD $TC_TOOL_MANAGEMENT_TOOLHOLDER. The machine data settings refer to these

$MC_TOOL_MANAGEMENT_MASK
$MC_RESET_MODE_MASK
$MC_START_MODE_MASK
$MC_TOOL_RESET_NAME
$MC_CUTTING_EDGE_RESET_VALUE

**Bit 17=1:**

The toolholder last programmed with SETMTH(x) remains the master toolholder after end of program and reset, regardless of the machine data setting.

This means that if bits 0/6=1, the offset remains active for the tool which is positioned in this toolholder.

Power On behavior
The machine data setting is active after Power On.
This means the offset for the tool which is positioned in the toolholder specified in $MC_TOOL_MANAGEMENT_TOOLHOLDER becomes active; the offset value is that of the smallest available D number No. for this tool.

## MD22562 $MC_TOOL_CHANGE_ERROR_MODE

**Bit 3=0:**

Change command for a replacement tool is output.

**Bit 3=1**:

The disabled status of the spindle tool is ignored. The tool becomes active with the last programmed offset.

**Bit 4=0:**

Change command for a replacement tool is output.

**Bit 4=1**:

The spindle tool is set down - "T0" is output.

## MD20122 $MC_TOOL_RESET_NAME

Identifier of tool to be loaded

This tool is either loaded when end of program is reached or at reset or Power On if the associated setting is made in MD $MC_RESET_MODE_MASK, or with NC Start if the respective setting was made in MD $MC_START_MODE_MASK.

If there are no entries here ($MC_TOOL_RESET_NAME="") this corresponds to "T0".

### MD20130 $MC_CUTTING_EDGE_RESET_VALUE

D number of tool which is to be loaded via $MC_TOOL_RESET_NAME.

This means the tool becomes active with the offset set here.

If no entries are made in this machine data, the behavior corresponds to "D0".

### MD20124 $MC_TOOL_MANAGEMENT_TOOLHOLDER

Specifies whether a toolholder number or spindle number is to be specified to define the location of the tool to be loaded.

### MD20090 $MC_SPIND_DEF_MASTER_SPIND

Definition of master spindle in channel. The number of the spindle is set.

### MD20310 $MC_TOOL_MANAGEMENT_MASK

Bit 14 is used to activate the reset and start behavior. If bit 14 is not set, the settings in machine data $MC_RESET_MODE_MASK and $MC_START_MODE_MASK which are specific to tool management have no meaning.

### MD20112 MC_START_MODE_MASK

**Bit 6=0:**

Keep the last programmed offset active.

If the tool is disabled on the spindle, bits 3 and 4 are also evaluated in MD $MC_TOOL_CHANGE_ERROR_MODE.

**Bit 6=1:**

Start behavior (tool and offset selection) according to MD $MC_TOOL_RESET_NAME and $MC_CUTTING_EDGE_RESET_VALUE

**Start behavior for spindles**

**Bit 16=0:**

The offset that was last selected remains active.

It does not matter whether the offset was selected in the part program or via settings in MD $MC_RESET_MODE_MASK.

The offset for the tool placed in the master toolholder that was last programmed can also be active (see $MC_RESET_MODE_MASK)

**Bit 16=1:**

The toolholder specified in MD $MC_Tool_Management_Toolholder becomes active.

This means an offset selection refers specifically to this toolholder.

**Start behavior for toolholder**

**Bit 17=0:**

The offset that was last selected remains active.

It does not matter whether the offset was selected in the part program or via settings in MD $MC_RESET_MODE_MASK.

The offset for the tool placed in the master spindle that was last programmed can also be active (see $MC_RESET_MODE_MASK).

**Bit 17=1:**

The spindle defined in MD20090 $MC_SPIND_DEF_MASTER_SPIND becomes active.

This means an offset selection refers specifically to this spindle.

**Note**

A reset is always initiated with a power on, this means that the settings in RESET_MODE_MASK are applied.

## Example 1

In this example, the tool on the spindle is to remain active after end of program (M02/M30) and reset.

The following applies:

$MC_TOOL_CHANGE_MODE = 1
$MC_CUTTING_EDGE_DEFAULT = -2

The following settings need to be made:

| | | |
|---|---|---|
| $MC_TOOL_MANAGEMENT_MASK | **Bit 14=1** | for reset and start behavior to be active |
| $MC_RESET_MODE_MASK | **Bit 0=1**,<br>**Bit 6=1** | for the tool offset to remain active |
| $MC_START_MODE_MASK | **Bit 6=0** | for the tool offset to remain active |

NC program

%MPFxxx1

...

```
N110 T="MILLER_10"
N115 M06                    ;   Tool "MILLER_10" is loaded
N120 G90 G00 D2 X...        ;   Offset D2 is becomes active
…
N850 M30                    ;   offset D2 remains active
```

At the next program start tool "MILLER_10" is active with offset D2.

%MPFxxx2

```
N10 G90 G00 Z100            ;;  this block is executed with offset D2
```

## Example 2

In this example, the spindle tool is to be set down again at end of program (M02/M30) and reset ("automatic T0").

The following applies:

$MC_TOOL_CHANGE_MODE = 1
$MC_CUTTING_EDGE_DEFAULT = -2
one spindle

The following settings need to be made:

| | | |
|---|---|---|
| $MC_TOOL_MANAGEMENT_MASK | **Bit 14=1** | for reset and start behavior to be active |
| $MC_RESET_MODE_MASK | **Bit 0=1** | Reset behavior |
| | **Bit 6=0** | TOOL_RESET_NAME is effective and CUTTING_EDGE_RESET_VALUE |
| $MC_TOOL_RESET_NAME**=""** | | Name of tool that should be loaded at change with reset. If no name is entered here, this has the same meaning as T0 |
| $MC_CUTTING_EDGE_RESET_VALUE**=0** | | The above mentioned tool becomes active with this offset ("0" has the same meaning as D0) |
| $MC_START_MODE_MASK | **Bit 6=0** | for the tool offset to remain active<br>In this example D0 remains "active" |

## Example 3

In this example, a specific tool is to be loaded at NC start, e.g. a probe.

The following applies:

$MC_TOOL_CHANGE_MODE = 1
$MC_CUTTING_EDGE_DEFAULT = -2
one spindle

The following settings need to be made:

| | |
|---|---|
| $MC_TOOL_MANAGEMENT_MASK **Bit 14=1** | for reset and start behavior to be active |
| $MC_START_MODE_MASK **Bit 6=1** | Start behavior<br>TOOL_RESET_NAME and CUTTING_EDGE_RESET_VALUE are effective |

| | |
|---|---|
| $MC_TOOL_RESET_NAME="Probe_1" | Name of tool that was loaded with reset/start.<br>In the example here, this tool is "Probe_1" |
| $MC_CUTTING_EDGE_RESET_VALUE=1 | The above mentioned tool becomes active with this offset, here D1 |
| $MC_RESET_MODE_MASK **Bit 6=0** | Is not relevant for this example |

## Example 4:

In this example, the tool on the master spindle that was last programmed is to remain active following end of program (M30/M02) and reset.

The following applies:

$MC_TOOL_CHANGE_MODE = 1
$MC_CUTTING_EDGE_DEFAULT = -2
two spindles
$MC_SPIND_DEF_MASTERSPIND=1

The following settings need to be made:

| | | |
|---|---|---|
| $MC_TOOL_MANAGEMENT_MASK | **Bit 14=1** | for reset and start behavior to be active |
| $MC_RESET_MODE_MASK | **Bit 0=1** | for the tool offset to remain active |
| | **Bit 6=1** | |
| $MC_RESET_MODE_MASK | **Bit 16=1** | keep the last programmed master spindle active |
| $MC_START_MODE_MASK | **Bit 6=0** | for the tool offset to remain active |

NC program

```
N05 SETMS(1)                ; Spindle becomes master spindle (is also set via MD)
N10 T="TL1"
N15 M06                     ; Change to spindle 1
N20 G90 G00 D1 Z...
...
N80 SETMS(2)                ; Spindle 2 becomes master spindle
N85 T="TL2"
N90 M06                     ; Change to spindle 2
N95 G90 G00 D2 Z...
...
N230 M02                    ; it is active: TL2 with offset D2 on spindle 2
                            ; No offset is active on spindle 1, although "TL1" is
                            ; positioned in spindle 1
```

**Note**

Using MD20310, bit 12 = 1 and the described settings, for each reset a preparation and change command is output to the PLC and must be acknowledged by the PLC. The automatic positive acknowledgment can also be used here.

**Note**

If a change is triggered by reset mode at Power On, the NC remains idle with "No NC Ready" until an end acknowledgment has been received for this change.

## 3.3.23 Repeating a tool change with the same tool identifier

### Overview

The behavior for repeated tool changes with identical tool identifier is set using two bits of MD 20310 $MC_TOOLMANAGEMENT_MASK.

Bit 11 = 1 The tool preparation command is also output, if it was already output for the tool. This setting is only effective as long as the prepared tool is still not located on the requesting spindle or toolholder.

Bit 12 = 1 The tool preparation command is also output if the tool is already located in the spindle/toolholder, however it is only issued just one more time.

The default setting (bit 11 and bit 12=0) is selected so that the preparation command is not executed if the tool is already located in the spindle/toolholder – or the same preparation was programmed a multiple number of times.

**Exception: Block search**

Here the preparation command is always issued even if the tool is already positioned in the spindle.

### Repeating the T preparation before loading

| | Bit 11 = 0 | Bit 11 = 1 |
|---|---|---|
| N10 T="TL1" | Tool preparation command is output to the PLC | Tool preparation command is output to the PLC |
| ... | | |
| N20 T="TL1" | No output to the PLC (assuming that the state of the tool is unchanged) | Tool preparation command is output to the PLC |
| N22 M06 | Change command to the PLC | Change command to the PLC |

A typical application is providing a new tool (positioning a chain) and checking before the change using the repeated T call.

### New programming for the tool that is still able to be used on the toolholder

Example 1:

| | Bit 12 = 0 | Bit 12 = 1 |
|---|---|---|
| N10 T="TL1" | Tool preparation command to the PLC | Tool preparation command to the PLC |
| N12 M06 | Tool change command to the PLC | Tool change command to the PLC |
| N20 T="TL2" | Tool preparation command to the PLC | Tool preparation command to the PLC |
| N30 "T=TL1" | No output to the PLC. This preparation replaces the preparation from block N20; it is identified that a tool, which can be used from group "TL1", has already been loaded. | Tool preparation command to the PLC. This preparation replaces (as for bit 12 = 0) the preceding T preparation from N20. The checks on the NCK side are identical. However, as a result of the machine data setting, command output is forced. |
| N32 M06 | No change command to the PLC | No change command to the PLC |

The preparation command from block N30 was deleted in the NCK; in the programming, it appears as if N10, N12 and N32 are programmed. As the state of the tool "TL1" on the tool holder has not changed, M06 is not output to the PLC.

Example 2:

| | Bit 12 = 0 | Bit 12 = 1 |
|---|---|---|
| N10 T="TL1" | Tool preparation command to the PLC | Tool preparation command to the PLC |
| N12 M06 | Tool change command to the PLC | Tool change command to the PLC |
| N20 T="TL1" | No output to the PLC | Tool preparation command to the PLC |
| N30 "T=TL1" | No output to the PLC | No output to the PLC (the preparation for the same tool is only repeated once) |
| N32 M06 | No change command to the PLC | No change command to the PLC |

The preparation command from block N20 was deleted in the NCK by the new T programming in block N30. In the programming, it appears as if N10, N12 and N32 were programmed. As the state of the tool "TL1" on the tool holder has not changed, M06 is not output to the PLC.

For these two examples, bit 11 has no significance.

### New programming for the tool that is still able to be used on the toolholder

```
N10 T = "TL1"
N12 M06
N20 T = "TL1"     ;   Preparatory command is output
N30 T = "TL1"     ;   No command output to the PLC
N32 M06           ;   Change and preparation are output together
```

N20, N30 and N32 are not output to the PLC.

### New programming for the tool that is no longer able to be used on the toolholder (time monitoring has for example assigned the status "blocked" to the tool)

```
N10 T = "TL1"     ; Tool preparation command to PLC
N12 M06           ; Tool change command to PLC
N20 T = "TL2"     ; Tool preparation command to PLC
N30 T = "TL1"     ; This tool preparation replaces the tool preparation from N20; tool
                  ; management detects that a tool from group "TL1" is loaded but that
                  ; the tool can no longer be used. A replacement tool is searched for in
                  ; the tool group and the tool preparation command is output to the PLC.
N32 M06           ; The tool change command N32 is output to the PLC.
```

### Condition for processing a new tool preparation command in the NCK

```
N10 T = "TL1"
N20 T = "TL2"      ; A command is only processed in the main run if the preceding
                   ; command from the PLC was acknowledged with "End".
```

The does not apply if N20 is not output to the PLC. Then the "End" acknowledgement must be present for a new tool preparation command to be output to the PLC.

### Condition for processing a new tool change command in the NCK

```
N10 T = "TL1"
N12 M06            ; A command is also processed in the main run if the preceding
                   ; command from the PLC was not yet acknowledged with "End".
```

# 3.4 Search for tool

## 3.4.1 Strategies for tool searches

The tool search is initiated by the preparation command (T selection). The search begins for a tool to load in the spindle.

In the default setting, tool searches are always performed on a magazine-specific basis, i.e. with this setting for the search strategy, the search is performed in the magazine from which the last change was carried out.

### Tool search

The tools with the same identifier (name or Ident) but different duplo numbers are combined to form one tool group. The tool identifier is programmed in the part program with the NC address, i.e. only the tool group is specified during preparation.

In order to move a tool from a physical magazine to a spindle it must have the following characteristics:

- Tool status must be "enabled"
- Tool status must not be "disabled" (exceptions: Language command TCA as well as PLC interface signal "Tool disable inactive")
- Tool status may not be "currently being changed"
- Tool must not already be used by a spindle other than the requesting spindle.
- Tool must be present in the magazine location (except for manual tools)
- This magazine must be linked to the requesting spindle via a distance relationship ($TC_MDP2)
- This magazine must not have the status "disabled".

The explicit tool is requested at the time of the tool call. The request is made for a special spindle (general toolholder); this is the number of the address extension of T. At this point in time, user interface DB 72 is written for the relevant spindle and must be evaluated by the PLC application program.

The tool search strategy is defined using the system variable **$TC_MAMP2** for the TO area, with the system variable $TC_MAP10[Mag_No] magazine-specific. With **bit 0** to **bit 2**, a search is made according to the criteria - active tool, lowest duplo No. and the shortest distance. The 'search criterion' for tool wear uses bit 3 to bit 5. Bit 7 is used to set whether the tool search is made on a magazine-for-magazine basis or across all linked magazines.

Setting bit 7=1 means that the search strategies defined using bits 0, 1, 2 start with the search from the 1st magazine of the distance table (the sequence in the distance table is defined using the programming sequence of $TC_MDP2). The standard setting is **bit 7=0**. The search starts in the magazine from which the previous tool that was loaded was taken.

Setting bit 6 means that a search is first made in the magazine currently being considered. This is only active in conjunction with bit 7 =1. The strategies, where the search always starts in the first magazine of the distance table are discussed in Chapter "Programming, magazine blocks"

**Note**

**Bit 3 = 1** to **bit 5 = 1** are only significant when the monitoring function is active (defined by $TC_TP9). Otherwise they have no effect on the suitability check.

**Note**

The tool search strategies apply equally for all magazine types (chain, box-type and circular) but not for the buffer magazine.

## Example, tool search routine

A tool change at a spindle shall take place.

The search sequence for the correct tool is as follows:

1. The control checks whether the tool which is called is already located on the spindle.
2. If buffer locations are linked to the spindle (see $TC_MSLR), the control checks whether a suitable tool is already located in one of these.
3. The tool search starts in the 1st magazine of the distance table ($TC_MDP2) according to the selected search strategy.

   (Applies only if bit 7 of $TC_MAMP2 = 1; otherwise, the search starts in the magazine from which the last loaded tool was fetched.)
4. If no tool is found in the first magazine, the search is repeated in the next magazine of the distance table.
5. If all the magazines that are linked to the spindle have been searched and no suitable tool found, the search is terminated with an alarm (22069 or 22068).
6. If the function "manual tool" is active, after an unsuccessful search in the magazines - a search is made in the TO unit for an unloaded tool, but a tool that can also be used. If none is found, the search is terminated with an alarm.

Any suitable tool with the programmed identifier found (not disabled) in one of the stages described above will be used.

# 3.5 Empty location search

## 3.5.1 Empty location search for a tool – from spindle to magazine

With the T preparation command, a matching empty location is automatically searched for the spindle tool. The location in which the new tool is stored is still occupied at this time and **cannot** therefore be identified as an empty location, the 1:1 interchange is the exception.

**Note**

Generally, a search is made for an empty location in that magazine from which the current tool in the toolholder was taken.

### Fixed location coding

When searching for an empty location for fixed-location coded tools its previous location in the magazine is usually retained.

If the search for an empty location for a fixed-location-coded tool is started with a specific magazine number, that number is ignored. The old tool location is defined as an empty location.

If this number is however an internal magazine number (for a loading or buffer magazine), then the number is explicitly taken into consideration and the fixed location coding is ignored. This case arises when loading/unloading tools.

If a location search for a fixed location coded tool is initiated using a specific magazine number and magazine location number, the fixed location coding is ignored and the specified location checked as a suitable location for the tool. This is used in the HMI function "Relocating".

### Variable location coding

Initially, the procedure for an empty location search is the same as that for a fixed location-coded tool. If this check fails, the search for a free location is continued. The search is performed according to the selected search strategy ($TC_MAMP2 / $TC_MAP10). If the search cannot find an available location with the specified location type in this magazine, a new search operation based on the location type hierarchy is started in the magazine. A location is only then considered as a suitable type of location when it applies that "Location type of the location" is larger than "Location type of the tool", whereby the "larger than" relationship is defined by the location-type hierarchy. If no free location is found in this magazine, the search is continued in the next magazine (search strategy).

## 3.5.2 Search strategy for empty locations

### Search strategy

The strategy can be defined with the magazine configuration according to which the search is made in magazines of TO units for an empty location. If it involves a box-type magazine, then the search is executed according to the default strategy (forwards search starting at the first location number).

Possible strategies are listed in the table.

| $TC_MAMP2 | Search strategies | Meaning |
|---|---|---|
| Bit 8 = 1<br>256 | Forwards search | The search takes place from location No. 1 in ascending order. |
| Bit 9 = 1<br>512 | Forwards search | The search takes place from the current location at the change position in ascending order. |
| Bit 10 =1<br>1024 | Backwards search | The search takes place backwards starting from the last location No. |
| Bit 11 = 1<br>2048 | Backwards search | The search takes place from the current location at the change position backwards. |
| Bit 12 = 1<br>4096 | Symmetrical search | The search starts at the current location number at the change position (1st location left, 1st location right, 2nd location left, 2nd location right, etc.). |
| Bit 13 = 1 | 1:1 exchange | If the location type and size of the old and new tool are the same, the magazine location of the "new" tool to be loaded is transferred to the "old" tool to be unloaded – and vice versa.<br>The 1:1 interchange acts in addition to other selected search strategies. If possible, the 1:1 exchange is treated as a priority. |
| Bit 14 | Magazine search strategy | =0<br>First search the magazine with a search run across the location types of the hierarchy of the tool type. If no location is found, then a search run is performed across the magazines.<br>=1<br>Search the location type of the tool in the magazine. If nothing is found, search run across the magazines. If a location is still not found, then a search run is repeated across all magazines with the next location type from the type hierarchy. |

**Note**

The empty location search strategy is set TO-specific using $TC_MAMP2, magazine-specific using $TC_MAP10. If the magazine-specific search is not set, when the NCK boots, it copies the value from MAMP2 to MAP10.

### Definition of the current magazine position

The current magazine position at the change location is stored in magazine parameter (system variable) $TC_MAP8. The value is automatically updated by the PLC acknowledgement of a command, if the new tool is moved. If the magazine or tool is moved without a task from the NCK, the user must correct the actual position. An NC cycle or also the PLC can write to parameter $TC_MAP8. Either by writing the OPI variable (selected with NCVAR selector block TM; variable magNrPaces) or with the FC 8/FC 6 (with the parameters TaskIdent=4 TasIIdentNo=channel number, Status=5, OldToolMag=9998,OldToolLoc=1. In NewToolMag and NewToolLoc, the actual position is parameterized (reference to the spindle)).

## 3.5.3 Assigning a hierarchy to the location types

If a tool is to be loaded from the spindle into the magazine or a tool is to be loaded into the magazine, then the location type decides which magazine locations are available for selection, i.e. $TC_TP7 and $TC_MPP2 must be defined and match or $TC_MPP2=0, i.e. every tool type fits in this location.

If the location type of the tool belongs to the location type hierarchy, then the location assignment is carried out in accordance with this hierarchy.

**Example:**
A tool with location type B should be placed in the magazine or a search made for a free location with type B.

The following location type hierarchy applies: A < B < C < D

The search is set in $TC_MAMP2 or in $TC_MAP10[Magazine-No.] with bit 14.

Procedure:

Bit 14=0
First a check is performed to see whether there is a location with type B in the magazine to be searched. If there is not, the search is continued for a type C or D location in the same magazine. In doing so, only the validity of the location types is tested. If the the search condition for the empty location of the type C is fulfilled, also if the empty location is of type D. This means that no search is run for the next largest location type. If a location is not found, the search is continued in the next, connected magazine.

Bit 14=1
First a check is performed to see whether there is a location with type B in the magazine to be searched. If not, then a search is made for precisely this location type in all of the linked magazines. If a location is still not found, then a search run is made across all magazines with the next larger location type from the type hierarchy.

Several such hierarchies can be set up in one TO unit. A location type may only be entered into one hierarchy.

Example: def int A,B,C,D,E

The following location type relationships are defined:

1st hierarchy

$TC_MPTH[0.0] = A
$TC_MPTH[0.1] = B
$TC_MPTH[0.2] = D

2nd hierarchy

$TC_MPTH[1.0] = C
$TC_MPTH[1.1] = E

Type A < type B < type D apply in the first hierarchy and type C < type E in the second hierarchy. In the first hierachy, location type A is the smallest (and fits to all other location types), location type D is the largest.

Both the number of different hierarchies as well as also the number of entries in a hierarchy can be set using a machine data (18078 $MN_MM_MAX_NUM_OF_HIERARCHIE, 18079 $MN_MM_MAX_HIERARCHIE_ENTRIES).

## 3.5.4 New type of location type hierarchy

It is now possible to define location types from 1 to 8. A table showing possible alternative location types can be added to each of these location types. The location types used in the tables can have values from 1 to 32000. This empty location search is configured by setting bit 15 in $TC_MAMP2.

The same location types can be entered into various tables.

A location type hierarchy can comprise a maximum of 8 additional location types. The location type hierarchy is defined using the already described system parameter $TC_MPTH[n,m] with n, m = 0,....7. A definition is made that the location type hierarchy of the designated location type 1 is defined to be $TC_MPTH[0,m]. In the NCK, it is not monitored which location types are entered into the location type hierarchy.

### Boundary conditions

This type of hierarchy formation of magazine location types is valid for the TO unit in which the system parameter $TC_MAMP2 is correspondingly set.

**Note**

If location type hierarchies are defined before writing to $TC_MAMP2, then the previous functionality is applied as default setting, i.e. each location type may be included precisely one time in the hierarchies.

## Examples

There are three tools with the T and location type numbers = 100 and 1, 200 and 2, 600 and 6. The following definitions apply.

```
$TC_MPTH[ 0, 0 ] = 10        ; hierarchy of the designated location type = 1
$TC_MPTH[ 0, 1 ] = 21
$TC_MPTH[ 0, 2 ] = 32
$TC_MPTH[ 0, 3 ] = 43
$TC_MPTH[ 0, 4 ] = 54
$TC_MPTH[ 0, 5 ] = 65
$TC_MPTH[ 0, 6 ] = 76
$TC_MPTH[ 0, 7 ] = 87

$TC_MPTH[ 1, 0 ] = 1         ; hierarchy of the designated location type = 2
$TC_MPTH[ 1, 1 ] = 10
$TC_MPTH[ 1, 2 ] = 111

$TC_MPTH[ 5, 0 ] = 1         ; hierarchy of the designated location type = 6
$TC_MPTH[ 5, 1 ] = 10
$TC_MPTH[ 5, 2 ] = 111
$TC_MPTH[ 5, 3 ] = 222
```

The location types 1, 10 and 111 are included in several hierarchies.

A search is now made for an empty location for tool with T No. = 200 and location type No. = 2. If no type 2 location is empty, then the search is continued by evaluating the type hierarchy $TC_MPTH[ 1, m ].

T No. = 200 also fits into a location, type 1, 10 or 111.

T No. = 600 with location type No. = 6 - in addition to the preferred location with type = 6, it also fits in location types 1, 10, 111 or 222.

On the other hand, T No. = 100 with location type number = 1 does not fit in locations, type = 111 or 222, but only in locations of the preferred type 1, or 10, 21, 32,.... 87.

## System variables

Magazine location type hierarchy (Page 255)

## See also

Magazine blocks (Page 259)

## 3.5.5 Search procedure for empty locations

The following apply as criteria for the empty location search:

- Location type must coincide with location type of tool. A hierarchy is taken into account.
- Check the tool size.
- Location must have the status "free".
- Location must not be "disabled".
- Magazine must not be "disabled".

The essential search criterion for the empty location search is the magazine location type. The magazine location type must match the magazine location type entered in the tool-specific data ($TC_TP). The magazine is searched. Each location is checked. If a suitable location is found the search is terminated.

If a matching location is not found, then a check is made whether there is a magazine location type hierarchy for the magazine-location type that is entered in the tool. If there is none, the next magazine is taken if there are further magazines available. If there is a defined hierarchy, then the search routine is repeated starting at the magazine that has just been searched. If this search is also unsuccessful, the search moves to the next magazine, assuming another one is available.

**Note**

With oversized tools, the location types of the adjacent location are not considered.

## 3.5.6 Search strategy, 1:1 exchange (old for new)

With this search option, the magazine location of the "new" tool (tool to be loaded) is made available as the empty location for the ’old’ tool (tool to be unloaded).

It is not assumed that the "new" tool is stored in the magazine location. It only needs to have been loaded (it may be located on a gripper, for example). If the location in question is not suitable for the "old" tool, then another appropriate empty location is sought.

### Description of function

The new search strategy for an empty location is preset in the already existing bit-coded system variable **$TC_MAMP2** with **bit 13**.

If 2 tools (new and old tool) are exchanged 1:1, then the two tools are marked. To do this, bit 15 is set to 1 in the tool status ($TC_TP8).

### Boundary conditions

With this empty-location search strategy, the NCK checks a magazine location that at the point of time of making the check is normally identified as still occupied by the "new" tool or is still "reserved for tool from buffer location". This location is defined as an empty location for the "old" tool if the check gives a positive result.

If the new or old tool is coded as a fixed location tool or the tool size or the location type is not identical, then the strategy is not used.

**Note**

The PLC program has to execute the tool transportation operations in the correct sequence for the tool change:

Remove "new" tool from the magazine location

Bring the "old" tool to the magazine location

Otherwise damage may occur to the machine or tool.

The 1:1 exchange can be set as the only search strategy for the buffer magazine (9998).

The empty location search strategy is only effective within tool changes programmed in the part program. PI services or language commands for an empty location search cannot use this.

**Example**

This strategy is especially suitable for use with double grippers and tools of the same type (same size and same location type).

The already defined system variable $TC_MAMP2 includes an additional setting option for the new empty-location search strategy.

| Bit | Value | Meaning |
|---|---|---|
| | | |
| 0 | | |
| ... | | Tool search strategy |
| 7 | | |
| 8 | | |
| ... | | Search strategy for empty location |
| 13 | | The magazine location for the "new" tool to be loaded is transferred to the "old" tool to be replaced and vice versa.<br>Precondition is that the **tool sizes and location types of the tools match** are compatible in terms of location hierarchy.<br>The location of the "new" tool is detected as empty location for the "old" tool even if the "new" tool is still positioned at this location at the time the check is performed.<br>The tool transport must be designed so that the "new" tool is first removed from the magazine location before the "old" tool is taken to it.<br>Otherwise, depending on the sequence of the mechanical tool transport operations, the machine could be damaged.<br>The type of empty location search is determined via the bits 8 through 12.<br>It is not possible for tool change to take place if the "old" tool does not have a magazine location assigned to it. The tool search strategy is then determined via bits 8 to 12. |

## 3.5.7 Tool search in wear group

### Overview

If "Wear group" function is used:

In the case of existing tool-search strategies, the search refers only to the active wear group, i.e. only those tools are considered during a search within a tool group that are at magazine locations of the active wear group.

Tools in magazine locations with wear group number 0 are also checked for suitability.

If there are no spare tools available, then all $TC_MPP5 parameters of the current groups are negated and all locations are individually disabled by this. $TC_MAP9 is also negated (wear group disabled). All active tools are reset if this response has been configured via $TC_MAMP3 (bit 1 = 1).

The next wear group is called ($TC_MAP9 is assigned the number of the next wear group that can be activated).

If no further groups are available the search is terminated with an alarm. In such a case, the disabled tools should be replaced, if necessary. In order to enable the wear groups again, the wear group numbers of the magazine locations must be again set to values > 0.

### Search strategies

There are two search strategies for finding the next available wear group that can be activated:

- Starting from the lowest magazine location number, the replacement tools are searched through location by location according to the way they are sorted internally (time-optimized search). The wear group that is the subject of the search is found by searching for the first tool that is assigned to a wear group that can be activated.
- A search is made for the wear group with the lowest enabled wear group number (the first that can be activated).

### Search in several magazines

The magazine definition for a machine defines whether the search is to be performed in one or several magazines.

If the search is conducted in several magazines while several wear groups are being used, always make sure that a wear group can only ever be assigned to one magazine.

The search is conducted acc. to the following priorities:

1. The search is performed in a magazine according to the configuration and strategy.
2. The search is performed in the active wear group.
3. The set tool-search strategy is taken into consideration.

## Activation

In order to work with wear groups, the magazine locations must be assigned to wear groups via system variable **$TC_MPP5** and the function must be activated via the machine data.

In addition, the number of the wear group with which machining is to commence must be assigned to system variable **$TC_MAP9** of the magazine to be selected (value > 0).

For the configuration of the machine, it is defined by **$TC_MAMP3** how the tool status shall change when switching from one wear group to the next (defaulted is an unchanged tool status).

**Note**

The PLC signal "tool selection from locked tools" has no effect when resetting the tool state.

## Example: Tool search in wear group

**$TC_MAMP3 = 3 - change "active" status of tools**

Target

- The tools must be set to "active" when a wear group is activated.
- When a wear group is disabled all the tools contained in that wear group should also be deactivated.

Specifications

- Circular magazine number 1 (6 locations)
- The circular magazine is to be divided into two parts:
  - Locations 2 and 3 form wear group 1.
  - Locations 4, 5, 6 and 1 form wear group 2.
- $TC_MAP9 = 1 (wear group 1 is "active")

Assignment to the wear group is achieved by:

$TC_MPP5[1,2] = 1
$TC_MPP5[1,3] = 1
$TC_MPP5[1,4] = 2
$TC_MPP5[1,5] = 2
$TC_MPP5[1,6] = 2
$TC_MPP5[1,1] = 2

The tools with T=10 and T=11 are assigned to wear group 1. As wear group 1 was activated, tools T=10, 11 were therefore also set to "active" (via $TC_MAMP3, bit 0=1).

**Note**

Language command SETTA (see index entry) can also be used to set the tools to active.

Tool assignment:

```
$TC_MPP6[1,2] = 10        ;   T=10 has identifier "TL1"/duplo No.=1 TL status
                              "active"
$TC_MPP6[1,3] = 11        ;   T=11 has identifier "TL2"/duplo No.=1 TL status
                              "active"
$TC_MPP6[1,4] = 12        ;   T=12 has identifier "TL1"/duplo No.=2
$TC_MPP6[1,5] = 13        ;   T=13 has identifier "TL2"/duplo No.=2
$TC_MPP6[1,6] = 14        ;   T=14 has identifier "TL1"/duplo No.=3
$TC_MPP6[1,1] = 15        ;   T=15 has identifier "TL2"/duplo No.=3
```

**$TC_MAMP2 = 1**

The active tool is to be searched for. If none is available, the next possible tool is to be located.

This tool search strategy is superimposed by a check for the number of the active wear group. That is to say only those tools are considered during the search for a tool with the status "active" that are at magazine locations and that have the number of the currently activated wear group.

**T="TL2"**

Tool group "TL2" consists of tools

T=11, 13, 15.

T=11 is positioned in a location of the active wear group (No. 1) and is "active". The result of the tool search is T=11.

Machining is continued. T=11 is "disabled" during machining.

**T="TL1"**

Wear group 1 is still active. T=10 is identified as active and suitable for use.

**T="TL2"**

The tool group of identifier "TL2" now has no active tool (has been disabled) and a new tool has not yet been set to "active". This step is not taken until "TL2" is reprogrammed. The tools of the group are examined. In the locations of wear group 1, which is still active, there is no tool with identifier "TL2" or any other suitable tool.

This condition causes the next wear group (2) to be activated. Wear group 1 is now no longer the active wear group. The status of the tools in wear group 1 has been reset (not "active"), as configured by **$TC_MAMP3, bit 1=1**.

The tool search is now exclusively performed in wear group 2. Its tools were set to "active" when the wear group was activated (one tool from each tool group in the wear group because setting of $TC_MAMP3, bit 0=1).

The turret is now assigned as follows:

```
$TC_MPP6[1,2]=10       ; T=10 has identifier "TL1"/duplo No.=1          ; Tool state "not active"
$TC_MPP6[1,3]=11       ; T=11 has identifier "TL2"/duplo No.=1          ; Tool status "disabled"
$TC_MPP6[1,4]=12       ; T=12 has identifier "TL1"/duplo No.=2          ; Tool state "active"
$TC_MPP6[1,5]=13       ; T=13 has identifier "TL2"/duplo No.=2          ; Tool state "active"
$TC_MPP6[1,6]=14       ; T=14 has identifier "TL1"/duplo No.=3            -
$TC_MPP6[1,1]=15       ; T=15 has identifier "TL2"/duplo No.=3            -
```

In the example **T=13** is now taken as the next available tool "TL2".

**Note**

The tool search only then generates an alarm when no further spare tool available in the tool group with the given identifier is found and no further wear group can be activated.

## Control system response

Control behavior at Power On, mode group change, reset, block search and Repos is described below.

**Configuration $TC_MAMP3, bit 0=1 (activate internally)**

At Power On, the NCK checks whether the value of $TC_MAP9 > 0, i.e. whether a wear group has been selected. In this case the tools of that wear group are checked again and the value for $TC_MPP5 of each location in question is set to positive. In addition, the status of the tool in the location is set to "active".

**Configuration $TC_MAMP3, bit 1=1 (disable internally)**

At Power On, the NCK checks whether $TC_MAP9 is negative, i.e. a wear group has been disabled. In this case the tools of the disabled wear group are checked again and the value for $TC_MPP5 of the location in question is set to negative. The "active" status of the tool in the location is reset.

# 3.6 Loading

## 3.6.1 Loading sequence

### Overview

Loading generally involves transporting a tool from a loading point (location in the loading magazine) into a real magazine. In so doing, the tool is allocated an empty location (the location where it was loaded). Only then, from the perspective of the NCK, is the tool considered to have been loaded. This means that a tool that was loaded onto the spindle – e.g. via SINUMERIK Operate – is considered as not having been loaded.

### Loading sequence

In the 1st step, a search is made for a suitable empty location for the tool to be loaded. In the 2nd step, the tool whose data must have been completely created (tool data and at least one cutting edge), is placed at a loading point. The tool is transported in the 3rd step.

**Note**

SINUMERIK Operate automatically handles the loading. The tool data are completely generated. The tool is placed at the loading point and tool transport initiated. This sequence does not change, even if the tool is visually created in the magazine list via the user interface.

## 3.6.2 Function of the PLC when loading?

### Loading sequence

When loading, the PLC is informed by the NCK about magazine and location numbers.

When a tool is loaded, the target address is the magazine and the loading location for the tool (DB71. DBW (n+24) and (n+26). This target address is communicated to FC 8/FC 6 as parameters **"NewToolMag"** and **"NewToolLoc"** and "Status = 1" or "Status = 10" once the load operation has been successfully completed. Parameters "OldToolMag", "OldTool-Loc" must be supply with 0. The number of the active interface identifies the loading location.

The loading procedure is performed as follows:

1. A request is sent to the PLC to load the tool. The information is transferred to the PLC in DB 71.

   Example:

   Data in DB71 when loading for the 2nd interface,

   (location 5 in magazine 1 is to be loaded from loading location 2)

| | | |
|---|---|---|
| DB71.DBX0.1 = 1 | ; | Interface 2 active |
| DB71.DBX34.0 = 1 | | Command: Loading |
| DB71.DBW50 = 9999 | | Magazine No. of the loading magazine |
| DB71.DBW52 = 2 | | Location No. within the loading magazine |
| DB71.DBW54 = 0 | | Magazine No. (source) for unloading |
| DB71.DBW56 = 0 | | Location No. (source) for unloading |
| **DB71.DBW58 = 1** | | **Magazine No. target for loading** |
| **DB71.DBW60 = 5** | | **Location No., target for loading** |

1. Generally, the PLC would now move "location 5" from "magazine No. 1" (into which the tool should be loaded) to "loading location 2" and execute the load operation.
2. If the tool is physically in the magazine, FC 8 must be called from the user program and the loading operation acknowledged.

## Example of FC 8/FC 6 call when loading

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | 1 | Starts job |
| TaskIdent | 1 | DB 71 interface |
| TaskIdentNo | 2 | No. of active interface |
| NewToolMag | 1 | Mag. No. 1 |
| NewToolLoc | 5 | Location No. 5 |
| OldToolMag | 0 | During loading = 0 |
| OldToolLoc | 0 | During loading = 0 |
| Status | 1/10 | Operation completed |
| Ready | | Checkback signal from FC 8 |
| Error | | Checkback signal from FC 8 |

For loading and unloading, as well as for relocating the acknowledgement status = 10 is available. It has the same effect as status =1 (final acknowledgment; however it does not change the magazine position ($TC_MAP8). For every final acknowledgment (if the tools were moved) the magazine position is always aligned.

In this specific case, loading from location 5 into magazine 1, with the final acknowledgment (status_1) the magazine position is set to 5 (possibly existing offsets are not taken into consideration). However, this is not always desirable (e.g. when equipping a revolver), as HMI Operate derives this display from the actual magazine position.

### Problems during loading

A tool cannot be loaded. Check the following:

- Is the location type correct?
- Is a suitable empty location available?
- Has the number of tools enabled in the NCK (MD 18082) been reached?
- Does the tool size include a "0", e.g. "1011"? (this is illegal.)

Alarms on the operator panel:

- No suitable empty location available
- "Create tools" command cannot be output to the NCK

## 3.6.3 Loading by directly assigning the T number

By directly writing to parameter $TC_MPP6[magazine No.,location No.] = T, a tool can be set to a magazine location (whether it is a real magazine, buffer or loading magazine). For example, for oversized tools, the NCK automatically reserves adjacent locations.

The NCK checks whether the tool fits at this location (location type, free adjacent locations, ...), if not, then an alarm is generated.

This does not involve an associated command output to the PLC.

## 3.6.4 Load tools via a part program

### T number

The data required for a tool can also be loaded via a part program.

There are two possibilities to get the T number that addresses the data. You can:

- assign the T number yourself or
- allow the NC to assign the T number

  (via the command NEWT(...), see index entry).

The other data can be addressed by the T number determined in this way. Otherwise the T number can be assigned by the user (refer to the following example):

### Example

```
DEF INT TNo
TNo=NEWT("test",1)
$TC_TP3[TNo]=2                ; Size left
$TC_TP4[TNo]=2                ; Size right
$TC_TP5[TNo]=1                ; Size top
$TC_TP6[TNo]=1                ; Size bottom
$TC_TP7[TNo]=2                ; Location type
$TC_TP8[TNo]=2                ; Tool status
$TC_TP9[TNo]=0                ; Monitoring mode
$TC_TP10[TNo]=0               ; Substitute-tool strategy
$TC_TP11[TNo]=0               ; Tool info
$TC_DP1[TNo,DNo]=120          ; Tool type: (all of the offset data is provided
                              ; here)
$TC_MPP6[MagNo,LocNo]=TNo     ; Tool with the determined T number is written/loaded
                              ; to the location
```

The tool described here also occupies adjacent locations. The tool management automatically assigns/reserves the adjacent locations.

It is also possible to delay assignment of a tool to a location, in which case the command $TC_MPP6 is not required. After execution of the part program the tools are contained in the tool list and can be loaded at a later time.

## 3.6.5 Retroload tool data

### Procedure

When tool data are "retroloaded" this means that the offset data are not entered or loaded until after the tool loading operation.

- The tools are already located in the magazine, both physically as well as their data, i.e. the "Tool <-> Location" assignment has taken place
- There is either no tool offset data in the NC or it is no longer up to date.

The offset data are assigned via the part program, i.e. the existing data are overwritten. If not already known, the internal T number of the particular tool first has to be determined in the "retroload" program to do this.

The internal T number is the tool number that the NC works with. It is unique and describes a tool. All parameters of this tool are addressed by this T number.

The T number can be assigned either by the operator when creating a tool or by the by the NC.

If the operator knows the T number (e.g. specified by the entries made at the measuring station), then this number can be retrieved in the retroload program.

If the T number is not known, then it has to be determined for each tool to be retroloaded and be supplied from a variable. This reduces the overhead for the user and also reduces the scope for errors.

## Create the retroload program

The tool is measured at a measuring station and the measured data stored. For this purpose, the tool must already be defined, i.e. by both an identifier ("Drill 12 mm" or "Miller 23" in the following) and the relevant duplo number. (The combination of tool identifier and duplo number uniquely defines the tool.) The internal T number of this tool is determined prior to the data record using the command GETT("Identifier", duplo No.) and saved a a variable ("T No." here). The data required for the tool are written and then the entire program is transferred to the NC where it is processed.

Only the variables for which data are entered have to be written. The first tool in the following example contains all the data, the second tool only contains the relevant data.

The T number does not have to be determined in the retroload program if already specified during loading because the data can then be assigned directly.

For example, for tool "1", writing length L1 looks like this:

```
$TC_DP1[1,1]=120        ; Tool type
$TC_DP3[1,1]=67.032     ; Length
```

### Program for retroloading tool offset data

```
DEF INT Tno                      ;  Definition of variable TNo
tl1:
TNo=GETT ("Drill 12mm",1)
if TNo==-1 goto tl2
$TC_DP1[TNo,1]=120               ;  Tool type
$TC_DP2[TNo,1]=0
$TC_DP3[TNo,1]=67.032            ;  Length1
$TC_DP4[TNo,1]=0
$TC_DP5[TNo,1]=0
$TC_DP6[TNo,1]=24                ;  Radius
$TC_DP7[TNo,1]=0
$TC_DP8[TNo,1]=0
$TC_DP9[TNo,1]=0
$TC_DP10[TNo,1]=0
$TC_DP11[TNo,1]=0
$TC_DP12[TNo,1]=0
$TC_DP13[TNo,1]=0
$TC_DP14[TNo,1]=0
$TC_DP15[TNo,1]=0
$TC_DP16[TNo,1]=0
$TC_DP17[TNo,1]=0
$TC_DP18[TNo,1]=0
```

```
$TC_DP19[TNo,1]=0
$TC_DP20[TNo,1]=0
$TC_DP21[TNo,1]=0
$TC_DP22[TNo,1]=0
$TC_DP23[TNo,1]=0
$TC_DP24[TNo,1]=0
$TC_DP25[TNo,1]=0
$TC_MOP1[TNo,1]=0
$TC_MOP2[TNo,1]=0
$TC_MOP3[TNo,1]=0
$TC_MOP4[TNo,1]=0
t12:                              ;  Next tool
TNo=GETT ("Miller23",2)
if TNo==-1 goto error             ;  Possible error routine if tool does not exist
$TC_DP1[TNo,1]=120
$TC_DP3[TNo,1]=82.51
$TC_DP6[TNo,1]=25
Fault:                            ;  Fault
:
:
M17
```

# 3.7 Unloading

## 3.7.1 Overview

Unloading removes the tool from the magazine. It always involves transporting a tool from a real magazine into the loading magazine. In so doing, the owner location of the tool as well as all reservations made in the real magazine are deleted. The job is initiated via PI service (initiated via the HMI user interface) or language command. In so doing, NCK generates a CMD1, this means that the DB71 is used.

## 3.7.2 PLC function when unloading

### Overview

When unloading, here in the example, this is initiated by an HMI operator action – the target address of the tool is specified to FC 8/FC 6 with the identifier of the loading/unloading point (DB71.DB(n+16) and DBW(n+18), start address "n" is included in the interface list). The target address is communicated to the FC 8/FC 6 as parameters "**OldToolMag**", "**OldToolLoc**" and "Status = 1" or "Status = 10" once the unload operation has been successfully completed. The "NewToolMag" and "NewToolLoc" parameters must be assigned the value zero.

### Unloading sequence

Unloading is controlled via DB 71. The unloading sequence is as follows:

1. The PLC receives the command to unload the selected tool. The information is transferred to the PLC in DB 71. Example for the in DB 71 when unloading for the 2nd interface. Location 7 of magazine no. 1 must be unloaded at loading location 2.

   **Example**:

| | | |
|---|---|---|
| DB71.DBX0.1=1 | ; | Interface 2 active |
| DB71.DBX34.1=1 | ; | Command: Unloading |
| **DB71.DBW50=9999** | ; | **Magazine No. of the unloading point** |
| **DB71.DBW52=2** | ; | **Location No. of the unloading point** |
| DB71.DBW54=1 | ; | Magazine No. for unloading |
| DB71.DBW56=7 | ; | Location No. for unloading |
| DB71.DBW58=0 | ; | Magazine No. target for loading |
| DB71.DBW60=0 | ; | Location No., target for loading |

1. Generally, the PLC must now position "Location 7" from "Magazine No. 1" (from which the tool should be unloaded) to the "loading/unloading point 2" and then unload the tool.
2. When the tool is removed from the magazine, FC 8/FC 6 must be called from the user program and the unloading operation acknowledged.

Example: FC 8/FC 6 call when unloading

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 1 | DB 71 interface |
| TaskIdentNo | 2 | No. of active interface |
| NewToolMag | 0 | During unloading = 0 |
| NewToolLoc | 0 | During unloading = 0 |
| OldToolMag | 9999 | Mag. No. 9999 |
| OldToolLoc | 2 | Location no. 2 |
| Status | 1/10 | Operation completed |
| Ready | | Checkback signal from FC 8 |
| Error | | Checkback signal from FC 8 |

The PLC user program then has to traverse the magazine to the correct unloading point and execute unloading. If the tool comes via a buffer location (gripper, loader) to the unloading point or station, then the NCK is to be notified of each position change by means of the FC 8/FC 6 with status 104, 105. Status "1" is not set via FC 8 until the tool is in the specified unloading point/station. This means that the unload operation has been completed; the magazine position is also automatically aligned. In this example, do not take into account possibly existing offsets at location_7.

## Positioning for unloading (with OP177 and SINUMERIK Operate)

This means that the HMI sends two jobs to the NCK (and this in turn to the PLC). First positioning (which is described in the following), then unloading.

When a magazine is being **positioned** at a loading magazine, the target address is stored in DB71.DBW(n+16) and DBW(n+18). This target address is passed to FC 8/FC 6 as parameters "NewToolMag" and "NewToolLoc" and "Status" = 1 once the magazine has been successfully positioned. Parameters "OldToolMag", "OldTool-Loc" must be set to 0.

The magazine and magazine location to be positioned are stored in DB71.DBW(n+20) and DBW(n+22). Positioning here only concerns magazine positioning a free location or a location with a tool to a loading/unloading station. The number of the active interface identifies the loading magazine (location No.).

### Example: Positioning for unloading

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 1 | DB 71 interface |
| TaskIdentNo | 2 | No. of active interface |
| NewToolMag | **9999** | **Mag. No. 9999** |
| NewToolLoc | **3** | **Loc. No. 3** |
| OldToolMag | 0 | During positioning = 0 |
| OldToolLoc | 0 | During positioning = 0 |
| Status | 1 | Operation completed |

## 3.7.3 Unloading by deleting the T number from the magazine location

By directly writing to parameter $TC_MPP&[magazine No.,location No.] = 0, a tool can be removed from this magazine location (whether it is a real magazine, buffer or loading magazine). All reservations of the removed tool are automatically deleted.

This does not involve an associated command output to the PLC.

# 3.8 Relocating tools and positioning the magazine

## 3.8.1 Relocate (task from TM system)

### Basis

When **relocating**, the target address is the magazine and the loading location for the tool to be relocated (DB71.DBW(n+24) and DBW n+26). The source of the tool is specified in DB71.DBW(n+20) and DBW(n+22). The target address is passed to FC 8/FC 6 as parameters "NewToolMag" and "NewToolLoc" and status = 1 when relocation has been successfully completed. Parameters **"OldToolMag"** and **"OldToolLoc"** must be set to zero because the tool management recognizes the location of the old tool.

All relocation jobs are handled via the 1st interface.

### Example of relocating a tool

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts task |
| TaskIdent | 1 | DB 71 interface |
| TaskIdentNo | 1 | Channel No. for tool management |
| NewToolMag | 2 | New magazine No. |
| NewToolLoc | 17 | New location no. |
| OldToolMag | **0** | **Old magazine number not used** |
| OldToolLoc | **0** | **Old location number not used** |
| Status | 1 | Operation complete |

## 3.8.2 Relocation by the PLC

### Task from PLC

The PLC can also issue a job to tool management to relocate a tool. This is done by notifying a new location for the tool to the tool management. The FC 8/FC 6 block (TaskIdent := 4) is called with the following parameters:

- Old magazine No.(OldToolMag)
- Old location No.(OldToolLoc)
- New magazine No.(NewToolMag)
- New location No.(NewToolLoc)

## 1st example

The tool in magazine No. 1, location No. 5 is to be relocated to magazine No. 2, location No. 17. The PLC takes responsibility for ensuring that the location type is correct for the transfer. This example for calling an FC8 does not take into any consideration any checkback signal to tool management for intermediate positions of tools.

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 4 | Task from PLC |
| TaskIdentNo | 1 | Channel No. for tool management |
| NewToolMag | 2 | New magazine No. |
| NewToolLoc | 17 | New location No. |
| OldToolMag | 1 | Old magazine No. |
| OldToolLoc | 5 | Old location No. |
| Status | 1 | Operation completed |

## 2nd example

Example: The tool is to be relocated from mag. No. 1, location No. 5 via grippers 3 and 4 to mag. No. 2, location No. 17.

FC 8/FC 6 must be called up four times in this procedure. Only the important parameters are listed. All other parameters are as for the example above.

**The tool is transported in 4 steps:**

1. Move from magazine 1, location 5 to gripper 3 (location No. 4)

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 4 | Task from PLC |
| TaskIdentNo | 1 | Channel No. for tool management |
| NewToolMag | 9998 | New magazine No. |
| NewToolLoc | 4 | New location No. |
| OldToolMag | 1 | Old magazine No. |
| OldToolLoc | 5 | Old location No. |
| Status | 1 | Operation completed |

2. Move from gripper 3 to transfer location 2, location No. 6

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 4 | Task from PLC |
| TaskIdentNo | 1 | Channel No. for tool management |
| NewToolMag | 9998 | New magazine No. |
| NewToolLoc | 6 | New location No. |
| OldToolMag | 9998 | Old magazine No. |
| OldToolLoc | 4 | Old location No. |
| Status | 1 | Operation completed |

3. Move from transfer location 2, location No. 6 to gripper 4, location No. 5

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 4 | Task from PLC |
| TaskIdentNo | 1 | Channel No. for tool management |
| NewToolMag | 9998 | New magazine No. |
| NewToolLoc | 5 | New location No. |
| OldToolMag | 9998 | Old magazine No. |
| OldToolLoc | 6 | Old location No. |
| Status | 1 | Operation completed |

4. Relocate from gripper 4, location No. 5 to magazine 2, location 17

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 4 | Task from PLC |
| TaskIdentNo | 1 | Channel No. for tool management |
| NewToolMag | 2 | New magazine No. |
| NewToolLoc | 17 | New location No. |
| OldToolMag | 9998 | Old magazine No. |
| OldToolLoc | 5 | Old location No. |
| Status | 1 | Operation completed |

**Note**

TaskIdent 5 may be programmed only for a tool transfer (magazine -> buffer location). Otherwise an error message is outputted, even though the tool is transferred.

The reservation is automatically reset when the tool is transferred from the buffer back into the magazine.

## 3.8.3 Positioning the magazine

### Overview

When positioning, a traversing block is sent to the PLC by the tool management. Bit 3 is set in DB71.DBB(n+0) "Position to the loading point". The magazine No. and the location No. (as target) are transferred in the parameters DB71.DBW(n+20) and (n+22) during positioning.

The PLC then has to move this location to the loading point. The number of the loading point is entered in DB71.DBW (n+18) or determined by the number of the interface. If the PLC has moved the magazine location to the loading point, FC 8/FC 6 must be called and the operation acknowledged with status 5 "Position changed".

**Example:**

Location 5 in magazine 1 (source) must be moved to the loading magazine 2 (target).

| | | | |
|---|---|---|---|
| DB71.DBX0.1 | =1 | Interface 2 active | |
| DB71.DBX34.3 | =1 | Positioning has been initiated | (n+0) |
| DB71.DBW50 | =9999 | Magazine No. of the loading magazine | (n+16) |
| DB71.DBW52 | =2 | Location No. of new loading magazine | (n+18) |
| DB71.DBW54 | =1 | No. of the magazine to be positioned | (n+20) |
| DB71.DBW56 | =5 | No. of the location to be positioned | (n+22) |
| DB71.DBW58 | | Magazine No. to which positioning is to be carried out | (n+24) |
| DB71.DBW60 | | Location No. to which positioning is to be carried out | (n+26) |

Parameters "OldToolMag" and "OldToolLoc" in FC 8/FC 6 are not required for positioning because only the PLC requires the information for traversing the magazine. The values for NewToolMag and NewToolLoc are from DB71 (n+24 and n+26). The PLC has to execute the positioning task and acknowledge it with an FC 8/FC 6 call as follows:

### Example: FC 8/FC 6 call when positioning

| FC 8 parameters | Values | Comment |
|---|---|---|
| Start | | Starts job |
| TaskIdent | 1 | DB 71 (load/unload, positioning, relocating) |
| TaskIdentNo | 2 | No. of active interface |
| NewToolMag | 9999 | Magazine no. 9999 (loading magazine) |
| NewToolLoc | 2 | Location 2 |
| OldToolMag | 0 | During positioning = 0 |
| OldToolLoc | 0 | During positioning = 0 |
| Status | 5 | Operation completed |
| Ready | | Checkback signal from FC 8 |
| Error | | Checkback signal from FC 8 |

# 3.9 Tool monitoring (workpiece count, tool life, wear)

## 3.9.1 Monitoring types

### Quantity

The quantity monitoring, initiated by the language command SETPIECE, considers the cutting edges of all of the tools that have been used. In this case, it must be observed that there can be several spindles.

### Service life

Tool life monitoring is only performed on the tool edge that is currently in use. As soon as the path axes are moved (with the exception of G00), then monitoring time of the active cutting edge is decremented. If the tool life for a cutting edge expires during machining, the tool is blocked as a whole.

### Wear

As is the case for the time and workpiece count (quantity) monitoring, the prerequisite for using the wear monitoring function is that tool monitoring is enabled in the machine data. In addition, wear monitoring must be enabled via an MD. The wear parameters of the cutting edge have their equivalence in the local offsets (total offset parameters), see index entry "total offsets".

### Service life, quantity

The monitoring value runs from a value greater than 0 to 0. The monitoring setpoint has no affect on the monitoring, this value is only evaluated when reactivating a tool.

## Tool life, workpiece count and wear

The monitoring type for the tools is generally set when creating or loading. You can change the monitoring type at any time by changing the setting for system variable MD $TC_TP9.

The tool management monitors a tool for tool life, workpiece count, tool wear state or additive offset with prewarning limit.

The monitoring counter triggering the tool status change depends on the system variable $TC_TP9 (= type of monitoring):

- $TC_TP9 = 0 -> no monitoring
- $TC_TP9 = 1 -> time-monitored tool
- $TC_TP9 = 2 -> workpiece count-monitored tool
- $TC_TP9 = 4 -> wear-monitored tool
- $TC_TP9 = 8 -> additive offset

Several monitoring types can be activated simultaneously for one tool. Of the monitoring types, only wear monitoring and additive-offset monitoring are mutually exclusive.

If the monitoring criterion (tool life/workpiece count and wear) for a tool that is currently located in the spindle expires, it remains in use. Machining is not automatically interrupted to replace the tool with a fresh backup tool. The tool is not disabled until the next time it is selected. Since it is no longer "available", a search is made for a replacement tool and the replacement tool is then loaded into the spindle. The tool change has to be organized by the PLC or come from the NC cycle.

The monitoring counters count from a set value > 0 down to zero. Once a monitoring counter has reached the value ≤ 0, the limit value is considered to have been reached. When a tool's cutting edge (one of maximum 12 cutting edges) has reached its limit value, the whole tool is set to status "disabled".

## Prewarning limit reached

If a cutting edge has reached its prewarning limit, then the whole tool is set to the status "Prewarning limit reached" (SLTD_SUSPENDED ($TC_TP8[i]=4)).

At the same time a message is issued to inform the operator that a replacement tool may be required. If an operator action resets the monitoring counter from zero or the prewarning limit back to a value > 0, or > prewarning limit, then the tool status changes automatically to reflect the change in the data. This allows the operator to selectively withdraw a "disabled" status caused by the tool expiring when its monitoring limit was reached.

If the tool has several cutting edges, all of the cutting edges must be beyond the monitoring limits.

### Tool monitoring alarms

When the prewarning limit or the monitoring limit of a tool is reached, one of the alarms 6010, 6011, 6012, 6013 (cancel clear delete condition) is output for information purposes.

With the NC language command SETPIECE(...) or PI command _N_TMPCIT (= other workpiece counters) it is possible for several tools to reach a limit value and therefore result in multiple alarms being issued.

No alarm is output if a limit value is reached as the result of data manipulation via variable service (OPI).

### Check monitoring status

A check can be made during program execution by issuing the programmed tool change command (e.g. "M06" for milling) without a T call to see whether a monitoring function has responded. If it has, tool life management will search for a replacement tool and issued a request for a tool change.

### Enable memory and function

In general, in machine data

- MD18080 MM_TOOL_MANAGEMENT_MASK and
- MD20310 TOOL_MANAGEMENT_MASK

at least the bits 0 and 1 (3) must be set. This prepares the memory for the monitoring data and enables the function.

### Enabling tool life monitoring

For the tool life monitoring, in addition, in the channel-specific MD20320 TOOL_TIME_MONITOR_MASK, the spindle (the toolholder) or the spindles must be specified, for which a tool life check should be performed. This machine data is bit-coded.

**Example**: MD20320 TOOL_TIME_MONITOR_MASK

- Value = 1, only spindle number 1
- Value = 2, only spindle number 2
- Value = 3, spindle numbers 1 and 2

## 3.9.2 Tool life monitoring

### Monitoring of tool cutting edge

Tool life monitoring is only performed on the tool edge that is currently in use. The spindle (toolholder) must have been activated beforehand (MD20320 TOOL_TIME_MONITOR_ MASK = spindle No.).

If MD20124 TOOL_MANAGEMENT_TOOLHOLDER is > 0, then for MD 20320, the toolholder No. is selected and not the spindle number.

| | |
|---|---|
| **Service life** | Data backup during unloading takes place in milliseconds. |
| **Disabled** | If the remaining tool life is less than or equal to 0, the tool is set to "disabled". After the next tool change it is no longer used. |
| **Monitoring from the NCK** | The residual tool life is decreased whenever one of the 3 path axes is traversed at machining feedrate (e.g. G01). G00 traversing blocks are not "counted". |
| **Monitoring from PLC** | The user can start and stop the time monitor using PLC signal "Time monitor active" (DB 21DBX 1.3). Machine data 20310 is used to select whether this control type is active. |
| **Prewarning limit** | Input when tool is loaded or via part program with $TC_MOP1=50. When the prewarning limit has been reached, the tool is assigned the status "Prewarning limit reached" (display in the magazine list). |
| **Special case, limit values** | The tool life of a tool expires while it is in use. A check is made if this disabled tool is re-programmed by a change operation (e.g. M06 without T word), whether the monitoring time has already elapsed. If yes, a replacement tool is located. |

### $A-MONIFACT factor

By entering a channel-specific factor which is set before a tool is used for the first time, it is possible to monitor the different degrees of tool wear resulting from machining different types of workpiece material. The value is multiplied by the current time unit before the time value of the cutting edge is decremented. The write operation is performed synchronously with the main run.

### Start and stop the tool life decrementation

Tool life monitoring runs when geometry axes are not traversed with **G00** (default setting).

The user can start and stop the time monitor using PLC signal "Time monitor active" (DB 21 DBX 1.3).

The type of control that is active is set using a machine data; MD20310 TOOL_MANAGEMENT_MASK bit 17. The default setting (bit 17=0), i.e. traversing blocks not equal to G00 will cause the time counter to run.

### Time monitoring hierarchy

The combination of system variable $A_MONIFACT and function "Program test active" produces the following nested time monitoring structure:

Machine data MD20310 TOOL_MANAGEMENT_MASK defines the monitoring control via G00 or via a PLC signal. The tools in spindle, which are activated using machine data MD20320 TOOL_TIME_MONITOR_MASK are monitored from a time perspective.

The VDI signal "Program test active" switches the momentarily valid time monitoring on or off; i.e. "Program test active" has a higher priority than the actual time monitoring.

When time monitoring is active, the real time (as defined by the internal clock) is multiplied by the factor $A_MONIFACT and the result subtracted from the current time count of a tool edge mounted on the spindle.

## 3.9.3 Workpiece count monitoring

### Changing the number of workpieces

The number of workpieces can be changed by:

- Operator action at the HMI
- With a part program command (SETPIECE)
- PI service (TMPCIT) by PLC or HMI-OEM

### Workpiece counter per spindle

Every spindle has a "memory" for the cutting edges used on it. With program command SETPIECE (1) the workpiece counter for the cutting edges that are used on the main spindle is decremented by 1. The workpiece counter of each spindle can be addressed individually.

The workpiece counter must count all the tools that are used to produce a workpiece. It will take into account that fact that the machine may have several spindles and that different tools can be used simultaneously.

The cutting edge of a tool is only counted once per spindle.

The part program programmer who programmed **SETPIECE** can program the parameter as a function of the material.

**SETPIECE (factor * no. of workpieces)**

Like the factor for time monitoring, this function allows a workpiece count that depends on the process, the workpiece material or other factors.

Workpiece count can be deactivated via the channel DB.DBX29.5.

| | |
|---|---|
| **Monitoring from the NCK** | The workpiece counter is decremented each time that SETPIECE is programmed. When the prewarning limit is reached, an information alarm is output. When the counter reaches the value=0, the tool is disabled and an alarm is output. The next time the tool is called, the replacement tool is loaded at change. |
| **Set workpiece counter** | Entered when creating or loading the tool or via the part program with e.g. $TC_MOP4=500. |
| **Decrement number of workpieces** | The number of workpieces must be decremented at the relevant point in the part program with the NC language command SETPIECE (x, y) (e.g. SETPIECE(1) -> workpiece counter for main spindle tools is decremented by 1).<br>The function for decrementing the workpiece count is activated from die PLC program using a PI command (TMPCIT). |
| **Disabled** | When the workpiece count has reached zero the tool is disabled. |
| **Prewarning limit** | Entered when creating or loading the tool or via part program with e.g. $TC_MOP3=50. When the prewarning limit has been reached, the tool is assigned the status "Prewarning limit reached". |
| **Special case, limit values** | It is not possible to realize a workpiece count for any number of cutting edges simultaneously! If the monitoring function has been enabled and activated by machine data, then all spindles can be monitored together at a time = "Number of cutting edges in the TO area" (= MD) for the number of cutting edges.<br>An edge of a tool is only counted once per spindle. |

## 3.9.4 Wear monitoring

The wear monitoring function is only available if the "Tool monitoring" system has been enabled via machine data.

In addition, wear monitoring must be enabled using machine data (MD18080 MM_TOOL_MANAGEMENT_MASK; bit 5).

### Definition

**$TC_TP9 = 4**; Wear monitoring is active for the tool.

**$TC_TP9 = 8** can be set to select the "Additive offset" monitoring function if this is required.

**$TC_TP9 = 4**

The wear parameters for a tool edge are defined with system variables $TC_DP12, ..., $TC_DP20.

These are assigned directly to the edge geometry values TC_DP3, ...,$TC_DP11.

$TC_DP10 and $TC_DP11 describe "angles". The other parameters stand for the tool edge lengths and radii.

Only these values are included in the monitoring, i.e. wear parameters $TC_DP19 and $TC_DP20, which are analogous to system variables $TC_DP10 and $TC_DP11, are not taken into account.

**Note**

Wear monitoring is performed automatically by the NCK when the user changes the cutting edge offsets.

**Note**

Wear monitoring does not monitor every single value but rather only the largest absolute value of each of these maximum seven wear parameters ($TC_DP12, ..., $TC_DP18).

**$TC_TP9 = 8**

Wear parameters (system variables) of the cutting edge can be found in the **additive offset parameters**.

Analog to wear, the following system variables are monitored for the additional offsets that are dependent on the location (location-specific offsets) of the cutting edge:

- $TC_SCP12, ... $TC_SCP18

  first additive offset for the cutting edge (if defined)

- $TC_SCP22, ... $TC_SCP28

  second additive offset for the cutting edge (if defined) etc. for the other additive offsets for the cutting edge

  **Note**

  Wear monitoring does not monitor every single value but rather only the high contribution of each of these maximum seven additive offset parameters * number of defined additive offsets for the cutting edge ($TC_SCP12, …, $TC_SCP18, $TC_SCP22, …, $TC_SCP28, …).

Most tool geometries are described by a subset of the named data records.

If a parameter is changed (written), the NCK then checks whether the new value is higher than any of the other parameters and, if necessary, this value is subtracted from the wear setpoint. The result is the new actual value for the wear.

Analogous to other monitoring variables, the actual wear runs from the positive setpoint towards zero.

## Monitoring parameters (system variables)

| | |
|---|---|
| $TC_MOP15 | Wear setpoint or additive offset value |
| $TC_MOP5 | Wear pre-warning limit or additive offset pre-warning limit |
| $TC_MOP6 | Wear value or additive-offset setpoint |

The physical quantity of the new monitoring parameters is "Length". The unit is the same as for the wear values.
The wear monitoring can be deactivated using channel DB DBX29.6.

The signal only acts on changes in wear data that occur during execution of the NC program. The PLC signal is suppressed if these data change because of OPI (e.g. during HMI operation).

## Reset to setpoints

Resetting the actual values of wear and additive offset "fine" means that all the parameters for wear offset and additive offset used for monitoring are set to zero.

## Example

For the tool with T No.=3, the wear monitoring is active and

```
$TC_MOP5[3,1]=0.002        ;=    Wear prewarning limit
$TC_MOP6[3,1]=0.003        ;=    Wear actual value
$TC_MOP15[3,1]=0.007       ;=    Wear setpoint
```

It was already set

```
$TC_DP12[3,1]=0.004      ;=  Wear component 1
$TC_DP13[3,1] =+0.00     ;=  Wear component 2
```

Wear component 3 is now set

$TC_DP14[3,1] ;= -0.006.

Thus the maximum absolute value is given for the wear components = 0.006.

The resulting new actual value is

$TC_MOP15[3,1] - 0.006 = 0.001 = $TC_MOP6[3,1].

The prewarning limit has been reached.

Note: The wear components can be negative or positive - or be mixture of each.

**Note**

The VDI signal "Activate program test" has no effect on wear monitoring since new wear values are only entered during machining and not during the program test (provided that wear was not changed by the machining program itself).

## 3.9.5 Signals to and from the PLC

### Overview

Previously, an alarm message was output as soon as the prewarning limit or limit value was reached. Alarms **6410** and **6411** are output when the prewarning limit is reached and **6412** and **6413** when the limit value is reached. Alarms 6410 and 6412 are triggered via the OP interface and alarms 6411 and 6413 via the NC program. The alarm texts identify the affected tool via the tool ID, duplo number and D number.

The following information is returned to the channel interface for one OB1 cycle (internal T numbers):

- Prewarning limit reached
- Limit reached

A strobe signal is set for one PLC cycle (DB channel.DBB344) which indicates that new data is available.

### VDI signal "Warning limit reached" channel DB.DBD348

If a tool reaches its prewarning limit with tool life, workpiece count or wear monitoring, the internal T No. of the tool is entered here and the associated strobe signal is set.

### VDI signal "Limit value reached" channel DB.DBD352

If the tool life, workpiece count or wear value has expired for a monitored tool, the internal T No. of the tool is entered and the associated strobe signal is set.

**Note**

If machining is being performed with tools that are monitored for their workpiece count, it is possible for several tools to reach their prewarning limit or limit value simultaneously (SETPIECE is programmed at the end of program).

In this case, only the T No. of the tool that was last programmed is output.

### VDI signal "T number of new replacement tool" - channel DB.DBD356

The transition to a new replacement tool is initiated by the tool status "was in use". This means that when searching for a tool in the NCK, if a (usable) tool was found that had still not been used, then it is evaluated as being the first selection and the interface signal set.

This process state change is output to the PLC via the T number of the replacement tool.

The action of the operator changing the tool status does not cause any change to the signal.

### VDI signal "Last replacement tool in the tool group" - channel DB.DBD360

If, during the tool change when searching for a tool in the NCK a tool is found, and at this point in time there are no further replacement tools available for the programmed spindle/toolholder, then this is evaluated as the "Last replacement tool found in the tool group".

If there is only one tool (i.e. there is no replacement tool) it is also a tool group. When this tool is programmed, the interface signal is set immediately.

This process state change is output to the PLC via the T number of the replacement tool.

The action of the operator changing the tool status does not cause any change to the signal.

**Note**

For tool groups containing many tools, the function increases the time required in the NCK for the main run when the tool is selected.

The function must be enabled **MD20310 $MC_TOOL_MANAGEMENT_MASK bit 18=1**.

### Disable monitored tools - PLC-controlled by the VDI signal

In earlier versions, a tool assumed the status "disabled" as soon as the actual value of the active monitoring function reached the value zero. A tool being used for machining that is set to "disabled" remains operational until the next tool change takes place. After that the tool can no longer be used.

The PLC can also determine when a disabled tool can no longer be used, i.e. when the "disabled" status is taken into account in the tool search.

- With the **VDI signal "Tool disable not active"** = 1

  (channel DB. DBX29.7 = 1) the NCK does not take the tool status "disabled" into account during the tool search.

- With the **VDI signal "Tool disable not active"** = 0

  (channel DB. DBX29.7 = 0) the NCK takes the tool status "disabled" into account during the tool search.

The bit is channel-specific.

### "Search for active tool" strategy

This search strategy can ensure that a machining operation is not performed with different tools from the same tool group.

When the tool is disabled, a monitoring function and the set VDI signal "Tool disable not active" mean that the status "active" is **not** canceled.

This **tool is therefore assigned** the status **"active"** and **"disabled"**.

If the required machining operation is terminated without a tool change, the status of all disabled tools must be checked. A PI service (_N_TMRASS, in PLC TMRASS) is provided for this. This service can be used to cancel the status "active" for all tools that have been disabled (e.g. by the PLC program at the end of the program).

### The other tool-search strategies

A disabled tool can still be used with the other tool-search strategies as well provided the VDI signal "Tool disable not active" (channel DB. DBX29.7 = 1) is set. The tool selected solely depends on the search strategy.

The **search strategy** therefore takes **precedence over** the **VDI signal "Tool disable not active"**. Both the last tool to be disabled or any other disabled tool can be selected.

Another tool which is not disabled might also exist, but is not selected because of the search strategy!

### TO unit active in several channels

If a TO unit is assigned to several channels (tool and magazine data are "visible" in several channels), then the setting of the channel-specific VDI signal "Tool disable" is effective in each channel.

# 3.10 Tool monitoring without active tool management

## 3.10.1 Tool monitoring overview

### General information

**Note**

The function is designed for simple applications, only 1-channel systems are supported

The tool monitoring without active tool management is activated via the following machine data:

- MD18080 $MN_MMTOOL_MANAGEMENT_MASK: Bit 1=1
- MD20310 $MC_TOOL_MANAGEMENT_MASK: Bit 1=1

**Note**

The function "monitoring without active tool management" (WZMO) is set in the option data. This function and the "classic" tool management (TMMG) cannot be selected at the same time (only alternatively).

The tool monitoring without active tool management function allows the following monitoring types of the active cutting edge of the active tool:

- Monitoring the **tool life**
- Monitoring the **workpiece count**
- Monitoring the **wear**
- Monitoring the **additive offset**

The function allows identifiers to be used and is also possible to use replacement tools.

### Monitoring counter

Monitoring counters exist for each monitoring type. These count from a set value > 0 down to zero. When a counter has decremented to a value of ≤0, the limit value is reached. An appropriate alarm message is issued and an interface signal output. The same applies if a cutting edge of a tool has reached its set prewarning limit.

**Note**

The monitoring function cannot be used with the "flat D numbers" function.

## State and type of tool monitoring

System parameter $TC_TP8 can be used to determine the state for the particular tool, $TC_TP9, the monitoring function type.

Contrary to magazine management (see Chapter 3.1), in the tool monitoring function without active tool management, only the following states are of significance:

- $TC_TP8[t] - State of the tool with the number t

  Bit 0 = 1: Tool is active
  Bit 0 = 0: Replacement tool

  Bit 1 = 1: Tool is enabled
  Bit 0 = 0: Tool is not enabled

  Bit 2 = 1, tool is disabled
  Bit 2 = 0: Tool is not disabled

  Bit 3: Reserved

  Bit 4 = 1: Prewarning limit reached
  Bit 4 = 0: Prewarning limit not reached

- $TC_TP9[t] - Type of the monitoring function for the tool with the number t

  = 0: No monitoring
  =1: Time-monitored tool
  = 2: Tool monitored for workpiece count
  = 4: Wear-monitored tool
  = 8: Additive offset

Several monitoring types are possible for a tool. Wear and additive offset monitoring cannot be simultaneously selected (only alternatively).

## System variables for active tool

The active cutting edge of the active tool can be determined using an existing system/OPI variable:

- $P_TOOL / actDNumber: active tool offset D
- $P_TOOLNO / actTNumber: active tool number T

## 3.10.2 Tool life monitoring

### Overview

Tool life monitoring is done for the tool cutting edge that is currently in use (active cutting edge D of the active tool T).

As soon as the path axes traverse (G1, G2, G3, ... but not for G00), the residual tool life ($TC_MOP2[t,d]) of this tool cutting edge is updated. If the remaining tool lifetime of a cutting edge of tool expires during a machining operation, an alarm is output and an interface signal is set. The tool changes to the "disabled" condition and cannot be programmed as long as the "disabled" condition is present. The operator must intervene and ensure that an operational tool for machining is provided.

Using a PLC signal, it is also possible to inform the NCK that machining should also be realized with disabled tools:

1. from the PLC program via the channel DB
2. from the NC part program via the parameter $TC_MOP2
3. 3. from the NC part program via the command RESTMON
4. in the control

**Note**

As standard, the time is counted if the geometry axes are traversed - but not equal to G00. As an alternative, using MD $MC_TOOL_MAANAGEMENT_MASK, bit 17, the time monitoring can be started and stopped from the PLC.

The channel-specific system parameter $A_MONIFACT allows the clock to be either run slower or faster.

### Time monitoring and reference to the spindle or to the toolholder

For MD $MC_T_M_ADDRESS_EXT_IS_SPINO = TRUE, only the time for the active tool is counted whose programmed spindle number has a value that is set is by selecting the bit in MD $MC_TOOL_TIME_MONITOR_MASK.

The value of MD $MC_TOOL_TIME_MONITOR_MASK has no significance, if MD $MC_T_M_ADDRESS_EXT_IS_SPINO = FALSE. In this case, the time is counted and monitored for each active cutting edge.

## 3.10.3 Workpiece count monitoring

### General

The active cutting edge of the tool that has been loaded at change is monitored for the workpiece count without reference to the spindle number (standard).

Monitoring the workpiece count registers all the tool edges that are used to produce a workpiece. If the workpiece count is changed by an operator input, the monitoring data of all the cutting edges that have become active since the last workpiece count are adjusted. It is taken account that several tool cutting edges can be simultaneously used.

The workpiece count can be updated by the PLC, using the PI command _N_TMPCIT or from the NC program using the language command SETPIECE.

### Workpiece count monitoring and reference to the spindle or to the toolholder

If MD $MC_T_M_ADDRESS_EXT_IS_SPINO = TRUE is used, the address extension of T is interpreted as spindle number. The workpiece counter monitoring is then realized separately for the spindles; further, the SETPIECE command requires the "spindle number" parameter.

If MD $MC_T_M_ADDRESS_EXT_IS_SPINO = FALSE is used, the parameter "spindle number" in SETPIECE and/or the analog PI service is ignored.

## 3.10.4 Wear monitoring

The wear monitoring must be enabled using MD $MN_MM_TOOL_MANAGEMENT_MASK, bit 5. As default, the function is not activated.

The wear parameters for a cutting edge are defined with system variables $TC_DP12 ...20. The highest value of parameter $TC_DP12 ...18 - responsible for the lengths and radii of the cutting edge - is monitored.

The wear monitoring can be activated and deactivated by the PLC using an interface signal.

## 3.10.5 Monitoring the additive offset

When using the "additive offset" function, using $TC_TP9=8 for the wear monitoring, additive offset monitoring can be selected. Instead of wear parameters $TC_DP12 ... 18, the additive offset parameters $TC_SCP12 ...18 are monitored. This corresponds to a defined 1st additive offset of the cutting edge. In turn, only the highest value of the additive offset parameter of all defined additive offsets is monitored.

## 3.10.6 Working with replacement tools

If replacement tools are used, it is necessary to define the rules relating to the transition to the replacement tool.

When changing a tool, only the name of the tool group is specified in the part program. This comprises several tools, that differ by their duplo number. The NCK selects, if available, the tool with the "active" state. If there is no tool with the "active" state, the next tool that can be used is selected whose value of the system variable $TC_TP10 regarding the other tools in the tool group is the lowest. The user allocates the parameter values so that tools are used in the required sequence. If values are not allocated, then the NCK automatically selects some sort of suitable tool.

## 3.10.7 Examples

### Precondition

Activating the tool monitoring without active tool management for the option "tool monitoring":

MD18080 $MN_MM_TOOL_MANAGEMENT_MASK = 0x02
MD20310 $MC_TOOL_MANAGEMENT_MASK = 0x02

**Service life monitoring for tool 2, cutting edge 1 in the NC program**

```
$TC_TP9[2,1]=1              ; Activation of the service life monitoring
$TC_MOP1[2,1]=100           ; Prewarning limit in minutes
$TC_MOP2[2,1]=245           ; Residual tool life in minutes
$TC_MOP11[2,1]=800          ; Setpoint service life in minutes
```

**Service life monitoring for the active tool with active D number in the NC program**

```
$TC_TP9[$P_TOOLNO, $P_TOOL]=1           ; Activation of the service life monitoring
$TC_MOP1[$P_TOOLNO, $P_TOOL]=200        ; Prewarning limit in minutes
$TC_MOP2[$P_TOOLNO, $P_TOOL]=602        ; Residual tool life in minutes
$TC_MOP11[$P_TOOLNO, $P_TOOL]=700       ; Setpoint service life in minutes
```

## 3.10.8 NC language commands

### General

The NC language commands, which apply for tool monitoring without tool management, are only listed here. A detailed description is provided in this documentation under the appropriate index entry.

- SETPIECE

  Decrement workpiece counter
- RESETMON

  Language command for setpoint activation
- $A_MONIFACT

  Read factor for tool life monitoring
- NEWT

  Create new tool
- DELT

  Delete tool
- GETT

  Read T number
- GETACTT

  Read the active internal T No.

The associated PI commands can also be used:

- _N_TMCRTO
- _N_TMCRTC
- _N_TMGETT
- _N_TRESMO

# 3.11 Variants of D-number assignments

## 3.11.1 Relative D No. for each T - standard

D numbers ranging from 1 to max. 12 are available for every T = "identifier" (with TM) or for every T number (without TM). These D numbers are assigned directly to the tool cutting edges.

An data record ($TC_DPx[t,d]) belongs to each D number (= cutting edge number).

D0 is the offset deselection code.

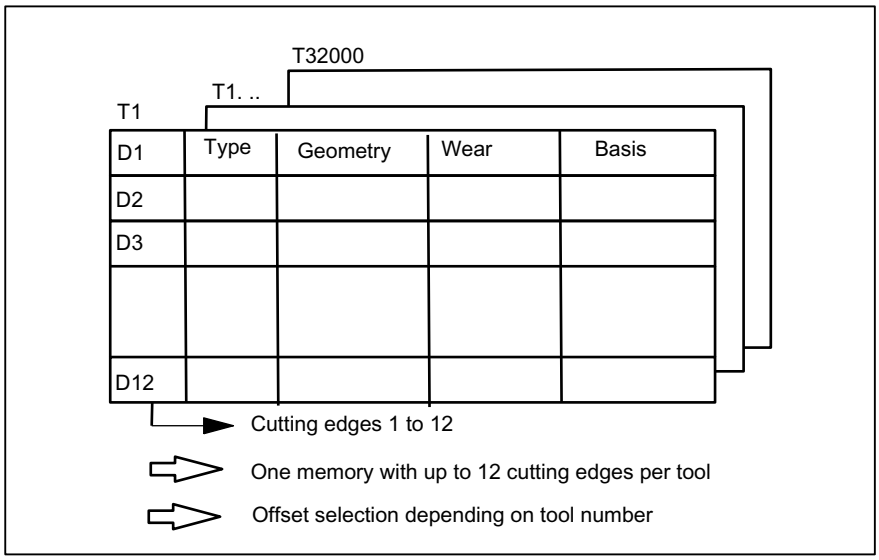



Figure 3-20 Structure of the tool offset memory

## 3.11.2 Absolute D No. without reference to the T number (flat D No.)

Independence between D number and T number can be selected as an alternative to relative D numbers in systems without tool management.

The reference of T number, cutting edge and offset by the D number is defined by the user.

The D numbers range from 1 to 32000. D0 is the offset deselection code.

**Note**

The T number is always output to the PLC with an extended address (= spindle or toolholder number) with this type of tool offset.

Universal system support is not available for this function.

(SINUMERIK Operate does not support the function)

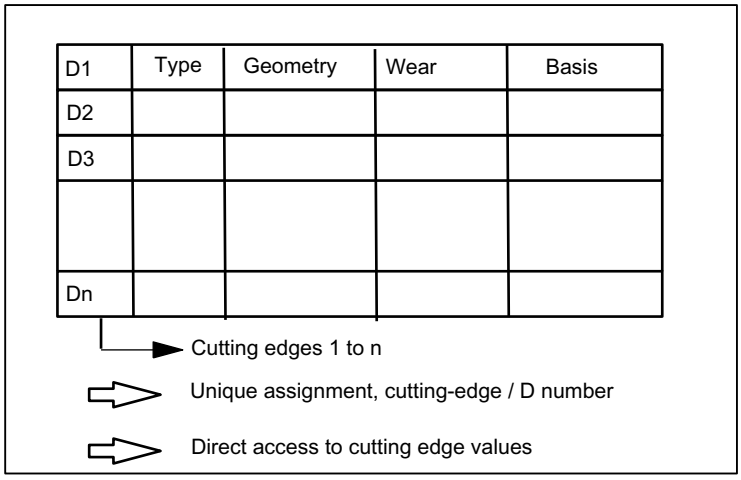



Figure 3-21 Structure of the tool offset memory

## 3.11.3 Free selection of D numbers for every T

D numbers can be freely assigned to tool edge numbers in systems with and without TM. A maximum of 12 cutting edges are possible for each tool "T". The upper limit for the D numbers used is limited by the machine data.

This assignment option is an extension of the process to relative D numbers.

With this setting ($MN_MM_MAX_CUTTING_EDGE_NO > $MN_MM_MAX_CUTTING_EDGE_PER_TOOL) additional program commands can be used that make a check for unambiguous assignment of D numbers to T numbers or identifiers possible. With this setting, the cutting edge number $TC_DPCE[T-No,D-No] is also created

The same D numbers shall be assigned in each case for the cutting edges for duplo tools (same identifiers).

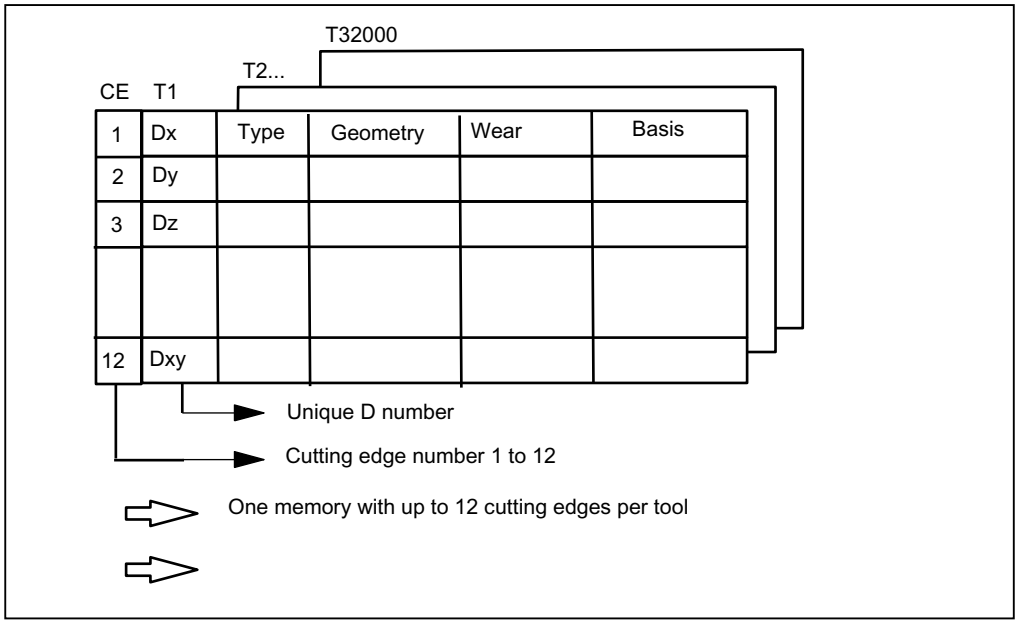



Figure 3-22 Structure of the tool offset memory

**Note**

Universal system support is not available for this function.

### Machine data for available (unique) assignment of D numbers

**$MN_MAX_CUTTING_EDGE_NO=** Maximum permissible D number

Example:

```
$MN_MAX_CUTTING_EDGE_NO=1               A maximum of 1 offset (D1) can be defined
                                        per tool.
$MN_MAX_CUTTING_EDGE_NO=9999            Tools can be assigned unique D numbers here
                                        as follows:
                                        T1 with D1, D2, D3
                                        T2 with D10, D20, D30
                                        T3 with D100, D200, D300
```

**$MN_MAX_CUTTING_EDGE_PER_TOOL=** Assignment of tool edges per tool

Example:

```
$MN_MAX_CUTTING_EDGE_PER_TOOL=1             Only tools used with 1 cutting edge
$MN_MAX_CUTTING_EDGE_PER_TOOL=12            Up to 12 cutting edges per tool.
```

### Check for uniqueness (CHKDNO)

The NC language command **CHKDNO** checks the D numbers assigned within the NCK for uniqueness. The D numbers of all tools defined within a TO unit may not occur more than once. No allowance is made for replacement tools.

### Check within the magazine (CHKDM)

Exactly like CHKNO, the NC language command **CHKDM** checks the D numbers assigned within the NCK for an activated tool management for uniqueness. This check function can be restricted to individual magazines.

### D number to T number (GETACTTD)

Using the NC language command **GETACTTD** if tool management is active, the T number in which the D number occurs can be searched for.

Precondition for this is that the D numbers have been uniquely assignment in the TO unit being considered.

## GETDNO, SETDNO when re-equipping

The NC language commands **GETDNO** and **SETDNO** permit reading and writing the offset number D for a specified cutting-edge number CE.

GETDNO (T, CE): Read the D number for the cutting edge CE of the tool T

SETDNO (T, CE, D): Set the D number for the cutting edge CE of the tool T

$TC_DPCE[T, D]=...: Assignment of tool edge number CE to offset number D

## Example:

Rename cutting edge CE=3 from D2 to **D17**

- With initial situation:

  Internal T number 1

  D number: 2

  Tool 1 cutting edge with:

  $TC_DP2[1, 2]=120 ;tool radius T1, D2: 120 mm

  $TC_DP3[1, 2]=5.5 ;tool radius T1, D2: 5.5 mm

  **$TC_DPCE**[1, 2]=3 ;cutting edge number T1, D2: 3

  (programming: T1,...D2)

- using variable definition:

  DEF INT DNoOld, DNoNew=17

  DnOld=**GETDNO** (1, 3) ;value 2 is read in DnOld

  **SETDNO** (1, 3, DNoNew) ;the new D no. is assigned to the cutting edge

- The new D value 17 is assigned to cutting edge CE=3

  $TC_DP2[1,**17**]=120

  $TC_DP3[1, **17**]=5.5

  **$TC_DPCE**[1, **17**]=3

## 3.11.4 Location-dependent offsets (additive offsets)

### Overview

Location-dependent offsets are a generalized form of wear. They are part of the cutting edge data. The parameters of the additive offset refer to the geometrical data of a cutting edge.

Location-dependent offset can in general be used, i.e. with active/inactive tool management; with flat D-number function.

To meet the requirements of special machine operating modes, the location-dependent offsets can be subdivided into the following categories by setting the appropriate machine data:

- Location-dependent offset, fine
- Location-dependent offsets, coarse = setting-up offset

The purpose of the setting-up offset is to allow the operator to set values prior to the machining operation. These values are stored in their own memory in the NCK, the operator can access the location-dependent fine offsets via the HMI. Location-dependent offsets "fine" and location-dependent offsets "coarse" are added NCK-internally and then act like the additive offset itself.

Several location-dependent offsets can be defined per D number. Machine data define the absolute number of location-dependent offsets, the maximum number of location-dependent offsets per cutting edge and specify which additive offsets are active after the end of program or when the Reset key is pressed.

Applicable only when tool management is active:

Machine data 18112 MM_KIND_OF SUMCOR can be set to define which additive offset must be operative if a tool is assigned the "active" status in the part program in the course of a programmed tool change:

- Additive offset values "fine" of the tool cutting edges remain unchanged or
- Additive offset values "fine" of the tool cutting edges are set to the value 0

The function is enabled by setting bit 8 = 1 in machine data $MN_MM_TOOL_MANAGEMENT_MASK.

### DL - programming the additive/setting-up offset

Programming the additive offset is always relative to the active D number and is executed using the command

DL ="n"

The additive offset with the relative number "n" with respect to the active D number is activated by this. This means that the additive offset "n" is added to the wear of the active D number.

The additive offset is deselected with the command

DL = 0

## Configuration of additive/setting-up offset

$MN_MM_KIND_OF_SUMCORR, bit 4=0

Corresponds to the default setting; only one data record of additive offset available per DL number. In this case, the term "additive offset" merely refers to the data represented by $TC_SCPx.

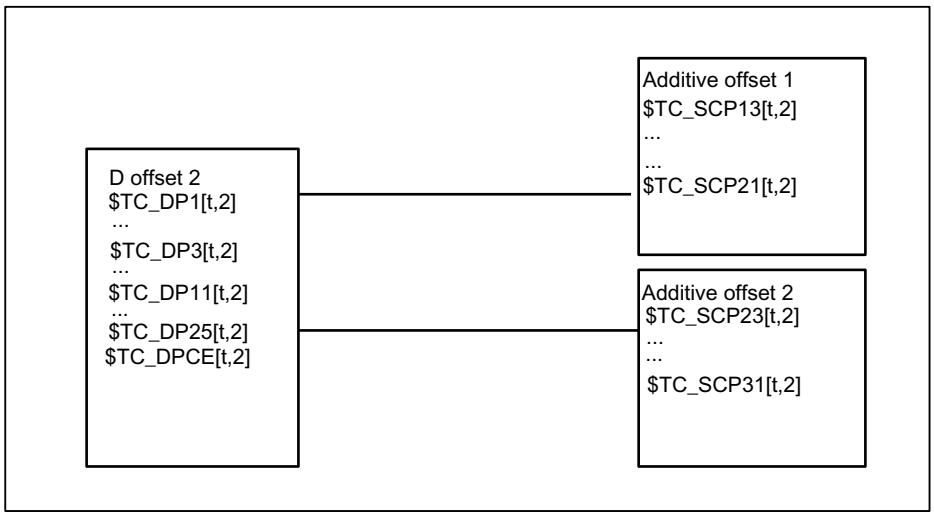



Figure 3-23 $MN_MM_KIND_OF_SUMCORR, bit 4=0

The data in the diagram are used when programming (the tool with T=t is active):

```
D2              ; Cutting edge offsets
                ; i.e. $TC_DP3,...$TC_DP11 + wear ($TC_DP12,...$DP29) + adapter
                ; dimensions
                  ...
DL=1            ; Additive offset 1 is added to the existing offsets of D2
                ; i.e. $TC_SCP13,...$TC_SCP21
                ;
                  ...
DL=2            ; Additive offset 1 is no longer added to offset D2, but to additive
                ; offset 2 instead
                ; i.e. $TC_SCP23,...$TC_SCP31
                  ...
DL=0            ; Deselection of additive offset; only the data of D2 are still
                ; effective
```

$MN_MM_KIND_OF_SUMCORR, bit 4=1

Setting-up offsets are available. The general term "additive offset" refers to a combination of the "fine" additive offsets, represented by $TC_SCPx, and the additive offset, represented by $TC_ECPx. There are two data records for one DL number. The additive offset equals the product of the corresponding components $TC_SCPx + $TC_ECPx.

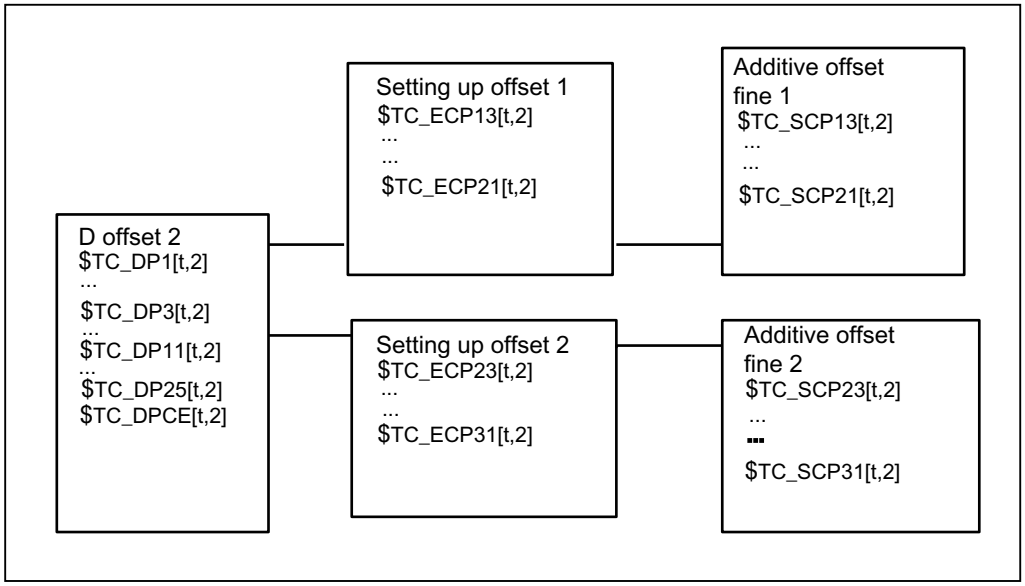



Figure 3-24 $MN_MM_KIND_OF_SUMCORR, bit 4=1

The data in the diagram are used when programming (the tool with T=t is active):

```
D2              ; Cutting edge offsets
                ; i.e. $TC_DP3,...$TC_DP11 + wear ($TC_DP12,...$DP29) + adapter
                ; dimensions
                  ...
DL=1            ; Additive offset 1 is added to the existing offsets of D2
                ; i.e. $TC_ECP13 + $TC_SCP13 ,...$TC_ECP21 + $TC_SCP21
                  ...
DL=2            ; Additive offset 1 is no longer added to offset D2, but to additive
                ; offset 2 instead
                ; i.e. $TC_ECP23 + $TC_SCP23,... $TC_ECP31 + $TC_SCP31
                  ...
DL=0            ; Deselection of additive offset; only the data of D2 are still
                ; effective
```

The new NC language command DELDL can be used to delete location-dependent offsets from cutting edges.

# 3.12 Adapter data

## 3.12.1 Overview

### Purpose

With the system variables **$TC_DP21, $TC_DP22** and **$TC_DP23**, the standard data record for the tool offset offers the option of entering the dimensions for an adapter (length1, length2 and length3).
This data is defined offset-specific.

If tool management is active the additional adapter data can also be assigned to specific magazine locations.

This function is used for adapters that are fixed to a magazine location for a long period and used by different types of tool.

In individual cases, it is also possible to use identical adapters on several magazine locations. To do this it makes sense to define and store the adapter data records separately from the magazine locations.

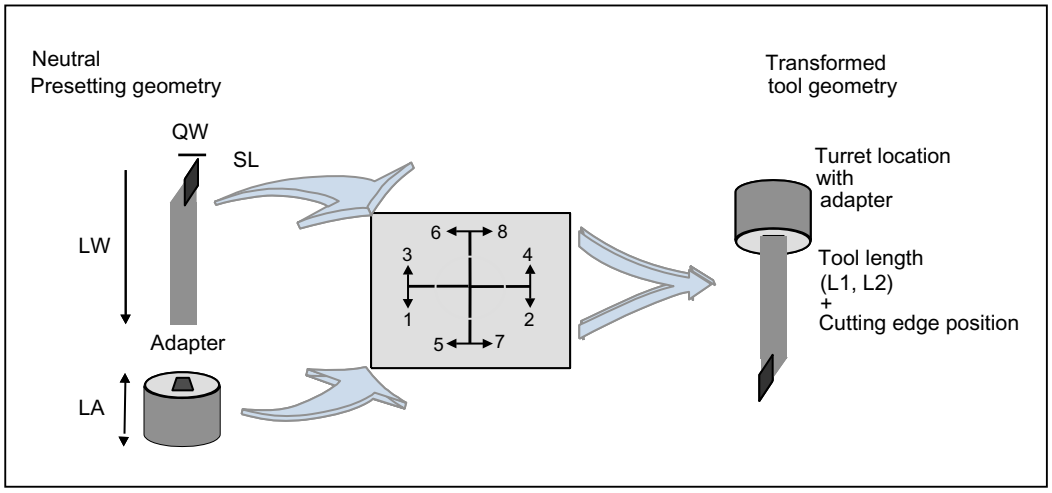



Figure 3-25 Adapter transformation

### Adapter transformation

Adapter data "adapter transformation" allows fixed orientation of the tool on the adapter or orientation of the adapter including its tool with reference to the machine.

This function can be used as an alternative to the previous one. If adapter data are used, system variables $TC_DP21, $TC_DP22 and $TC_DP23 have a different reference and are therefore only formally part of the cutting edge data record in the NCK.

## 3.12.2 Description of function

The adapter data function must be enabled via machine data (MD18104: MN_MM_NUM_TOOL_ADAPTER).

In order to activate the setting, bit 7 must be set in MD18080 MM_TOOL_MANAGEMENT_MASK.

### Definitions

The machine data can be used to set two definition types of adapter data:

- One adapter data record is assigned to each magazine location as standard.
- Adapter data records can be defined independently of magazine locations. The magazine locations are then assigned as an additional step.

The magazine location is the reference point for adapter **and** tool. Both are assigned to the magazine location.

The following elements are implemented when programming D numbers in the part program:

- The offset must be assigned to a real tool.
- The tool is assigned to a magazine location.
- It is possible to assign an adapter to the magazine location, for which a transformation (orientation) of the tool it contains can be defined.

Thus, the working offset can be clearly computed and the tool path accordingly adjusted.

If an additive offset is programmed, then the value for this refers to the active D compensation.

## 3.12.3 Activation

### Preconditions

- In order to be able to use magazine location oriented adapter data, machine data **MD18104 MM_NUM_TOOL_ADAPTER** must have a value that is not equal to zero.
- Adapter data records must be defined.
- If the values of the machine data are > 0 ,the adapters must be linked to the magazine locations or assigned to them (can be automated via the HMI or using a cycle).

As a result, the adapter data including the defined transformations are always taken into account for the tool located on the magazine location in question. The work offset is calculated including the transformation and the adapter data.

The offset data can then be displayed as follows:

- Geometrical data for the tool (system variable $TC_DP3,...DP11); designated as neutral default geometry
- Non-transformed working offset (sum of the values from tool geometry, wear, additive offset, tool base dimension or adapter)
- Non-transformed working offset (transformation of the sum of the values from tool geometry, wear, additive offset) and tool base dimension of the adapter).

The quantities to be transformed can be selected via machine data. The mode of transformation of the additive offset can be set.

## Magazine-location-related adapter data records

### Create new

MM_NUM_TOOL_ADAPTER = -1:

One magazine location and one adapter data record are created. The specified values are put into the adapter data record which is automatically linked to the magazine location.

It is not possible to create a new free adapter at this point. The adapter numbers are assigned automatically (1 ... max. number of available magazine locations).

### Delete

If an adapter data record is linked to a magazine location (MM_NUM_TOOL_ADAPTER = -1), it cannot be deleted.

## Free adapter data records

### Create new

MM_NUM_TOOL_ADAPTER > 0:

The adapter data can be created freely. Adapter data can be created by the user with a write operation to a non-existent data record.

**$TC_ADPTi[n] = value;**i = T, 1 2, 3, ..., n (number of the adapter)

If data record n does not yet exist and the maximum number of adapter data records that have already been defined is less than the value of MD18104 **MM_NUM_TOOL_ADAPTER**, the adapter data record is newly created and assigned specific values.

The value "value" is assigned to parameter i. The following applies, 0 < n ≤ 3 2000. Index value 0 is reserved.

---

### Note

The adapters must be assigned explicitly to the magazine locations for MM_NUM_TOOL_ADAPTER > 0. The function "adapter" is permanently linked to the "circular" magazine type. The adapter calculation is not supported with the magazines types "chain" and "box type magazine".

---

**Delete**

If, MD18104 MM_NUM_TOOL_ADAPTER has the value > 0, then the adapter data can be deleted as required provided it is not assigned to a magazine location.

$TC_ADPTT[n] = -1

Adapter data record n is deleted and the memory becomes free again.

**Deleting an assigned adapter data record:**

The assignment to the magazine location must be undone first. You can only do this if the magazine location is empty. An alarm is issued if deletion fails.

Please proceed as follows:

- Remove the tool from the magazine location

  (unload, relocate).
- Remove the adapter from the magazine location.
- Delete the adapter data record (with $TC_ADPTTi[n] = -1).

Adapter data record n is deleted and the memory becomes free again.

## Deleting all adapter data records

For **MM_NUM_TOOL_ADAPTER > 0**, you can delete the adapter data if it is not assigned to a magazine location:

$TC_ADPTT[0] = -1

All non-assigned adapter data of the TO units are deleted. If you want to delete assigned adapters, you must first undo the assignment of those adapters to magazine locations. An alarm is issued if deletion fails.

## Read/write adapter parameters

You can modify adapter data whenever you want to even if that adapter is assigned to a magazine location and/or a tool is located in the magazine location with the adapter.

## Magazine location assignment/release

For **MM_NUM_TOOL_ADAPTER > 0**, an adapter record must be assigned to a magazine location explicitly:

$TC_MPP7[m,p] = "adapter No."

Adapter number "adapter No." is assigned to magazine location p of magazine m. With "adapterno." = 0 any previous assignment is removed.

**Note**

An assignment can only be established or released if no tool is assigned to the magazine location.

## Example of an adapter transformation

A turning tool with lengths L and Q is described below.

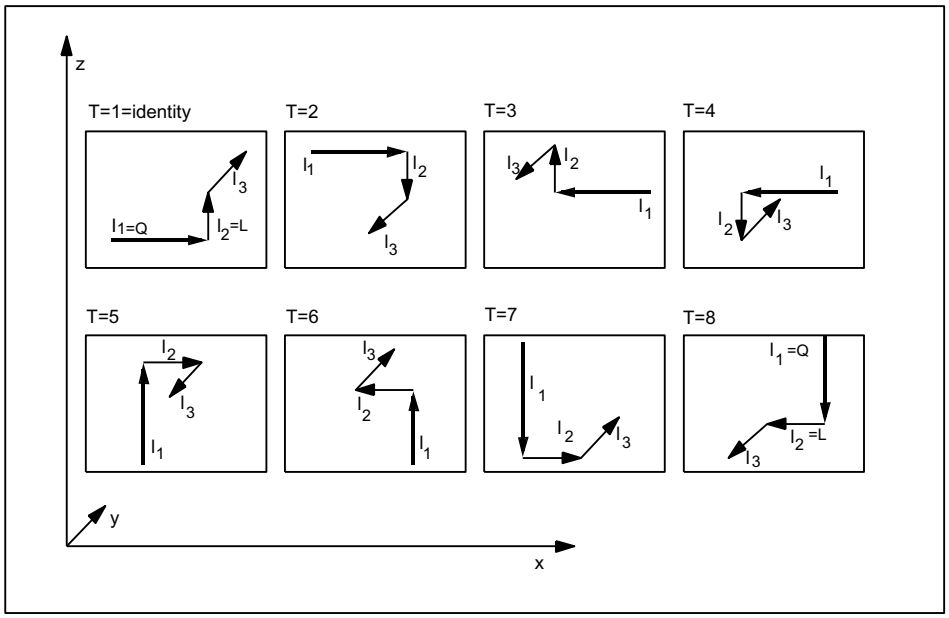



Figure 3-26 The 8 defined transformations (T = 1...8) for the adapter with G 18 and for a turning tool. The assignments of tool lengths I1, I2, I3 are shown on the geometry axes x, y, z.

Transformations for numbers 1 to 8 are defined. Number 1 is the identity: no transformation of input data.

Other transformations can be implemented. The available transformations are designed initially for turning tools. These are typically defined by **Q=$I_1$=$TC_DP3** and **L=$I_2$=$TC_DP4**.

The transformation numbers correspond to the transformations shown in the table. In general:

**Length1$_t$, length2$_t$, length3$_t$ = f(length1, length2, length3) = f($l_1$,$l_2$,$l_3$) = f(Q,L,$l_3$)**

| Transformation number | GEO | | | |
|---|---|---|---|---|
| | X | Y | Z | Turning tool with G18 transformation |
| 1 | +L1 | +L3 | +L2 | - |
| 2 | +L1 | -L3 | -L2 | ROT X 180 |
| 3 | -L1 | -L3 | +L2 | ROT Z 180 |
| 4 | -L1 | +L3 | -L2 | ROT X 180 Z 180 |
| 5 | +L2 | -L3 | +L1 | ROT Y 90 Z 180 |
| 6 | -L2 | +L3 | +L1 | ROT Y -90 |
| 7 | +L2 | +L3 | -L1 | ROT Y 90 |
| 8 | -L2 | -L3 | -L1 | ROT Y -90 Z 180 |

L1, L2 and L3 are working offsets of the tool prior to transformation with or without adapter (depending on machine data settings). They are assigned to the geometry axes during compensation.

**Note**

In turning, L and Q are also used to describe a tool. In the above table, $l_1$ corresponds, for example, to variable Q (or x direction) and $l_2$ to variable L (or z direction), assuming the plane G18 is selected (default setting for turning machines).

As standard, activation of an offset is calculated as follows:

**Offset = D offset + $x_i$**(e.g. wear, additive offset)

| | |
|---|---|
| Length1 | \$TC_DP3 + $x_i$ |
| Length2 | \$TC_DP4 + $x_{i+1}$ |
| Length3 | \$TC_DP5 + $x_{i+2}$ |
| Length4 | \$TC_DP6 + $x_{i+3}$ |

The adapter transformation then acts on the transformed tool offset values and is added to the transformed offset values.

The transformation number of the adapter causes a transformation of the tool (the cutting edges) located in this adapter (orientation according to the transformation number).

**Working offset = f(offset) + adapter dimensions of the magazine location**

| | |
|---|---|
| aLength1 | Länge$1_t$ + $TC_ADPT1 |
| aLength2 | Length$2_t$+ $TC_ADPT2 |
| aLength3 | Length$3_t$ + $TC_ADPT3 |
| ARadius1 | Radius1 |

Depending on the programmed plane selection G17, G18, G19, these values are added to the geometry axes.

## G17, G18, G19 - plane selection (declarations)

The following agreements (different for machining and milling tools) apply for assigning tool-length parameters of the tools to the geometry axes:

| Machining plane | System variables for tool length description | | |
|---|---|---|---|
| | $TC_DP3($I_1$) | $TC_DP4($I_2$) | $TC_DP5($I_3$) |
| G17 Milling | Z | Y | X |
| Turning | Y | X | Z |
| **G18** Milling | Y | X | Z |
| **Turning** | **X** | **Z** | **Y** |
| G19 Milling | X | Z | Y |
| Turning | Z | Y | X |

## Transformation of cutting edge position

The cutting edge position described by system variable $TC_DP2 is also transformed.

Transformations for the cutting edge position are performed as shown in the table below:

| Transformation number | Cutting edge position | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| 1 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 2 | 2 | 1 | 4 | 3 | 7 | 6 | 5 | 8 | 9 |
| 3 | 4 | 3 | 2 | 1 | 5 | 8 | 7 | 6 | 9 |
| 4 | 3 | 4 | 1 | 2 | 7 | 8 | 5 | 6 | 9 |
| 5 | 1 | 4 | 3 | 2 | 6 | 5 | 8 | 7 | 9 |
| 6 | 4 | 1 | 2 | 3 | 8 | 5 | 6 | 7 | 9 |
| 7 | 2 | 3 | 4 | 1 | 6 | 7 | 8 | 5 | 9 |
| 8 | 3 | 2 | 1 | 4 | 8 | 7 | 6 | 5 | 9 |

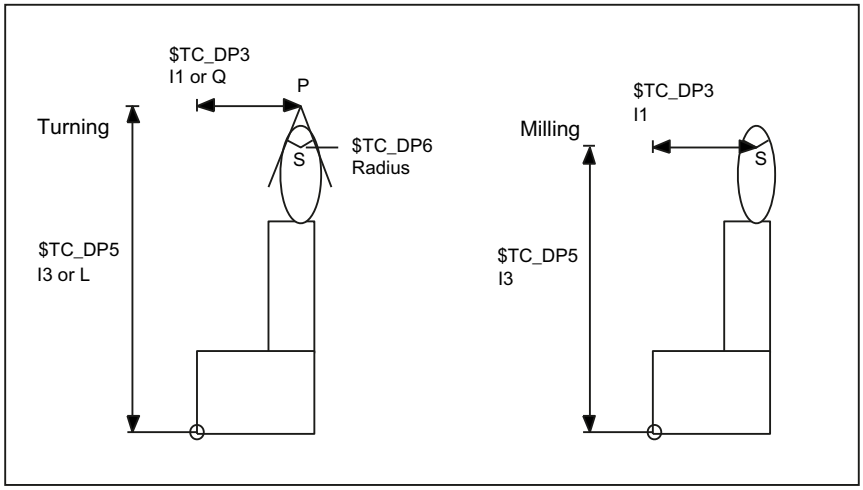



Figure 3-27 Turning and milling tools - relationship between cutting edge position and radius compensation

Turning tool geometries ($I_1$, $I_3$ or L, Q) are described in terms of P, the point of approach at the workpiece. However, the center point of cutting edge S with reference to the tool nose radius must be known for radius compensation.

This center point can only be accurately calculated if the cutting edge position is known. Point S can then be derived from point P.

The position of the tool to the workpiece coordinate system is defined using the cutting edge position (values 1 ... 8). Cutting edge position 9 corresponds to S = P.

**Note**

The cutting edge position is only used for turning tools because their geometry is described with reference to P and not with reference to S as is the case for milling tools.

## Adapter transformation for tools with three length components

The transformations defined here constitute a subset of all conceivable transformations. Only certain discrete values are considered here - in particular those that meet the requirements for turning tools (2 length components only).

## System variables $TC_DP21 ... 23 and $TC_ADPT

If the function "Adapter" is active, then there are no further cutting-edge specific data for the "Base adapter dimension".

In order to keep cycles that operate with adapter data compatible, the following rules apply:

If a tool is at a magazine location with an adapter and the adapter data can be accessed by system variable $TC_DP21...23, then the adapter parameters of the location can be read and written.

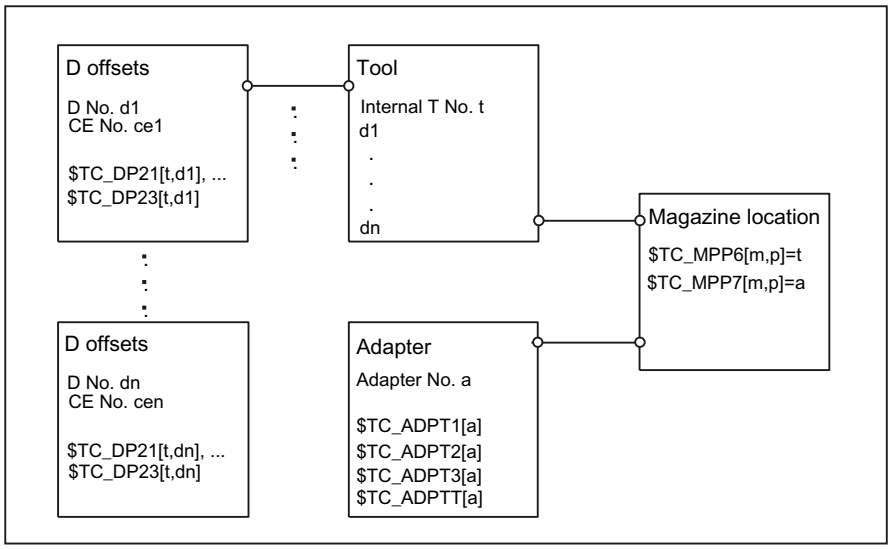



Figure 3-28 Fig. 3-30 $TC_DP21, ...23 - Contents for an active "Adapter" function

Specifications:

- Tool t
- Magazine location p
- Magazine m
- Adapter a
- Tool with D offsets $d_1$, ... $d_n$

The adapter is assigned to the magazine location. If, for example, system variable $TC_DP21[t,$d_1$] is read or written in the part program, the programming accesses system variable $TC_ADPT1[a] of the adapter, i.e. the same machine data is accessed for all $d_1$, ... $d_n$.

If the assignment of the tool to the magazine location is released or the adapter is removed from the magazine location, no more data can be assigned to the parameters. A read operation returns the value 0, a write operation does not change the data (nor does it generate an alarm).

## Transformed and non-transformed offset values

The values included in the path offset are usually the transformed work offsets.

It can generally be said that the data that describe a tool are subject to transformation. The transformation of the adapter is communicated to the tool (orientation in which it is positioned in the adapter). The adapter data itself is not transformed.

## Data transfer to the NCK

You need to declare how the data is transferred to the NCK.

- You can transfer the data via the part program by programming the system variable $TC_...

  The parameters are defined as non-transformed values.

- The transfer can take place via the OPI interface using the variable services. In this case, the data can be transferred either as transformed or non-transformed values.

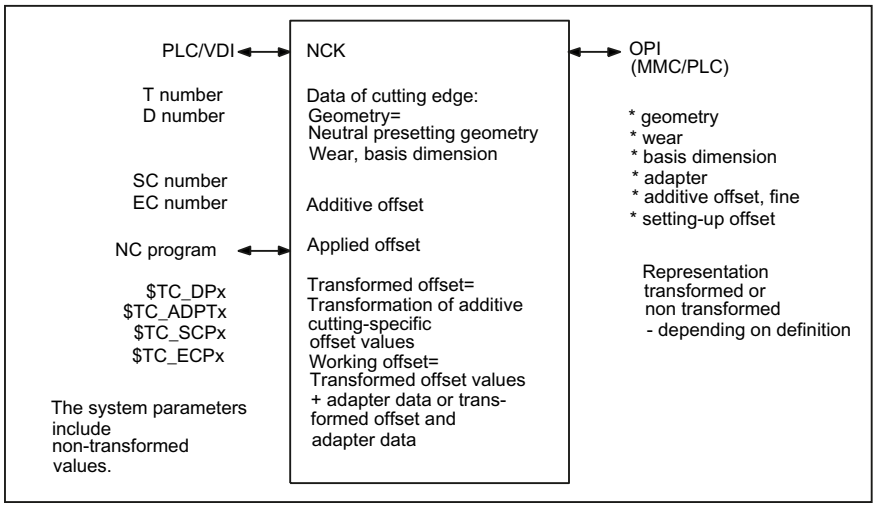



Figure 3-29 Geometry of a tool edge and applied offsets

## Boundary conditions

When using the function (magazine-location-oriented) "adapter data" the user must ensure that the old data records of all the data records with edge-specific adapter data are adapted to the requirements of the new function.

However, using the described edge-specific adapter parameter definition (system variables $TC_DP21,...23), it is possible that all old data is converted to the adapter data function by the NCK.

The function "Adapter data" excludes the existence of the cutting-edge specific data "base / adapter dimension".

The function "adapter data" is better suited to the applications of an adapter because it defines the adapter as part of the magazine location and not as part of the tool or cutting edge.

## Examples for assigning adapter data

### Example 1

Specifications:

- MM_NUM_TOOL_ADAPTER = -1
- MM_NUM_MAGAZIN_LOCATION = 20
- One chain with 16 locations, magazine number = 1
- Two grippers
- One spindle
- One loading and unloading point
- Assignment

When creating the 20 locations in all, 20 adapters should be assigned, i.e. exactly one adapter assigned to each location.

**Note**

It does not matter if the real locations are not actually fitted with an adapter. Preassigned adapter locations have no effect on the offset. When equipping a location with a real adapter make sure that the appropriate values are assigned to the adapter data.

The transformation number of the adapter in location 3 of the chain magazine (No. 1) is to be changed to the new value 8:

| | | |
|---|---|---|
| $TC_ADPTT[$TC_MPP7[1,3]] = 8 | ;<br>; | $TC_MPP7 contains the number of the adapter at the new magazine location |

Once adapter data records have been automatically generated and assigned, operations such as undoing an assignment, renewed definition of an assignment and deletion of an adapter data record are possible.

### Example 2

Specifications:

- MM_NUM_TOOL_ADAPTER = 4
- MM_NUM_MAGAZIN_LOCATION = 20
- One chain with 16 locations
- Two grippers
- One spindle
- One loading and unloading point

There are 4 different adapter geometries in this case. Adapters must be configured for the chain only.

Assignment

These locations (20 in total) are initially created without adapters. Locations 1 to 4 of the chain are equipped with adapters of the same geometry (here adapter 1). 4 chain locations are to be equipped with adapters with the same geometry.

First, you must define the 4 adapter data records. Now you assign them:

| | |
|---|---|
| $TC_MPP7[1,1] = 1 | $TC_MPP7[1,13] = 4 |
| $TC_MPP7[1,2] = 1 | $TC_MPP7[1,14] = 4 |
| $TC_MPP7[1,3] = 1 | $TC_MPP7[1,15] = 4 |
| $TC_MPP7[1,4] = 1 | $TC_MPP7[1,16] = 4 |
| .... | |

In this way you can assign one adapter data record to several magazine locations.

**Note**

If you want to delete an adapter data record with a multiple assignment you must make sure that you first undo all the adapter assignments.

## 3.12.4 Transformed data of the active tool $P_ADT[n]

A new system variable is introduced that reads the offset parameters of the active tool offset transformed according to the tool adapter $TC_DP1,... etc. Refer here to the system variable $P_AD that reads the non-transformed parameters.

$P_AD and $P_ADT have the same meaning without the function "Tool adapter" - as sub-function of the function TMMG. In other words the system variable application is only meaningful within the scope of the TMMG function.

With active function "Tool adapter", the $P_ADT provides when reading the offset parameters, transformed values of those parameters that are subject to the tool-adapter transformation in the event that the active tool is on a tool adapter at the point in time the parameters are read. The parameters not subjected to the transformation still provide the same values during reading as $P_AD.

When writing, the transformed parameter values subject to the tool-adapter transformation are accordingly transformed back by the NCK and are subsequently saved in a non-transformed form in the NCK. Non-transformed values are still written with $P_AD.

## 3.13 Power failure while tool command is in progress

If a power failure occurs during an action requested by tool management, defined strategies are executed by the PLC or special part programs, in order to establish a defined and consistent status on the machine and the tool management system. These strategies are machine-specific. SINUMERIK control systems thereby support the following measures:

### Buffered data

All tools, magazine data as well as all magazine assignments are buffered.

### Data initialized for control "Power On"

The following data is set to zero:

- Tool status "Tool change in progress"
- Magazine status "Motion is active"
- Magazine location status "Reserved for tool to be loaded"
- The PI-command status with respect to magazine operations like e.g. "Motion is active".
- The tool status selected for 1:1 exchange

### Task of the manufacturer's configuration

The PLC must send the last unacknowledged FC 7 or FC 8/FC 6 prior to power failure (READY did not change to TRUE before power off) back to the NC when the power supply is restored. The function "Asynchronous transfer" is used for tool transfer in FC 8/FC 6.

Without receiving the request from the tool management system, the PLC initiates a relocation of tool data from one location to another. For example, relocation of tool data from gripper to magazine if the tool needed to be returned manually to the magazine when the tool change operation was aborted.

Changes in position of the tools involved must be communicated via FC 8. The NC then updates the data for this tool in the tool management.

Further strategies may be necessary, e.g. if a tool change was interrupted. Tools stored in the buffer must be returned to the magazine for this purpose.

# 3.14 PLC description

## 3.14.1 Interfaces

### Overview

The interfaces in the PLC consist of data blocks that are updated by the basic program. Tasks such as load tool or prepare tool change are stored in the data blocks with the source and target for the particular tool. For the interfaces for spindle or turret, in addition to the tool numbers (internal number, which is assigned by the NCK when loading), tool size and tool status are transferred.

If the position of the tool changes (e.g. from magazine to gripper...), the new positions must be transferred to the tool management on the NCK. Three function blocks **FC 6** (TM_TRANS2), **FC 7** (TM_REV) and **FC 8** (TM_TRANS) are provided for this purpose. The PLC programmer can call these blocks and supply them with the required parameters.

If a magazine or a turret is not driven by an auxiliary axis, the shortest direction of rotation can be calculated with **FC 22** (TM_DIR) and the positioning time optimized. FC 18 is available if positioning is performed using an auxiliary axis of the 840D sl.

### Commissioning tool management

The precondition for commissioning the PLC is that the NC commissioning has been completed. The machine data must be correctly and completely set and the magazine configuration loaded. The basic program sets-up the user interface (DB 71 ... DB 73) as well as the internal data block (DB 74) when it boots. Information about this, which magazine, number of loading points, ... is located in DB 4.

If tool management is configured using HMI-Advanced, the entry in the DB is made using the softkey "create PLC data"; DB 4 can also be "manually" supplied. (Structure of the data blocks, refer to Chapter 7.6)

**Note**

If data blocks DB71...DB74 are already available, then the basic program first automatically deletes them, and then the new DB is set-up.

The data blocks DB 1071 - DB 1073 are automatically set-up by the basic program for the multitool. This means that the blocks are also set-up, if the "Multitool" function has not been set using the appropriate machine data.

## Overview of data blocks

| Block number | Length in byte | Meaning |
|---|---|---|
| DB 71 | 4 + 30 bytes * B | Interface for loading/unloading points |
| DB 72 | 4 + 48 bytes * W | Interface for spindle as change position |
| DB 73 | 4 + 44 bytes * R | Interface for tool turrets as change position |
| DB 1071 | 20 byte * B | Extended data for the multitool |
| DB 1072 | 50 byte * W | Extended data for the multitool |
| DB 1073 | 50 byte * R | Extended data for the multitool |
| DB 74 | Length depends on configuration | Internal data block for tool management |

B = number of loading locations

W= Number of spindles as change positions

R= Number of turrets

DB 71 to DB 74 occupy approximately 550 bytes for simple configurations of magazines, buffers and loading/unloading points.

There is one interface (data record) per data block for each loading/unloading point, spindle and turret. The data blocks are assigned to the respective tasks.

## DB 71

DB71 assumes the functions of loading and unloading, positioning and relocating. The relocating and positioning functions (no matter from which NC channel) are generally mapped on the 1st interface.

## DB 72

DB 72 is the interface for changing tools into the spindle. This change procedure also includes preparation of the tool. (Setting: $MC_TOOL_CHANGE_MODE=1)

## DB 73

DB 73 is the interface for tool changes with a circular magazine. (Setting: $MC_TOOL_CHANGE_MODE=0)

## DB 1071

Extended data for the multitool
Loading/unloading, relocating and positioning. The structure is analog to DB 71.

## DB 1072

Extended data for the multitool
T preparation and M06. The structure is analog to DB 72.

## DB 1073

Extended data for the multitool
Change with T command. The structure is analog to DB 73.

## DB 74

Data block DB 74 is an internal tool management data block used for communication control. You must not write to this data block.

For all the interfaces listed here, source and target positions are available for the tools associated with the machining operation.

FB 15 is called in the basic program for communication between the NCK and the PLC when tool management is active. This block informs the user interfaces (DB 71 to DB 73) if a tool management function is activated via the part program or operator input.

## Interfaces within DB 71 to DB 73

A bit field for the active and passive status of each interface is contained in bytes 0 and 1 of each of the data blocks (DB 71 to DB 73). DBX 0.0 represents the first interface, DBX 0.1 the second, etc. A total of 16 interfaces can be addressed. If one of these bits is set to the value = 1 by the tool management, the associated interface is activated. If set to 0, the interface may not be processed by the user.

Principle of interfaces DB 71-73

| No. 8 | No. 7 | No. 6 | No. 5 | No. 4 | No. 3 | No. 2 | No. 1 |
|---|---|---|---|---|---|---|---|
| No. 16 | No. 15 | No. 14 | No. 13 | No. 12 | No. 11 | No. 10 | No. 9 |
| 1st interface | | | | | | | |
| 2nd interface | | | | | | | |
| ..... | | | | | | | |
| 14th interface | | | | | | | |
| 15th interface | | | | | | | |
| 16th interface | | | | | | | |

If the value = 1, the user must evaluate the commands at this interface and initiate the necessary actions (e.g. position magazines, change tools, etc.). After activation, user programmers can also write access this interface (e.g. in order to delete the "prepare change" bit). Communication with the tool management is realized exclusively via FC8, FC7 or FC6, not via DB 71, 72, 73, .. (the fast acknowledgement is the only exception). For each change to tool positions and/or status information from an interface request, FC 8/FC 6 should be called with these modified values.

## Jobs from NCK tool management

| Jobs | Interface | Acknowledgment | Applications, special features |
|---|---|---|---|
| Loading | DB 71 | FC 8/FC 6, TaskIdent = 1, TaskIdentNo = interface No. | NewToolPlace = target destination of the tool<br>NewToolMag = target magazine<br>OldToolPlace = No. of the loading or unloading point<br>OldToolMag = 9999<br>or:<br>OldToolMag/OldToolPlace = 0<br>Status = 1 |
| Unloading | DB 71 | FC 8/FC 6, TaskIdent = 1, TaskIdentNo = interface No. | NewToolPlace = No. of the loading or unloading point<br>NewToolMag = 9999<br>OldToolPlace = Location of the tool to be unloaded.<br>OldToolMag = Magazine No. of the tool to be unloaded (real or also buffer magazine)<br>or: OldToolMag/OldToolPlace = 0, status = 1 |
| Relocating | DB 71 | FC 8/FC 6, TaskIdent = 1, TaskIdentNo = 1 | NewToolPlace = target position of the tool<br>NewToolMag = target magazine<br>OldToolPlace source location<br>OldToolMag = source magazine<br>Status = 1 |
| Positioning | DB 71 | FC 8/FC 6, TaskIdent = 1, TaskIdentNo = interface No. | Positioning at the loading magazine corresponding to the interface number - any positioning, always via interface 1<br>NewToolPlace = LMG or BL<br>NewToolMag = 9999 or 9998<br>OldToolPlace = magazine location to be positioned<br>OldToolMag = magazine to be positioned<br>Status = 5 |
| | | | |
| Prepare change for tool in spindle | DB 72 | FC 8/FC 6, TaskIdent = 2, TaskIdentNo = interface No. | Positioning NewTL to change position, OldTL remains in spindle to complete status 1, in order that the change command can be output.<br>OldToolPlace = BL(spindle)<br>NewToolPlace = NewTL location |
| Change in spindle | DB 72 | FC 8/FC 6, TaskIdent = 2, TaskIdentNo = interface No. | OldTL is unloaded (gripper or directly into magazine), NewTL is loaded to spindle. Status 1 required, so that part program processing is continued.<br>NewToolPlace = BL (spindle)<br>OldToolPlace = OldTL location |

| Jobs | Interface | Acknowledgment | Applications, special features |
|---|---|---|---|
| Without NCK<br>Command: Return OldTL to magazine | | FC 8/FC 6, TaskIdent = 4, TaskIdentNo = channel | The OldTL may need to be transferred asynchronously to the location specified in the prepare change command to move the tool from the gripper to the magazine. |
| | | | |
| Change with turret | DB 73 | Normally FC 7 or FC 8/FC 6, TaskIdent = 3, TaskIdentNo = turret No. | When turret has finished swiveling, FC 7 is called with turret No. As parameter ChgdRevNo. |

LMG: Loading point
BL: Buffer location
TL: Tool
NewToolPlace: FC 8/FC 6 parameter NewToolMag, NewToolLoc
OldToolPlace: FC 8/FC 6 parameter OldToolMag, OldToolLoc

## Position changes of tools without job from NCK

| Jobs | Acknowledgment | Applications, special features |
|---|---|---|
| Asynchronous transfer | FC 8/FC 6, TaskIdent = 4,<br>TaskIdentNo = channel No.<br>Status = 1 | General tool transport from the PLC<br>NewToolMag/NewToolLoc = target<br>OldToolMag/OldToolLoc = source |
| Asynchronous transfer with location reservation for tool transport from a real magazine into the buffer | FC 8/FC 6, TaskIdent = 5,<br>TaskIdentNo = channel No.<br>Status = 1 | Tool transport from PLC<br>NewToolMag/NewToolLoc = buffer<br>OldToolMag/OldToolLoc = source in the real magazine |
| Asynchronous transfer without tool movement to align the magazine position | FC 8/FC 6, TaskIdent = 4<br>TaskIdentNo = channel No.<br>Status = 5 | Communicates the actual magazine position (e.g. after turret cycles) to the NCK<br>NewToolMag/NewToolLoc = actual location<br>OldToolMag/OldToolLoc = change or loading point |

## Further interfaces in the channel interfaces for the ToolMan function

| | |
|---|---|
| DBD 348 | T number for tool pre-alarm limit |
| DBD 352 | T number for tool limit value |
| DBD 356 | T number of the new replacement tool |
| DBD 360 | T number of the last replacement tool |

Change bits in DBB 344

The information can be evaluated within one OB 1 cycle on the basis of a change bit. The PLC can use this information to derive appropriate measures.

**Note**

The last replacement tool monitoring must be set in machine data $MC_TOOL_MANAGEMENT_MASK.

Other signals are as follows:

| | Channel DB | |
|---|---|---|
| Tool missing | DBX317.7 | From NCK |
| Do not disable tool (ignore disabled state) | DBX29.7 | to NCK |
| Deactivate wear monitoring | DBX29.6 | to NCK |
| Deactivate workpiece counter | DBX29.5 | to NCK |
| Activate time monitoring by PLC<br>The function must be set in machine data $MC_TOOL_MANAGEMENT_MASK | DBX1.3 | to NCK |

## Additional interfaces in the NCK interface (DB 10) for the ToolMan function

| | |
|---|---|
| DB10.DBX105.0 | Interrupt all tool commands in the NCK<br>The signal is intended for commissioning. While the negative acknowledgement (status 3) specifically interrupts a command, with DB10.DBX105.0, all NCK commands are interrupted, i.e. in all channels. |

## 3.14.2 Definitions of acknowledgement status

### Magazine identifier

*Real magazines*

The number range from 1 ...9997 is available for the real magazine, defined when generating the magazine configuration (the numbering must not be ascending).

*Buffer magazine*

The buffer magazine always has the number 9998. The number of locations in the buffer magazine is defined using the magazine configuration. The locations with the "spindle/toolholder" identifier correspond to an interface

*Loading magazine*

The loading magazine generally has the number 9999. A magazine location corresponds to a loading point (defined when generating the magazine configuration), every loading point corresponds to an interface (loading point 1 = interface 1 etc.). Loading point 1 has a special significance. Every relocation operation, unloading and loading a manual tool and manual loading, unloading is generally managed via this as basis.

*Status value 1 - 10*

The status information 1 to 10 (current upper limit 10) leads to the command being terminated. As a consequence, the "active bit" of the interface is reset to 0 and the operation is completed.

*Status value > 100*

When acknowledging this status information (FC 8/FC 6), the "active" bit of the relevant interface remains at "1", indicating the need for further processing by the user program in the PLC (e.g. continuation of magazine positioning). This item of status information is generally used to transfer changes in position of one or both tools while the operation is still in progress.

## Synchronization

There are various methods by which the PLC and NCK can be synchronized. Synchronization is forced by machine data 20310 TOOL_MANAGEMENT_MASK using bits 5, 6, 7, 8 and 19. For internal communication between the PLC and NCK, the devices wait for an acknowledgement after each command. We distinguish between two types of acknowledgement:

- Transport acknowledgement

  The transport acknowledgement indicates to the NCK that the issued command has been accepted by the basic PLC program. Before a new command is output, the system checks whether the previous command was accepted. If this is not the case, no output is made. The NCK waits for the acknowledgement before a new command is output.

- End acknowledgement

  Status feedback signal of the PLC for an NCK command that has been accepted with acknowledgement status 1, 10 or acknowledgement status 3.

## Output of the command

Synchronization of the NCK and PLC is implemented in three steps:

- The interpolation task from NCK has prepared a command on the basis of the programming and outputs this to the NCK-internal image of the VDI interface.
- The NCK-internal image of the VDI interface is transferred in the same cycle to the VDI.
- The basic PLC program accepts the command from the VDI interface.

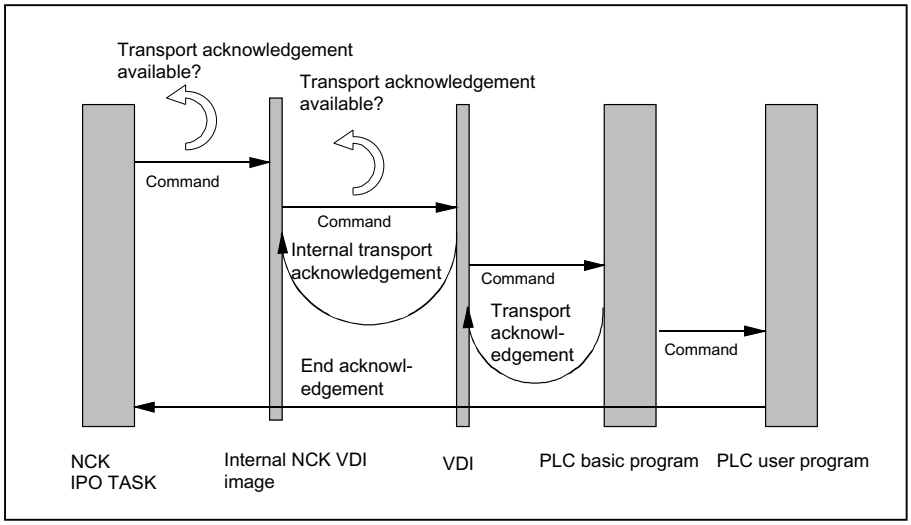



Figure 3-30 Transport and end acknowledgement

### Acknowledgement of output commands

Acknowledgements from the basic PLC program and from the VDI are returned while the command that has been output is being executed.

- The basic PLC program outputs the transport acknowledgement to the NCK once the command has been accepted.
- An internal transport acknowledgement is issued after the internal VDI image has been transmitted.

The PLC user program can only process one command at a time. It determines how long it takes until a command is processed. If the NCK provides the command faster than can be processed by the PLC user program, then the NCK is put into the waiting state.

The NCK can also output commands which do not originate from the part program over the interface. Included here are PI services that are synchronously superimposed over the part program processing.

### Completion of the command

Depending how bits 5-8 and 19 of the MD20310 TOOL_MANAGEMENT_MASK are set, the command output is considered to have been completed at various points in time.

- If bit 5 (or bit 6 for the secondary spindle) is set, the command output is completed when the internal transport acknowledgement and the transport acknowledgement are available. The command has been accepted by the basic PLC program.
- If bit 7 is set (or 8 for the secondary spindle), this means that the command output is only completed when the end acknowledgement is received from the PLC.
- If the bits are not set, then the output of the command is considered as being completed when the NCK has output the command to the NCK-internal VDI image. This is the default setting.

**Note**

From the viewpoint of the tool-change command, the block change can take place as soon as the NCK has output the command.

The set bit 19 in conjunction with set bits 5-8 permit a block change to be prevented as long as the extended acknowledgements are not present.

### Changing the acknowledgement data

When acknowledging a command from the NCK, the PLC can change the parameters of this command in the acknowledgement data.

The following sequence is implemented to allow acknowledged commands from the PLC to be assigned in the NCK:

- Using the ID number in the acknowledgement command (this is tracked by the basic program), the tool in the NCK is determined.
- The data of the current tool location are obtained from the tool.

- This current tool location is checked against the address specified in the command.
- If these data do not match, then after the acknowledgement data of the PLC have been checked, they are accepted in the NCK data management.
- Acknowledgement of the command in the NCK is continued.

**Note**

If the tool to be loaded at change is transported from the magazine to the toolholder in multiple individual steps, the PLC acknowledgement number 105 applies.

With the PI command _N_TMMVTL or the analog language command "MVTOOL", a tool in status "being changed" cannot be moved.

The following applies for loading, relocating, reloading and positioning: The PLC must not change the target positions specified by the NCK for the NewTool as they have to be identical with those in the NCK.

## Example 1

A tool is being prepared and already with the preparation is to be brought into gripper_1 (preparation). The change moves the new tool from gripper_1 to the spindle and moves the old tool into gripper_2. This therefore completes the change.

The NCK command looks like this:
Bring the new tool (T No.6) from magazine_3, location_6 to the spindle and the old tool from the spindle (9998/1) into magazine_3, location_11.

*ID:00000/00000-------- CMD:00002*

NewTool:
from M: 00003 P: 00006 **to M: 09998** P: **00001** TNo: 00006 Spindle: 00001

OldTool:
from M: 09998 P: 00001 **to M: 00003** P: **00011**

As a result of this change sequence, this job is not executed like this. When acknowledging, the PLC program must change the data shown in bold.

There are two options to do this:

Case_1
The PLC synchronously acknowledges the preparation command

*ID:00000/00001-------- ACK:00002 St: 00001*

NewTool:
from M: 00003 P: 00006 to M: 09998 P: 00002

OldTool:
from M: 09998 P: 00001 to M: 09998 P: 00001

Case_2
The PLC asynchronously transports the prepared tool to the gripper and now synchronously acknowledges the preparation command to the end.

*ID:00000/00001-------- ACK:00008 St: 00001*

NewTool:
from M: 00003 P: 00006 to M: 09998 P: 00002

OldTool:
from M: 00000 P: 00000 to M: 00000 P: 00000

*ID:00000/00002-------- ACK:00002 St: 00001*

NewTool:
from M: 09998 P: 00002 to M: 09998 P: 00002

OldTool:
from M: 09998 P: 00001 to M: 09998 P: 00001

In both cases, using the final acknowledgment, the NCK checks the tool data acknowledged by the PLC against the data in the command - and after an internal command assignment, corrects the command data, in order that additional acknowledgments are made with valid data (new tool located on 9998/2). The source file ("from") for the old tool and the new tool are managed by the basic program, a change is not possible.

## 3.14.3 Simplified acknowledgement of tool management commands

### Overview

Previously, it was only possible to acknowledge tool management commands via the user program using FC 8/FC 6 or FC 7. Now, for the standard acknowledgement with the end status per interface, there is a bit available within DB 71, DB 72, DB 73 which can be used to acknowledge the command using the cyclic basic program. For this purpose, acknowledgement bits are defined in DB 71, DB 72, DB 73 in DBW2, which the user program must set to acknowledge an active command for one PLC cycle. When the acknowledgement bit is set for the pending job, then end acknowledgements are generated.

The acknowledgement parameters used are described in the following table:

| Function | New tool | Old tool | Status |
|---|---|---|---|
| Loading | Target position (n+24, n+26) | 0 | 1 |
| Unloading | 0 | Specified loading point | 1 |
| Relocating | Target position (n+24, n+26) | 0 | 1 |
| Positioning | Target position (n+24, n+26) | 0 | 5 |
| Prepare change | Actual position or 0 | Actual position or 0 | 1 |
| Change | Target position (n+16, n+18) or 0 (for T0) | Target position (n+24, n+26) | 1 |
| Change with preparation | Target position (n+16, n+18) or 0 (for T0) | Target position (n+24, n+26) | 1 |
| Change with turret | Target position (n+16, n+18) or 0 (for T0) | Target position (n+24, n+26) | 1 |

If active commands with fault are to be acknowledged, this can also be realized using the acknowledgement bit in DBW2. In addition, for the particular job, in DBX(n+1.0) the value 1 must be connected in parallel to set the acknowledgement bit. The acknowledgement parameters are listed in the following table.

For DBX(n+1.0), n is the start address of the interface in the particular data block.

| Function | New tool | Old tool | Status |
|---|---|---|---|
| Loading | Current position | 0 | 3 |
| Unloading | 0 | Current position | 3 |
| Relocating | Current position | 0 | 3 |
| Positioning | Current position | 0 | 3 |
| Prepare change | Actual position or 0 (for T0) | Actual position or 0 | 3 |
| Change | Actual position or 0 (for T0) | Actual position or 0 | 3 |
| Change with preparation | Actual position or 0 (for T0) | Actual position or 0 | 3 |
| Change with turret | Actual position or 0 (for T0) | Actual position or 0 | 3 |

When processing an acknowledgement using the acknowledgement bits, the acknowledgement bit and also DBX(n+1.0) are automatically reset by the basic program.

**Note**

Before setting the acknowledgement bit, additional intermediate acknowledgements (with the status > 100), are realized from the user program via the FC 8/FC 6 (e.g. re-storing in the gripper).

## 3.14.4 Diagnostics for communication between NC and PLC

### General

The NCL-PLC communication can be logged in a file as part of the tool change procedure.

**Note**

The diagnostics data is saved with the reset or cancel key.

## Precondition

- Bit 13 of machine data MD20310 TOOL_MANAGEMENT_MASK must be set.
- The trace is a ring buffer (_NTCTRA'xx'MPF, with 'xx' = channel number 01, 02, ...). Free memory space must be available on the NC for saving the data. The number of files in the file system must be below the maximum number of files.
- The trace size can be set using the machine data $MN_TOOL_MANAGEMENT_TRACE_BUFFER_SZ[Index] = number of commands

  Index 0 = buffer size of the IPO trace (prepare, change commands and acknowledgements, asynchronous transfers).

  Index 1 = buffer size of the preparatory trace (commands and acknowledgements due to PI services).

  The Trace representation with index 0 also assumes the commands and acknowledgments due to PI services, the trace file with index 1 is then irrelevant.

## Example

Milling machine with a chain magazine, a spindle and double gripper (any tool is located on the spindle)

```
T="Miller_30mm"        - The tool remains at its location, after positioning the
                       magazine, the preparation is acknowledged with "end"
M06                    Step 1 (is acknowledged with Status_105)
                       - Old tool comes from the spindle into Gripper_1
                       - New tool comes from the magazine into Gripper_2
                       Step 2 (is acknowledged with Status_1 (end))
                       - New tool comes from the Gripper_2 into the spindle
                       - Old tool comes from the Gripper_1 into the magazine
```

The recorded trace (**TCTRA'xx'_MPF)**, looks like this:

ID:00002/00002 ---------- CMD:00002
NewTool: from M: 00003 P: 00006 to M: 09998 P: 00001 TNo: 00006 Spindle: 00001
OldTool: from M: 09998 P: 00001 to M: 00003 P: 00002

ID:00002/00003 ---------- ACK:00002 St: 00001
NewTool: from M: 00003 P: 00006 to M: 00003 P: 00006
OldTool: from M: 09998 P: 00001 to M: 09998 P: 00001

ID:00003/00003 ---------- CMD:00003
NewTool: from M: 00003 P: 00006 to M: 09998 P: 00001 TNo: 00006 Spindle: 00001
OldTool: from M: 09998 P: 00001 to M: 00003 P: 00002

ID:00003/00004 ---------- ACK:00003 St: 00105
NewTool: from: M: 00003 P: 00006 to M: 09998 P: 00003
OldTool: from M: 09998 P: 00001 to M: 09998 P: 00002

ID:00003/00005 ---------- ACK:00003 St: 00001
NewTool: from: M: 09998 P: 00003 to M: 09998 P: 00001
OldTool: from M: 09998 P: 00002 to M: 00003 P: 00002

**Explanation**

The ID number is used by the NCK to assign acknowledgements. The first number specifies the command ID of the output command. The second number specifies the command identification with which the PLC had acknowledged the command.

Definition of command identification: Every command via the tool management interface from the NCK to the PLC is allocated a unique identification number. PLC (the basic program, not the user program) acknowledges a command with this command number. This means that it is possible to assign the acknowledged command to the command that was output.

Every NCK command (CMD) has the following structure:

1. The command ID (this is incremented at each command output)
2. The command No. (CMD preparation, change, ...)
3. The transport for the tool to be loaded at change (from - to)
4. The internal T No. of the tool to be loaded at change
5. The No. of the requesting spindle or toolholder
6. The transport for the tool to be replaced (from - to)

Every PLC acknowledgement (ACK) has the following structure:

1. From the ID No. The ID of the NCK is returned + a PLC ID
2. The command No. (NCK sends a CMD:00002, PLC responds with an ACK:00002)
3. The acknowledgement status (refer to FC 8/FC 6 description)
4. The transport for the tool to be loaded at change (from - to)
5. The transport for the tool to be replaced (from - to)

## List of values and meanings for CMD and ACK

| CMD | Explanation |
|---|---|
| 1 | A tool is transported from ... to ... . Load, unload, change, positioning. |
| 2 | Tool change is to be prepared (setting MD 22550 = 1) |
| 3 | Tool change is to be carried out (setting MD 22550 = 1) |
| 4 | Tool change is to be prepared and carried out (setting MD 22550 = 0) |
| 5 | Tool change is to be prepared and carried out (setting MD 22550 = 1) |

| ACK | Explanation |
|---|---|
| 1 | Tool is/was transported. Load, unload, relocate, positioning.<br>FC 8/FC 6 - parameter TaskIdent = 1 |
| 2 | Tool is/was prepared (setting MD 22550 = 1)<br>FC 8/FC 6 - parameter TaskIdent = 2 |
| 3 | Tool change is/was executed (setting MD 22550 = 1)<br>FC 8/FC 6 - parameter TaskIdent = 2 |
| 4 | Tool change is/was prepared (setting MD 22550 = 0)<br>FC 8/FC 6 - parameter TaskIdent = 3 |
| 5 | Tool change is/was prepared (setting MD 22550 = 1)<br>FC 8/FC 6 - parameter TaskIdent = 2 |
| 7 | Terminate canceled tool command<br>DB10.DBX105.0=1 |
| 8 | Tool was transported. If a tool is present at the source address, its data are transported to the target address. Otherwise, only the current magazine position is changed. If the tool transport is from a real magazine, the location to which the source address points is reserved.<br>FC 8/FC 6 - parameter TaskIdent = 5 |
| 9 | Tool was transported. If a tool is present at the source address, its data are transported to the target address. Otherwise, only the current magazine position is changed.<br>FC 8/FC 6 - parameter TaskIdent = 4 |

## 3.14.5 Function blocks

### Overview

| Block number | Meaning |
|---|---|
| FC 7 | Transfer block for tool change with turret |
| FC 8 | Transfer block for tool management, call at position and status changes |
| FC 6 | Transfer block for tool management, call at position and status changes. FC 6 is required for the "multitool" function. The block corresponds to the FC 8. It has an additional parameter - "MultitoolPosition". FC 6 includes the complete FC8 functionality; as a consequence, FC 6 can completely replace FC 8. |
| FC 22 | Direction selection for shortest path |

All function blocks are described in: /FB1/ P3, Basic PLC Program

## Additional PLC services

In addition to the function blocks given above, there are further PLC services available for more complex requirements on the part of the PLC user program to influence tool management. These services are possible using FB 2, FB 3, FB 4 and FB 7 (read and write variables or PI services). A description of these function blocks is part of the basic PLC program description. The PI services (program instances) of the tool management are also described in the basic PLC program description regarding subject item FB 4 or FB 7. The tool management variables are described in the lists in the section on variables.

# Commissioning

# 4

## 4.1 Input of the machine data

### 4.1.1 Input of the machine data

#### General machine data

Machine data for memory partitions, assignment of channels to TO units have to be set for tool management. Also, memory will be needed in the battery-buffered RAM. When "memory-influencing" machine data is changed, i.e. at next power on, restart or cold restart (reboot), this memory area is deleted and configured again. Therefore, data must be backed up prior to reset/cold restart.

#### Order when releasing memory using the machine data

Option: More than three magazines (if require)

Activate the function "Tool management" (tool monitoring+magazine management)

MD $ON_TECHNO_FUNCTION_MASK, bit 4=1

| | |
|---|---|
| MD18080 | MM_TOOL_MANAGEMENT_MASK<br>Activate the memory for tool management |
| MD17500 | MAXNUM_REPLACEMENT_TOOLS<br>Maximum number of replacement tools |
| MD17510 | TOOL_UNLOAD_MASK<br>Behavior of tool data at unloading |
| MD17515 | TOOL_RESETMON_MASK<br>Behavior of tool data at RESETMON |
| MD17520 | TOOL_DEFAULT_DATA_MASK<br>Create new tool: Data default setting |
| MD17530 | TOOL_DATA_CHANGE_COUNTER<br>Identifying tool data change for HMI |
| MD17540 | TOOLTYPES_ALLOWED<br>Permitted tool types |
| MD18074 | MM_TOOL_MANAGEMENT_TRACE_SZ<br>Maximum size of the tool management diagnostics ring buffer |

MD18075 MM_NUM_TOOLHOLDERS
Max. number of toolholders
MD18076 MM_NUM_LOCS_WITH_DISTANCE
Max. number of magazine locations per TOA with distance connections
MD18077 MM_NUM_DIST_REL_PER_MAGLOC
Max. number of magazines in the distance table of a magazine location
MD18078 MM_MAX_NUM_OF_HIERARCHIES
Maximum number of definable hierarchies for magazine location types
MD18079 MM_MAX_HIERARCHY_ENTRIES
Maximum permissible number of entries in a magazine-location-type hierarchy

Definition of number of magazines and magazine locations

MD18084 MM_NUM_MAGAZINE
Maximum number of magazines that NCK can manage (minimum of 3 magazines). Buffer and loading magazines must be added (i.e. for e.g. 2 real magazines, "4" must be specified)!
MD18086 MM_NUM_MAGAZINE_LOCATION
Number of magazine locations that the NCK can manage. Buffer and loading locations must be added!

Definition of tools and tool edges

MD18082 MM_NUM_TOOL
Number of tools to be managed by the NCK
MD18100 MM_NUM_CUTTING_EDGES_IN_TOA
Number of cutting edges in NCK, tool offsets per TOA block
MD1810: MM_MAX_CUTTING_EDGE_PERTOOL
Maximum number of cutting edges (D offset) per tool (per T number)

Options for providing additional user data for magazines, magazine locations, tools and tool edges

MD18090 MM_NUM_CC_MAGAZINE_PARAM
Number of additional magazine data $TC_MAPCx[n]
MD18091 MM_TYPE_CC_MAGAZINE_PARAM
Type definition for magazine-oriented user data
MD18092 MM_NUM_CC_MAGLOC_PARAM
Number of additional magazine location data $TC_MPPCx[n,m] generated
MD18093 MM_TYPE_CC_MAGLOC_PARAM
Type definition for magazine location-oriented user data
MD18094 MM_NUM_CC_TDA_PARAM
Number of additional tool-specific data per tool $TC_TPPCx[t] generated

MD18095 MM_TYPE_CC_TDA_PARAM
Type definition for tool-oriented user data
MD18096 MM_NUM_CC_TOA_PARAM
Number of additional data per tool edge $TC_DPCx[t,d] generated
MD18097 MM_TYPE_CC_TOA_PARAM
Type definition for cutting edge-oriented user data
MD18098 MM_NUM_CC_MON_PARAM
Number of additional monitoring data per tool edge $TC_MOPCx[t,d] generated
MD18099 MM_TYPE_CC_MON_PARAM
Type definition for monitoring-related user data

### Channel-specific machine data

Enabling of channel-specific functions for tool management.

MD20310 TOOL_MANAGEMENT_MASK
Channel-specific activation of tool management

Specification of spindle number for tool life monitoring

MD20320 TOOL_TIME_MONITOR_MASK
Activation of tool life monitoring for the spindle specified here (toolholder number)

Tool change turret or spindle.

MD22550 TOOL_CHANGE_MODE
Change with M06 or with T selection
MD22560 TOOL_CHANGE_M_MODE
M function for tool change

Cutting edge selection after tool change.

MD20270 CUTTING_EDGE_DEFAULT
Offset selection or deselection at tool change

Definition of tool with which tool offset is to be selected as a function of MD20110 and MD20112 during power-up and reset.

MD20122 TOOL_RESET_NAME
Definition for selection of tool length compensation

Definition of the active toolholder number.

MD20124 TOOL_MANAGEMENT_TOOLHOLDER
Definition of the active toolholder number

Assignment of TO units to channels.

MD28085 MM_LINK_TOA_UNIT
Allocation of a TOA range to a channel

Definition of initial setting for control after boot, reset, end of part program in relation to G code, tool length compensation and transformation.

MD20110 RESET_MODE_MASK
Definition of the control basic setting. Relevant bit = 0: The actual value remains valid.

**Note**

For machine data 20310 TOOL_MANAGEMENT_MASK and 18080 MM_TOOL_MANAGEMENT_MASK, bits 0-3 must always be set the same.

# 4.2 Load the machine manufacturer PLC blocks

## 4.2.1 Overview

### Overview

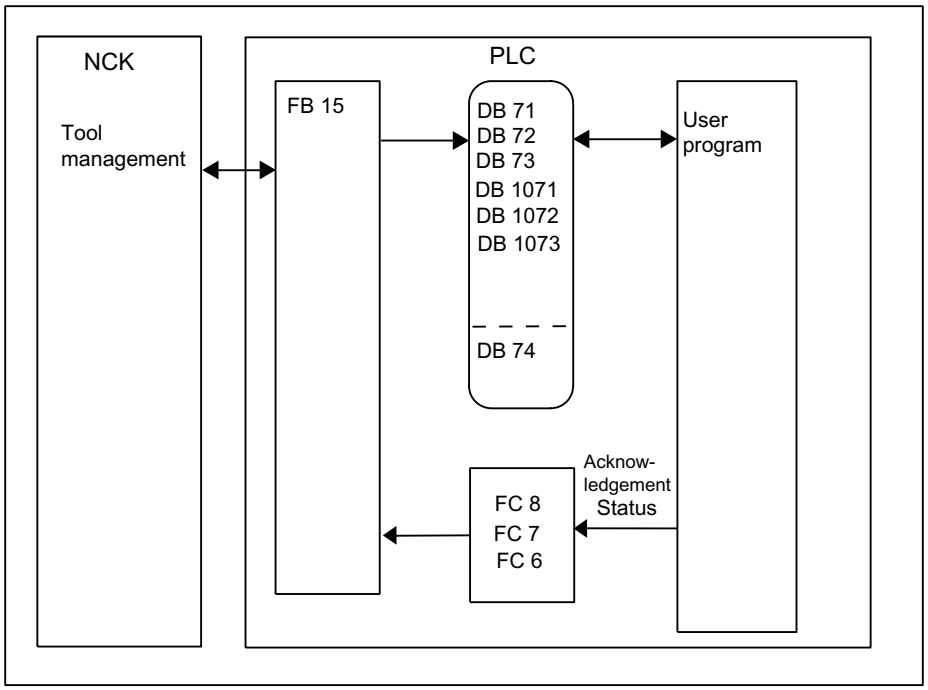



Figure 4-1 Commissioning the PLC Program

The basic program supplies the tool management interfaces (data blocks DB 71-DB 73) with information for the new and old tool. The user must process this data from the active interface in the user program and ensure that the tools (old and new) are placed on the respectively associated positions (magazine, location). In order for the tool management to always know where a tool is located, each time a tool changes location the new location must be transferred to the tool management via FC 7 or FC 8/FC 6 acknowledgement status.

## 4.2.2 Create PLC data

### Commissioning tool management

If the magazine configuration was created (for all channels involved), the PLC data must be generated. This is done as follows

- a) Manually, by pre-defining data block DB 4
- b) by pressing the "Generate PLC data" softkey on HMI-Advanced if the magazine configuration was generated with it.

FC 8/FC 6 (FC 7 for circular magazines), TM_TRANS / TM_TRANS2 (transfer blocks) and if required FC 22 TM_DIR (selection of direction) must still be loaded and called by the user program.

When commissioning has been completed, the next time the PLC is booted the following data blocks are set up for the user (user interfaces for tool management) in addition to a data block for the tool management FCs. The lengths of the data blocks are derived from the commissioning parameters in tool management.

### Example of chain magazine

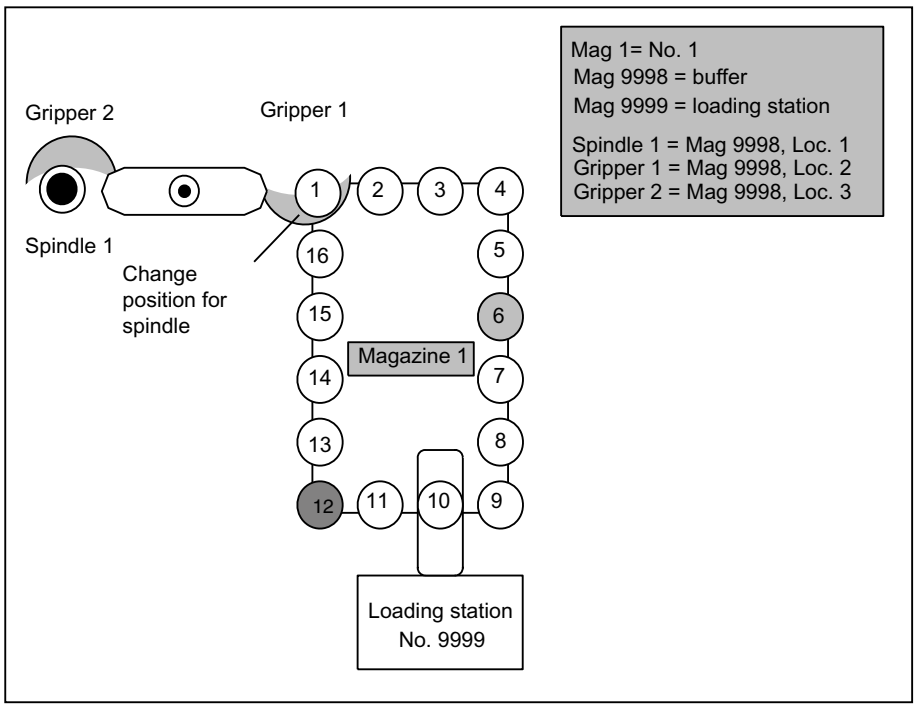



Figure 4-2 Example of a magazine with gripper and loading station

"Drill120" is placed in location 6 and location 12 is reserved for the spindle tools to be changed out.

## Execution example for tool change

1. Part program contains T="Drill120"

   Output at the PLC:
   "PREPARE CHANGE" DBB(n+0) bit 2=1
   (bring new tool from Mag1, location 6 to Mag9998, location 1 and bring old tool from Mag9998, location 1 to Mag1, location 12).

2. Location 6 is moved to the point of change.

3. The tool is taken from location 6 and placed into gripper 1. The user program resets "PREPARE CHANGE" DBB(n+0) bit 2 to zero. The new position (9998, 2) of the new tool ("Drill120") is signaled via FC 8 with status 1. The old tool remains at position 9998,1. FC 8/FC 6 resets bit 0.0 in DB 72.

   The magazine is moved with location 12 to the change position for the old tool to be placed into it.

4. M06 is executed in the part program

   Output to PLC. "CHANGE" DBB(n+0) bit 1=1
   No new tool positions are entered in the interface with output of the M06 command. If required, they can be later made by the user program at change of position.

5. The PLC user program carries out the tool change and brings the tool into the spindle. During this process, the old tool is removed from the spindle and placed into gripper 2. The new tool in gripper 1 is placed into the spindle. When the process is completed, FC 8/FC 6 acknowledges with status 105 (position of new tool: 9998, 1; position of the old tool: 9998, 3).

6. The (old) tool is returned from gripper 2 to the new magazine location 12. This is acknowledged using FC 8/FC 6, status 1 (position of new tool: 9998, 1; position of old tool 1, 12). This represents the end of the tool change procedure. Bit 0.0 in DB 72 is reset by the FC 8/FC 6.

**Note**

The timing of the tool change can be optimized by applying the following strategy for further processing in the part program:

Use status 1 with FC 8/FC 6 in step 5 instead of status 105. The old tool is then returned to storage in step 6 with the asynchronous FC 8/FC 6 transfer function (status 1, OldToolMag=9998, OldToolMag=1, NewToolLoc=12).

### 4.2.3 Description of the test blocks

#### Overview of test blocks

| Block No. | Structure | Meaning |
|---|---|---|
| FC 40 | Subprogram | Preparation of the data for a change with gripper via asynchronous transfer |
| FC 41 | Block to be called in OB 1 | Global functions (job control, check commands, H decoder, ...) |
| FC 42 | Subprogram | Supply of data for FC 8/FC 6 if a task is active |
| DB 62 | Data for active tasks, control parameter | |
| DB 63 | Data for FC 22 | |
| DB 64 | Data for asynchronous transfer | |

## Test blocks for tool management

To test the tool management function, blocks FC 40, FC 41, FC 42 and data blocks D B62, DB 63 and DB 64 must be loaded to the PLC. FC 41 (without parameters) must also be called in the organization block 1 (OB 1). The following overall procedure is implemented by integrating these blocks:

1. The tool management function is activated (acknowledgement of tasks) by programming H9001 in the first channel (and deactivated with H9000).

   The system can also be activated by setting data bit DB62.DBX15.7. The initial setting when the PLC is rebooted is H9000. The other functions can only be used once the system has been activated via H9001.

2. The direction selection function (FC 22) can be activated with the machine control panel (MCP) key above the rapid traverse override key (i.e. the normal MCP connected via FC 19 or FC 25). Data must be written to data block DB 63 (e.g. via the variable status) before the function is activated.

   *Structure of data block DB63:*

   **Input parameters**

   DBW0 = magazine number
   DBW2 = setpoint position
   DBW4 = actual position
   DBW6 = offset for special positioning

   **Output parameters**

   DBW8 = Difference position (shortest distance)
   DBB10 = clockwise rotation == 1
   DBB11 = counter-clockwise rotation == 1
   DBB12 = position reached
   DBB13 = error == 1

   If an error (e.g. parameterizing error) occurs, the LED for the key lights up.

3. Every user interface (DB 71 to DB 73) is scanned for active status by block FC 41.

   If an interface is active, a transfer with new positions (usually target positions) and status information "1" (completed) is passed to the NCK immediately.

4. If H9003 is programmed in the first channel (corresponding to data block DB62. DBX15.6 set), the transfer operation described under point 3 is only executed after operating the MCP key above the minus-direction key.

   As a result, it is possible to intervene in the transfer values via a status function. The function is deactivated via H9002 (default setting). The transfer blocks are provided in data block DB 62.

   Input parameters:
   DBB0 = jog identifier (1, 2, 3)
   DBB1 = job number

   **(only make changes in DBW2 to DBW10)**

   DBW2 = magazine for new tool
   DBW4 = location for new tool
   DBW6 = magazine for old tool
   DBW8 = location for old tool
   DBW10 = status information (refer to the description of FC 8/FC 6)

   Output parameters:
   DBW12 = error occurred
   If an error occurs, the LED for the activation key is lit.

   The following functions are implemented for command acknowledgement in DB 71, DB 72, DB 73:

   *Loading/unloading, relocating:*
   The required target positions are acknowledged with status 1 via FC 8/FC 6.

   *Positioning:*
   The required target position is acknowledged with status 5 via FC 8/FC 6 because the tool remains in the magazine.

   *Prepare change (spindle interface):*
   "New tool" remains at the original location, "old tool" remains in the spindle.
   Special treatment for T0 or empty spindle is implemented.
   Acknowledged via FC 8/FC 6 with status = 1.

   *Change (spindle interface):*
   "Old tool" goes into the allocated magazine location, "new tool" goes into the spindle.
   Acknowledged via FC 8/FC 6 with status = 1.
   Special treatment for T0 or empty spindle has been implemented.

   *Change (turret interface):*
   Acknowledged via FC 7.
   Optional with DB62.DBX15.4 = 1, acknowledged via FC 8/FC 6 with status = 1.

5. Values other than zero can be set in DB62.DBW20 and DB62.DBW22. DB62.DBW20 means the spindle number and DB62.DBW22 the buffer number of a gripper assigned to the spindle.

   It is thus possible to automatically allow for a gripper located *between a spindle* and a *magazine* in the acknowledgement.

   The following sequence is implemented (only for spindle as change position, M06 setting as change command):

   When preparing, the behavior is identical to "normal operation".
   The "new tool" remains in the magazine, the "old tool" remains in the spindle. The "old tool" must continue to machine.

   On the change command:

   "New tool" goes into the spindle, "old tool" goes into the gripper. An asynchronous transfer is used to move the "old tool" to the suggested magazine location. A manual acknowledgement is required for this purpose.

6. Asynchronous transfer (changes in a tool location can be communicated without an NCK task)

   DB 64 can be used to communicate a change in position of a tool to the tool management function in the NCK.
   The tool position change was made be the PLC. Entries must be made in DB 64 (e.g. via variable status). Asynchronous transfer can then be started via DB64.DBX14.0 = 1.
   Asynchronous transfer with location reservation can be selected using data DB64.DBX15.4 = 1.
   This corresponds to TaskIdent = 5.
   TaskIdent = 4 is switched-in for a value of zero in the specified data.

   Input parameters:
   DBB1 = associated NC channel number
   DBW2 = original tool magazine
   DBW4 = original tool location
   DBW6 = target tool magazine
   DBW8 = target tool location
   DBW10 = status information (refer to the description of FC 8/FC 6)
   Only status = 1 and status = 5 permissible.

   Output parameters:
   DBW12 = an error has occurred

---

**Note**

If incorrect values are communicated from the NCK, the following error signals causing PLC stop are output and either displayed via the HMI or entered in the diagnostics buffer of the PLC.

Test blocks exclusively use FC 7 and FC 8/FC 6. This means that the multitool function is presently not supported by the test blocks.

Alarm 400604:
For function 4, the specified magazine is not a turret.
Remedy: Machine data (tool change with M06 command)

---

### 4.2.4 Delete pending tasks

#### General

The communication initiated by the NC yet interrupted by the PLC job "Cancel pending job" (DB10.DBX105.0) can be terminated by the PLC during commissioning.

The function cancels all pending tool management jobs from the NCK (compare NC switch-on). The NC tool management is reset in a defined manner. This is intended to be a pure commissioning function. If a command must be cancelled in regular operation, then this is done using the FC 8/FC 6 and acknowledgement status "3" (negative acknowledgement).

This function enables direct intervention by the operator to e.g. take a tool out of the gripper where a change is just about to take place, or if there is no acknowledgement from the PLC program.

**Note**

Please ensure that the data consistency in the NC is maintained.

#### Boundary condition

The "Delete pending task" function can be activated only if the NC is in the "Channel not active" state.

# Programming 5

## 5.1 Overview of OPI and system variables

### Fundamentals

All the data required for the purpose of data management (e.g. to define a magazine or load a tool...) is stored in the NCK. This data can be read and written via part programs using system variables and via the PLC using FB 2 and FB 3. When configuring the machine, the user (machine manufacturer) must determine the most efficient method of reading and writing tool management data, i.e. in the PLC, the NC or in an ASUB.

Read and write access can generally be made to system variables.

When language commands are used, it may be necessary to program the "STOPRE" command.

The $TC variables do not generate a preprocessing stop.

Tool identifiers can consist of the following characters:

a...z

A...Z

0...9

+ - _ . ,

The names are case-sensitive, i.e. uppercase and lowercase characters are considered different characters.

---

**Note**

Additional information on OPI variables can be found in the Help file for the NC variables selector.

---

## Overview

The following diagram shows an overview of all cutting edge, tool and magazine data ($TC_...) when tool management is active.

Note:

The sequence of system variables shown in the diagram corresponds to the OPI numbering sequence.

**Note**

System variables are available for OEM Siemens data. However, they are not described here because they are not meaningful at present.

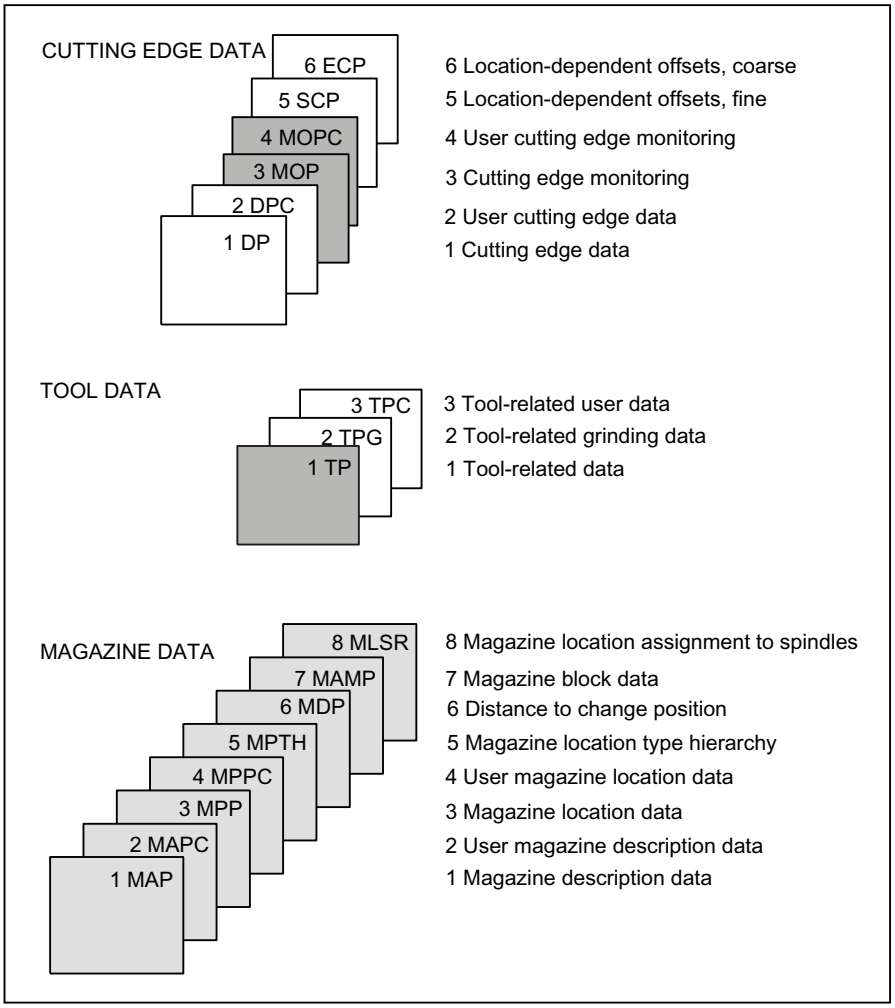



Figure 5-1 Overview of cutting edge, tool and magazine data

The identifiers (DP,...PP,...MAP,...) are taken from the NC language. They are part of the names of the system variables $TC_DP,...

**Note**

The gray data fields are only available if tool management is active.

Dark gray data fields are also available without tool management, but with monitoring function.

White data fields are available also even if tool management is not active.

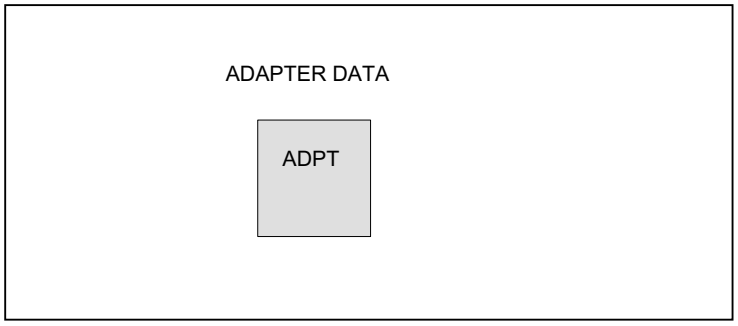



Figure 5-2 Adapter data

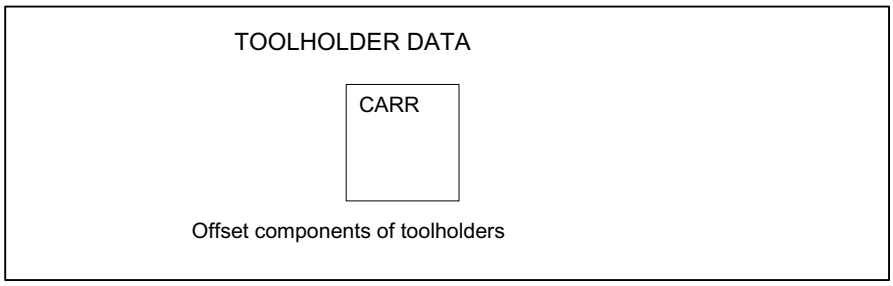



Figure 5-3 Toolholder data

# 5.2 Cutting edge data

## 5.2.1 Cutting edge data

### Cutting edge data

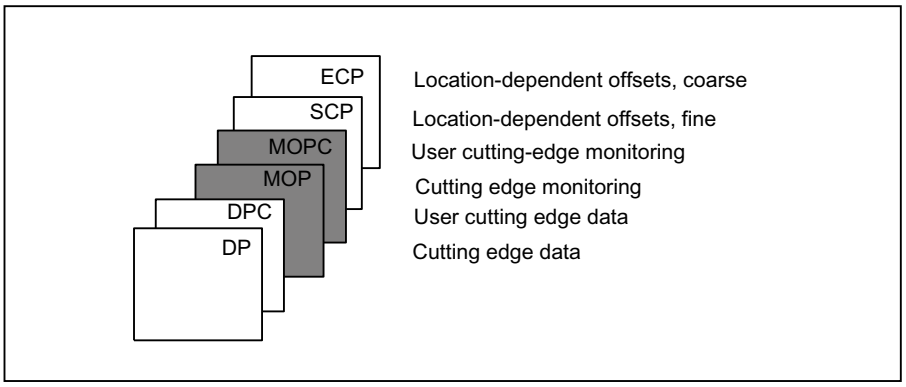



Figure 5-4 Overview of cutting edge data

This data exists for each cutting edge that is created (D1-D12). Tool management includes the geometry and user data as well as the optional monitoring data for the cutting edges.

If the cutting edges are created via HMI, the D number is counted up from 1. It is possible to program the D no. with gaps, e.g. D1, D3, D6 if cutting edges are set up using the NC program.

## 5.2.2 Cutting edge parameters

### $TC_DPx[t,D]

Cutting edge parameters for geometry, technology and tool type.

Depending on the tool type, up to 25 cutting edge parameters can be programmed for each tool cutting edge.

References: /FB1/, W1, Tool offset

X = Parameters 1...25

T = T number 1...32000

D = Cutting edge number 1...12

D = D number

The maximum value of x is stored in OPI variable numCuttEdgeParams in block Y.

## OPI block TO

Calculation of line: (d-1)*numCuttEdgeParams+parameter No.

Calculation of column: T number

| Tool offset parameters (system variables) | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| $TC_DP1 | INT | Tool type | edgeData | REAL | 9999 |
| $TC_DP2 | Double | Cutting edge position* | edgeData | REAL | 0 |
| $TC_DP3 | Double | Geometry length 1 | edgeData | REAL | 0 |
| $TC_DP4 | Double | Geometry length 2 | edgeData | REAL | 0 |
| $TC_DP5 | Double | Geometry length 3 | edgeData | REAL | 0 |
| $TC_DP6 | Double | Radius geometry | edgeData | REAL | 0 |
| $TC_DP7 | Double | Geometry - corner radius<br>(tool type 700; slotting saw) | edgeData | REAL | 0 |
| $TC_DP8 | Double | Geometry length 4<br>(tool type 700; slotting saw)* | edgeData | REAL | 0 |
| $TC_DP9 | Double | Geometry length 5* | edgeData | REAL | 0 |
| $TC_DP10 | Double | Geometry - angle 1* | edgeData | REAL | 0 |
| $TC_DP11 | Double | Geometry - angle 2 for conical milling tools* | edgeData | REAL | 0 |
| $TC_DP12 | Double | Wear - length 1 | edgeData | REAL | 0 |
| $TC_DP13 | Double | Wear - length 2 | edgeData | REAL | 0 |
| $TC_DP14 | Double | Wear - length 3 | edgeData | REAL | 0 |
| $TC_DP15 | Double | Wear - radius | edgeData | REAL | 0 |
| $TC_DP16 | Double | Wear - slot width b/rounding radius | edgeData | REAL | 0 |
| $TC_DP17 | Double | Wear - projection k | edgeData | REAL | 0 |
| $TC_DP18 | Double | Wear - length 5 | edgeData | REAL | 0 |
| $TC_DP19 | Double | Wear - angle 1 | edgeData | REAL | 0 |
| $TC_DP20 | Double | Wear - angle 2 for conical milling tools | edgeData | REAL | 0 |
| $TC_DP21 | Double | Adapter length 1 | edgeData | REAL | 0 |
| $TC_DP22 | Double | Adapter length 2 | edgeData | REAL | 0 |
| $TC_DP23 | Double | Adapter length 3 | edgeData | REAL | 0 |
| $TC_DP24 | Double | Clearance angle | edgeData | REAL | 0 |
| $TC_DP25 | Double | 1. The cutting rate value is stored here for ManualTurn<br>2. A bit-coded value for various states of tools of type 1xx and 2xx is stored here for ShopMill. | edgeData | REAL | 0 |

| Tool offset parameters (system variables) | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| $TC_DPCE [t,d] | INT | System variable of an offset data record with T=t and D=d containing cutting edge number CE. (unique D No. or user assignment of D Nos. for cutting edge numbers)<br>Value range for permissible cutting edge numbers: 1 up to value of MD 18106. | - | | 0 |
| $TC_DPH [t,d] | INT | H parameter (Y / extraCuttEdgeParams), Bit0=1 | - | | 0 |
| $TC_DPV | Double | Tool cutting edge orientation | - | | - |
| $TC_DPV3 | | L1 component of the tool cutting edge orientation | - | | |
| $TC_DPV4 | | L2 component of the tool cutting edge orientation | - | | |
| $TC_DPV5 | | L3 component of the tool cutting edge orientation | - | | |

* The meaning of this data is different depending on the tool type.

## $TC_DP11

$TC_DP11 contains the identification for the main direction of machining as is defined and required by the Siemens cycle 950. $TC_DP11 assumes an intermediate position between tool OEM parameter and NCK system variable.

$TC_DP11 is a tool OEM parameter in so far as NCK does not evaluate the contents of the value.

$TC_DP11 is a tool system variable in so far as when accessing via $P_ADT[ n ] - n=11, NCK is subject to the special values 1, 2, 3, 4 of the tool adapter transformation if TMMG and the subfunction "Tool adapter" are active. This system parameter property is also used with the analog OPI block TOT.

## 5.2.3 User cutting edge data

### $TC_DPCx[t,D]

Up to 10 additional cutting edge parameters can be programmed for each cutting edge. Setting with MD18096 MM_NUM_CC_TOA_PARAM and enable with MD18080 MM_TOOL_MANAGEMENT_MASK (set bit 2=1)

X = Parameter 1...10

T = T number 1...32000

D = Cutting edge number 1...12

D = D number

### OPI block TUE/TUO

Calculation of line: (d-1)*numCuttEdgeParams_tu+parameterNo.

Calculation of column: T number

| User-related cutting edge data | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| $TC_DPC1 | Double | CC_Cutting edge parameter 1 | edgeData | REAL | 0 |
| ... | Double | ... | edgeData | REAL | 0 |
| $TC_DPC10 | Double | CC_Cutting edge parameter 10 | edgeData | REAL | 0 |

**Note**

The data is displayed in the tool management. Here you could store "Max. cutting rate", for example, which is then evaluated in the part program.

## 5.2.4 Cutting edge-related tool monitoring

### $TC_MOPx[t,D]

Tool cutting edges are monitored according to tool life, workpiece count and/or wear.

X = Parameter 1...15

T = T_Number 1...32000

D = Cutting edge number 1...12

D = D number

### OPI block TS

Calculation of line: (d-1)*numCuttEdgeParams_ts+parameterNo.

Calculation of column: T number

| Tool management monitoring data | | | | | |
|---|---|---|---|---|---|
| **NCK identifier** | **Type** | **Designation** | **OPI variables** | **Type** | **Default setting** |
| $TC_MOP1 | Double | Prewarning limit for tool life in min. | data | REAL | 0 |
| $TC_MOP2 | Double | Residual tool life in minutes | data | REAL | 0 |
| $TC_MOP3 | INT | Prewarning limit for count | data | REAL | 0 |
| $TC_MOP4 | INT | Residual unit quantity | data | REAL | 0 |
| $TC_MOP11 | Double | Setpoint for tool life | data | REAL | 0 |
| $TC_MOP13 | INT | Setpoint for workpiece count | data | REAL | 0 |
| $TC_MOP5 | Double | Wear prewarning limit - or location-dependent offset fine prewarning limit | data | REAL | 0 |
| $TC_MOP6 | Double | Actual wear or location-dependent offset, fine actual value | data | REAL | 0 |
| $TC_MOP15 | Double | Wear setpoint - or location-dependent offset, fine setpoint | data | REAL | 0 |

## 5.2.5 User cutting-edge monitoring

### $TC_MOPCx[t,D]

Tool monitoring user data (edge-specific)

Up to 10 additional tool monitoring parameters can be programmed for each cutting edge. Setting with MD18098 MM_NUM_CC_MON_PARAM and enable with MD18080 MM_TOOL_MANAGEMENT_MASK (set bit 2)

X = Parameter 1....10

T = T_Number 1....32000

D = Cutting edge number 1....12

D = D number

### OPI block TUS

Calculation of line: (d-1)*numCuttEdgeParams_tus+parameterNo.

Calculation of column: T number

| Tool monitoring user data (edge-specific) | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| $TC_MOPC1 | Int | CC monitoring parameters | userdata | REAL | 0 |
| ... | Int | ... | userdata | REAL | 0 |
| $TC_MOPC10 | Int | CC monitoring parameters | userdata | REAL | 0 |

## 5.2.6 Location-dependent offsets, fine (additive offsets)

### $TC_SCPx[t,D]

Location-dependent offsets fine (the term "additive offsets" is also frequently used) comprise all the magnitudes of error which contribute to the total deviation between the actual workpiece and the specified dimensions. The parameters for the location-dependent offsets refer to the geometrical data of a cutting edge. DL stands for D Location, whereby Location refers to where the cutting edge is used.

X = Parameter for DL=1...DL=6

T = T number 1...32000

D = Cutting edge number 1...12

D = D number

### OPI block TOS, TOST

Calculation of line: (d-1)*(maxnumEdgeSC*numParams_SC) + ((EdgeSC_1)*numParams_SC)+ParameterNo.

Calculation of column: T number

| Location-dependent offsets | | | | |
|---|---|---|---|---|
| Name | Type | Designation | OPI variables | Type |
| $TC_SCPx | | | | |
| x = 13-21 | Double | Can be activated with DL=1 | edgeSCData | REAL |
| x = 23-31 | Double | Can be activated with DL=2 | edgeSCData | REAL |
| x = 33-41 | Double | Can be activated with DL=3 | edgeSCData | REAL |
| x = 43-51 | Double | Can be activated with DL=4 | edgeSCData | REAL |
| x = 53-61 | Double | Can be activated with DL=5 | edgeSCData | REAL |
| x = 63-71 | Double | Can be activated with DL=6 | edgeSCData | REAL |
| | | Transformed location-dependent offsets fine, block TOST | edgeSCData | REAL |

## 5.2.7 Location-dependent offsets, coarse (setting-up offsets)

### $TC_ECPx[t,D]

The location-dependent offsets, coarse (also setting-up offsets) can be set by the machine setter before the machining operation (see also $TC_SCP).

X = Parameter for DL=1...DL=6

T = T number 1...32000

D = Cutting edge number 1...12

D = D number

### OPI block TOE, TOET

Calculation of line: (d-1)*(maxnumEdge_SC*numParams_SC)+((EdgeSC-1)*numParams_SC)+ParameterNo.

Calculation of column:T number

| Setting-up offsets | | | | |
|---|---|---|---|---|
| Name | Type | Designation | OPI variables | Type |
| $TC_ECPx | | | edgeECData | REAL |
| x = 13-21 | Double | Can be activated with DL=1 | edgeECData | REAL |
| x = 23-31 | Double | Can be activated with DL=2 | edgeECData | REAL |
| x = 33-41 | Double | Can be activated with DL=3 | edgeECData | REAL |
| x = 43-51 | Double | Can be activated with DL=4 | edgeECData | REAL |
| x = 53-61 | Double | Can be activated with DL=5 | edgeECData | REAL |
| x = 63-71 | Double | Can be activated with DL=6 | edgeECData | REAL |
| | | Transformed setting-up offsets, block TOET | edgeECData | REAL |

# 5.3 Tool data

## 5.3.1 Overview

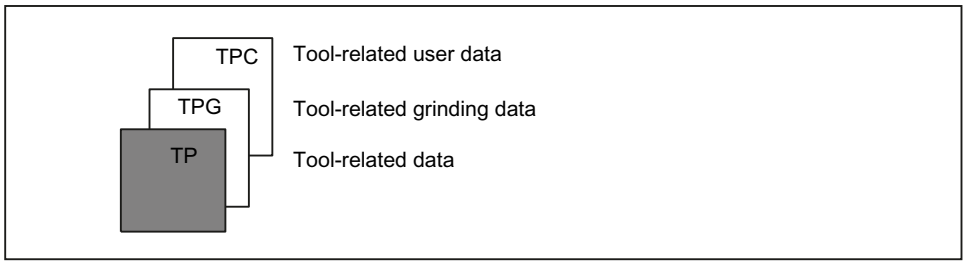



Figure 5-5 Overview of tool data

## 5.3.2 Tool-related data

### $TC_TPx[t]

General tool data

This data describes the tool in the magazine.

Programming of general tool data with tool management

x: = Parameter 1...11

t: = T number 1...32000

### OPI block TD

Calculation of line: T number

Calculation of column: n.a.

| Tool-related data, tool management | | | | | |
|---|---|---|---|---|---|
| **NCK identifier** | **Type** | **Designation** | **OPI variables** | **Type** | **Default setting** |
| $TC_TP2 | String | Tool identifier | toolIdent | String | "T No." |
| $TC_TP1 | INT | Duplo number | duploNo | WORD | T No. |
| $TC_TP3 | INT | Size on left | toolsize_left | WORD | 1 |
| $TC_TP4 | INT | Size on right | toolsize_right | WORD | 1 |
| $TC_TP5 | INT | Size above | toolsize_upper | WORD | 1 |
| $TC_TP6 | INT | Size below | toolsize_down | WORD | 1 |
| $TC_TP7 | INT | Magazine location type | toolplace_spec | WORD | 9999 |

| Tool-related data, tool management | | | | | |
|---|---|---|---|---|---|
| **NCK identifier** | **Type** | **Designation** | **OPI variables** | **Type** | **Default setting** |
| $TC_TP8 | INT | Status<br>Value 0 not enabled<br>Bit 0 active tool<br>Bit 1 enabled<br>Bit 2 disabled<br>Bit 3 measure<br>Bit 4 prewarning limit reached<br>Bit 5 tool being changed<br>Bit 6 fixed-location coded<br>Bit 7 tool was in use<br>Bit 8 identifier for tools in buffer<br>Bit 9=1 ignore disabled state<br>Bit 9=0 do not ignore<br>Bit 10 to be unloaded<br>Bit 11 to be loaded<br>Bit 12 master tool<br>Bit 13 reserved<br>Bit 14 1:1 exchange<br>Bit 15, manual tool | toolState | WORD | 0=not enabled |
| $TC_TP9 | INT | Tool monitoring method<br>Value 0 no tool monitoring<br>Bit 0 tool life<br>Bit 1 workpiece count<br>Bit 2 wear monitoring active<br>Bit 3 wear monitoring, location-dependent offset fine active | toolMon | WORD | 0 |
| $TC_TP10 | INT | Replacement change strategy | toolSearch | WORD | 0 |
| $TC_TP11 | INT | Tool information:<br>Allows tool groups to be divided into subgroups. Tool selection, only with tools of the lower group | toolInfo | Integer | 0 |
| $A_TOOLMN | INT | Magazine assignment tool | toolInMag | WORD | |
| $A_TOOLMLN | INT | Location assignment tool | toolInPlace | WORD | |
| $P_TOOLND | INT | Number of cutting edges | numCuttEdges | WORD | |
| - | | Adapter No. Assignment | adaptNo | WORD | |
| $A_MYMN | INT | Owner magazine for tool | toolMyMag | WORD | |
| $A_MYMLN | INT | Owner magazine location for tool | toolMyPlace | WORD | |
| $TC_TP_PROTA | string | Name of the three-dimensional protection area for the tool or name of the file that contains the description of the protection area for the tool. | | | |

| Tool-related data, tool management | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| $TC_TP_MAX_VELO | real | Maximum speed of the tool, if the value is > 0. If a speed limit is not defined (=0), then no monitoring is performed | maxSpindVeloOfTool | | |
| $TC_TP_MAX_ACC | real | Maximum acceleration of the tool, if the value is > 0. If an acceleration speed limit has not been defined (=0), then no monitoring is performed | maxSpindAccOfTool | | |

### $TC_TP1 and $TC_TP2

Like the T No. is sufficient to identify a tool, a tool is equally unique in terms of its duplo number and its tool name (identifier).

TO units may therefore only contain names that have different duplo numbers. The write operations of $TC_TP1 and $TC_TP2 are checked for the above and rejected if collisions are found.

### $TC_TP3 to TP6

Size in terms of half locations:

Size 1 means that the tool exactly completely occupies its own magazine location. The maximum programmable size is 7.

The tool size (half locations) can only be written or changed if the tool does not have an owner location. This applies to the following situations:

- The tool has still not been loaded
- During loading, as long as the tool is not at its target location in a real magazine
- If the tool is at a location of the buffer or loading magazine and beforehand, the owner location as well as the reservation in the magazine was deleted (exclusively using the language commands DELMRES and DELMOWNER).

### $TC_TP7

The magazine location type can only be written or changed if the tool does not have an owner location. This applies to the following situations:

- The tool has still not been loaded
- During loading, as long as the tool is not at its target location in a real magazine
- If the tool is at a location of the buffer or loading magazine and beforehand, the owner location as well as the reservation in the magazine was deleted (exclusively using the language commands DELMRES and DELMOWNER).

## $TC_TP8

The tool status is described with system variable $TC_TP8. The system variable is bit-coded. In other words, a particular state of the tool is assigned to each bit of this data.

The status of a tool must be **bit 1=1** ("enabled") so that it can be loaded within the scope of a programmed tool change for machining in the toolholder.

During tool selection, the status of a tool that is loaded onto the toolholder (spindle, ...) is set by the NCK to **bit 0** ("active").

A tool cannot be loaded if its status is **bit 2=1** ("disabled"). The status is set automatically by the tool monitoring function, when the monitoring value of at least one cutting edge reaches the limit value. The status bit 2=4 of the tool on the toolholder can or will be ignored when generating the INIT blocks (see MD 20110 and 20112). The PLC also has the option to make NCK ignore the status during tool selection.

The status **bit 4=1** ("prewarning") is mainly for information purposes. With this status the tool can still be loaded.

The status **bit 7=1** ("was in use") is set by the NCK if the tool is removed from a magazine location of the type spindle or toolholder.

The tool status **bit 5=1** (="W"= is being change) is always reset by the software during buffered booting. A tool receives/loses this status within the scope of a programmed tool change.

The following applies: All tools (new and old) involved in the tool change are given the status bit 5=1 by the tool selection. The status is reset again by the end acknowledgement for each tool command.

The following applies in particular:

The end acknowledgement of the PLC command 2 (programming the T address with $MC_TOOL_CHANGE_MODE=1), resets the status "W" of the old tool.

With the end acknowledgement of the PLC command 3, 4, 5
(programming M06 in a block with $MC_TOOL_CHANGE_MODE=1, T, M06 in a block with $MC_TOOL_CHANGE_MODE=1
T address with $MC_TOOL_CHANGE_MODE=0)
the status bit 5=1 of the old and the new tool is reset.

Tools that are in the buffer can be used for a new programmed tool command if the tool status bit 5=! (being changed).

Tools that are in the real magazine and have this status can be used depending on bit 21 of the MD 20310 or cannot be used for a competing tool-change command for another spindle.

The status bit 5=1 is generally not taken into consideration for a tool selection within the scope of a block search or for init block generation.

For a RESET, the status is reset for those tools that are involved in a tool change at that point in time.

The status bit 5=1 is not evaluated when a manual tool is selected.

The tool status **bit 8=1** ("return transport") ensures that during the next tool change, a tool that is at a buffer location and not intended for the next job in machining is returned to the real magazine.

**Bit 9** ignores disabled state.

If this bit is set, the disabled state of this tool is ignored. This means the disabled tool can be used (depending on the search strategy).

This state acts independently of the PLC interface signal:

"Tool disable not effective" (DB21.DBx29.7).

**Status bit 11 (to be loaded)**

Bit 11 is set for tools that are not in a magazine and are to be loaded. The following definitions apply:

- The state remains for Power On.
- It is included in the data back-up and rewritten when transferred back to the NCK.
- When assigning a tool to a real magazine the tool status is reset by the NCK (applies to locations of location type 1, i.e. not to internal magazines such as the loading magazine, buffer magazine, etc).

| Bit | Value | Meaning |
|---|---|---|
| 11 | 0 | "Not to be loaded" |
| | 1 | **"To be loaded"** |

**Status bit 10 (to be unloaded)**

Bit 10 is set for tools that are located in a magazine and are to be unloaded. The following definitions apply:

- The state remains for Power On.
- It is included in the data back-up and rewritten when transferred back to the NCK.
- Unloading a tool via an unloading location causes the NCK to reset the tool status.

| Bit | Value | Meaning |
|---|---|---|
| 10 | 0 | "Not to be unloaded" |
| | 1 | **"To be unloaded"** |

**Status bit 12 (master tool)**

Bit 12 is set for tools that are to be permanently assigned to a magazine. This status is only set to provide information and has no effect on the NCK (e.g. does not disable a location). The user defines via the unload program whether the tool can be unloaded.

| Bit | Value | Meaning |
|---|---|---|
| 12 | 0 | "Not a master tool" |
| | 1 | **"Master tool"** |

**State bit 14 (tool marked for 1:1 exchange)**

NCK internal state, that indicates (for a selected search strategy, 1:1 interchange), that the new and old tool should be interchanged 1:1.

**Note**

Take care when "manually" changing the tool status via the OPI during machining. This could undo internal state changes by the NCK and result in incorrect machining.

## $TC_TP9

If a monitoring type is activated for the tool with $TC_DP9, then the current monitoring parameters are evaluated and, if necessary, the tool status set to ’disabled’ or ’prewarning limit reached’. An existing tool disable is however not withdrawn. Not even then when the monitoring function for this tool has been deactivated.

## $TC_TP11

**Tool subgroups**

The system variable is bit-coded. Only bits 0...3 are evaluated. A tool group (the same identifier, different duplo No.) can be split into a maximum of 4 subgroups in this way. A tool can also be included in several subgroups.

If no bit is set, so $TC_TP11[x]=0, this means the same as "all bits set", i.e. the tool belongs to all the defined subgroups.

*Selection of the tool subgroup*

1. With the language command **$P_USEKT** (UseKindofTool)

   (only possible when not working with the setting T=location)

   During tool search, only tools that have one of these bits in system variable $TC_TP11, can be found. This means that it is possible to form so-called "Technology Groups", to differentiate between tools with the same identifier and specifically release them for machining.

   Example 1:

   $P_USEKT=4
   i.e. the only tools to be taken into account are those with bit 2 in $TC_TP11 or

   Example 2:

   $P_USEKT=9
   i.e. the only tools to be taken into account are those with bit 3 or 0 in $TC_TP11

2. By programming a tool

   with the function **T=location** $P_USEKT is set automatically at every tool change and in fact at the $TC_TP11 value of the loaded tool.

   Example: T3 M06
   the bit value of $TC_TP11 of T3 is now valid (is accepted in "USEKT").

   During the transition to a spare tool (and there only) the only tools to be taken into account are those with one of these bits set in system variable $TC_TP11.

## 5.3.3 Tool-related grinding data

### $TC_TPGx[t]

Technology-specific grinding data

The default setting for grinding data is 0. Tools with **tool type 400 to 499** are always **grinding tools**, i.e. have these additional data which take up additional memory space. If a tool of type 400-499 is set to a value outside this range, then its loses its grinding-specific data - the associated memory is released again and can be used for other tools.

x: = Parameter 1....9

t: = T number 1...32000

### OPI block TG

Calculation of line: T number

Calculation of column: n.a.

| Tool-related grinding data | | | | |
|---|---|---|---|---|
| Name | Type | Designation | OPI VAR | Type |
| $TC_TPG 1 | INT | Spindle number | spinNoDress | REAL |
| $TC_TPG 2 | INT | Chaining rule | conntectPar | REAL |
| $TC_TPG 3 | Double | Minimum grinding wheel radius | minToolDia | REAL |
| $TC_TPG 4 | Double | Minimum grinding wheel width | minToolWide | REAL |
| $TC_TPG 5 | Double | Current grinding wheel width | actToolWide | REAL |
| $TC_TPG 6 | Double | Max. speed | maxRotSpeed | REAL |
| $TC_TPG 7 | Double | Maximum peripheral speed | maxTipSpeed | REAL |
| $TC_TPG 8 | Double | Inclination angle of inclined wheel | inclAngle | REAL |
| $TC_TPG 9 | INT | Parameter number for radius calculation | paramNrCCV | REAL |

## 5.3.4 Tool-related user data

### $TC_TPCx[t]

User-related tool data

An additional 10 tool-specific parameters can be set up per tool. Setting with MD18094 MM_CC_TDA_PARAM and enable with MD18080 MM_TOOL_MANAGEMENT_MASK (set bit 2)

x: = Parameter 1...10

t: = T number 1...32000

### OPI block TU/TUD

Calculation of line: T number

Calculation of column: Parameter number

| Tool-related OEM user data | | | | |
|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI VAR | Type |
| $TC_TPC1 | Double | | data | REAL |
| ... | Double | | data | REAL |
| $TC_TPC10 | Double | | data | REAL |

**Note**

The data is displayed in the tool management. In addition, e.g. tool status information can also be stored here.

# 5.4 Magazine data

## 5.4.1 Overview of magazine data

### Magazine data

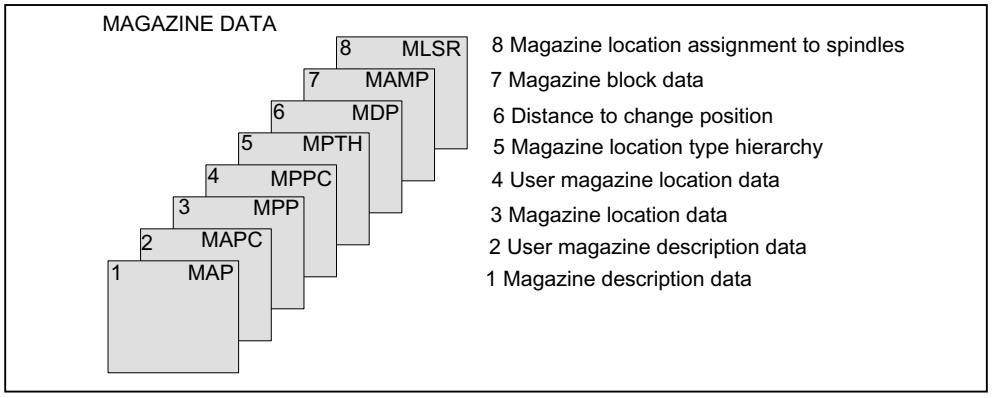



Figure 5-6 Overview of magazine data

## 5.4.2 Magazine description data

### $TC_MAPx[n]

Magazine description data

This data identifies the real magazine

x: = Parameter 1...10

n: = Magazine number 1...30, 9998, 9999

### OPI block TM

Calculation of line: Magazine number

Calculation of column: n.a.

| Magazine description data, tool management | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| | | Magazine number | magNo | WORD | 0 |
| $TC_MAP2 | String | Identifier of the magazine | magIdent | String | " " |

| Magazine description data, tool management | | | | | |
|---|---|---|---|---|---|
| **NCK identifier** | **Type** | **Designation** | **OPI variables** | **Type** | **Default setting** |
| $TC_MAP1 | INT | Type of magazine<br>**1** = Chain<br>**3** = Turret<br>**5** = Box magazine<br>**7** = Tool buffer magazine<br>**9** = Loading magazine | magKind | WORD | 0 |
| $TC_MAP3 | INT | Status of magazine<br>Bit 0: Active magazine<br>Bit 1: Disabled<br>Bit 2: Magazine is at load position<br>Bit 3: Tool motion is active<br>Bit 4: Magazine or tool may be moved. Released for loading<br>Bit 6: Magazine is fixed-location-coded, i.e. tools in this magazine are considered fixed-location-coded tools and treated accordingly<br>Bit 8: Edge location must not be overlapped left<br>Bit 9: Edge location must not be overlapped right<br>Bit 10: Edge location must not be overlapped top<br>Bit 11: Edge location must not be overlapped bottom | magState | WORD | 2 |
| $TC_MAP6 | INT | Number of tiers (box magazines only) | magDim | WORD | 1 |
| $TC_MAP7 | INT | Number of columns | - | - | |
| - | - | Number of locations for the magazine, corresponds to $TC_MAP6*$TC_MAP7 | magNrPlaces | WORD | 0 |
| $TC_MAP8 | INT | Current magazine position relative to change position | magActPlace | WORD | 0 |
| - | | | magCmd | WORD | |
| - | | | magCmdState | WORD | |
| - | | | magCmdPar1 | WORD | |
| - | | | magCmdPar2 | WORD | |
| $TC_MAP9 | INT | Current wear grouping number | magWearCompoundNo | DINT | 0 |
| $TC_MAP10<br>(bit 0...7) | INT | Current tool search strategies of magazine (see $TC_MAMP2) | magToolSearchStrat | WORD | 0 |
| $TC_MAP10<br>(bit 8...15) | INT | Current empty location search strategy of magazine | magPlaceSearchStrat | WORD | 0 |

## $TC_MAP3

The magazine status **bit 3** (tool motion is active) is always reset when the software is booted with backup.

A magazine that has the status "Tool motion is active" cannot be deleted.

Empty locations are not sought in magazines with the "disabled" status. If a disabled magazine is explicitly defined for the empty location search the process is aborted with an error message.

A tool that is in a "disabled" magazine cannot be loaded into the spindle or the toolholder.

Overlapping edge locations (bit 8...11=1)

For default setting (Bit 8 ...11 = 0), an oversized tool extends beyond the magazine edge locations. If this has to be prevented (e.g. due to the mechanical situation at the machine), then one or several of these bits can be set.
Example: Bits 8 and 9 are set, bits 10 and 11 are not set.
This means that an oversized tool must not overlap the magazine (typically a box-type magazine) at its lefthand and righthand sides, but an oversized tool may overload/extend beyond the magazine at its upper and lower side.
The following applies:
Left and above regarding a reference location is precisely there where the magazine locations with the lower magazine numbers are.
Right and below regarding a reference location is precisely there where the magazine locations with the higher magazine numbers are.

## $TC_MAP8

The current magazine position $TC_MAP8 is refreshed by the NCK every time the magazine is moved.

When the magazine configuration has been loaded, variable $TC_MAP8 is assigned the value zero. The position value is the number of the magazine location that is located at the zero position of the magazine. As a maximum, the magazine position can have the number of magazine locations in the magazine. Larger or negative values are rejected.

## $TC_MAP10

Magazine-specific tool search

The bit settings correspond precisely to the system variables $TC_MAMP2.

For buffer magazines, the default setting "0" always applies, i.e. the search is made forwards from the 1st magazine location.

## 5.4.3 Magazine user data

### $TC_MAPCx[n]

Magazine user data

Up to 10 user data can be additionally created for each magazine. Setting in the MD18090 MM_NUM_CC_MAGAZINE_PARAM and enable with MD18080 MM_TOOL_MANAGEMENT_MASK (set bit 2)

x: = Parameter 1...10

n: = Magazine number 1...30

### OPI block TUM

Calculation of line: Parameter number

Calculation of column: Magazine number

| Magazine description data OEM user | | | | |
|---|---|---|---|---|
| **Name** | **Type** | **Designation** | **OPI VAR** | **Type** |
| $TC_MAPC1 | | | userData | DINT |
| ... | | | userData | DINT |
| $TC_MAPC10 | | | userData | DINT |

## 5.4.4 Magazine location data

### $TC_MPPx[n,m]

Magazine location data

The following data describes the magazine location

x: = Parameter 1..7

n: = Physical magazine number 1..30, 9998, 9999

m: = Physical location number 1...32000

The maximum value of x is stored in OPI variable numMagPlaceParams in block Y.

### OPI block TP

Calculation of line: (magazineLocNo-1)*numMagPlaceParams+ParameterNo.

Calculation of column: Magazine number

| Magazine location data, tool management | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| $TC_MPP1 | INT | Location type<br>1 = Magazine location<br>2 = Spindle, toolholder<br>3 = Gripper<br>4 = Loader<br>5 = Transfer location<br>6 = Loading station<br>7 = Loading point | placeData | WORD | 0 |
| $TC_MPP2 | INT | Location type<br>> 0: Location type for virtual location<br>= 0: Every TL fits in this location<br>9999: Not defined | placeData | WORD | 9999 |
| $TC_MPP3 | BOOL | Consider adjacent location on/off | placeData | WORD | FALSE |
| $TC_MPP4 | INT | Location state<br>Bit 0: Disabled<br>Bit 1: Free to accept a tool (occupied)<br>Bit 2: Reserved for tool from buffer<br>Bit 3: Reserved for new tool to be loaded<br>Bit 4: Occupied in left half location<br>Bit 5: Occupied in right half location<br>Bit 6: Occupied in upper half location<br>Bit 7: Occupied in lower half location<br>Bit 8: Left half location reserved<br>Bit 9: Right half location reserved<br>Bit 10: Top half location reserved<br>Bit 11: Lower half location reserved<br>Bit 12: Wear group disabled<br>Bit 13: Overlapping permitted. Tools can overlap disabled magazine locations. Only possible if consider adjacent location is active (see also MD 17520). | placeData | WORD | 1 |
| - | | Reference phys. magazine (top right) | placeData | WORD | 0 |
| $TC_MPP5 | INT | Location type index (location type numbering) or wear group number | placeData | WORD | 0 |
| $TC_MPP6 | INT | T No. of tool at this location | placeData | WORD | 0 |
| $TC_MPP7 | INT | No. of adapter in mag. location | placeData | WORD | 0 |

| Magazine location data, tool management | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| $TC_MPP_SP | INT | For tool speed and acceleration monitoring<br>Only relevant, if $MC_TOOLHOLDER_MANAGEMENT is > 0. Spindle No., which is linked to the toolholder. | placeData | | |
| $TC_MPP66 | INT | T No. of the tool, for which the identification "reserved for tool in buffer" is set.<br>If a tool is transported into the spindle within the scope of changing from the magazine, the magazine location is reserved (identifier "reserved for tool in the buffer"), the T No. of this tool is entered into $TC_MPP& and the tool has entered this location in the variable $A_MYMN/MYMLN. | placeData | | |

## Writing magazine location data

Points to be noted about writing magazine location data:

When writing to a $TC_MPP... parameter for the first time, all of the magazine locations defined by magazine parameters are created with their default values (the memory for the locations is therefore "used up"). i.e. the magazine must have been defined by this time ($TC_MAP... parameter).

## $TC_MPP1 (location type)

Only magazine locations of the type "Magazine location" ($TC_MPP1 = 1) may be defined at magazines that are not of the type "internal" ($TC_MAP1 = 7 or = 9).

**Location types:**

1 = Magazine location
Only locations of type "1" can be defined at real magazines.

2 = Spindle/toolholder

3 = Gripper

4 = Loader

5 = Transfer location
The distinction gripper/loader/transfer location is intended for HMI applications. Here, NCK does not make a distinction, load and transfer location are treated just like a gripper.

6 = Loading station
After the tool moves to this location, the tool stays there. It can only be removed by explicit operation (unloading).

7 = Loading point
If a tool is moved from the magazine or buffer to this location, after the PLC acknowledgement of this motion command, the tool is automatically removed from this location.

Please note when writing the location status and number of the tool in this location that the following dependencies on $TC_MPP2 to $TC_MPP4 apply; these are checked during the write operation:

- If the location already contains a tool, the location type to be written must be checked against the tool location type.
- The status "not occupied" may only be written when none of the "assigned" states is set and there is no tool at the location.
- The "Disabled" state can be set irrespective of the other states.
- If there is no tool here then the state "not occupied" is automatically active; i.e., the state "not free" cannot be set by the NC program or PLC, HMI.
- "Occupied" states can only be set by the NCK within the scope of the adjacent location consideration; i.e. these states are ignored during writing by the NC program or PLC, HMI.
- The state "Reserved for tool from buffer" is set when a tool is removed by the NCK from the real magazine during a tool change. This location is then not designated as "Free" for tools other than the tool removed.
- The states "Reserved for tool from buffer" and "reserved for new tool to be loaded" **of a location** are automatically reset when a tool is placed in this location.
- The states "reserved for tool from buffer" and "reserved for new tool to be loaded" of a **real magazine location** are automatically reset when a tool from this location is placed at a location in the loading/unloading magazine.
- The state "Reserved for tool from buffer" is reset during an empty location search if the tool for which the empty location is being sought is assigned a magazine location other than its previous real magazine location. The newly found empty location is assigned the state "Reserved for tool from buffer" and becomes the new owner of the tool being sought.

The magazine location state "Reserved for tool to be loaded" is always reset when the control system is restarted. If "Consider adjacent location" is active, reservations of adjacent locations are also considered.

Users only have to deal with these rules if they wish to define the magazine directly at the NC program level. Data back-up is such that the rules are observed when data is imported to the NCK.

### $TC_MPP5 (location type index)

This data contains the spindle number for magazine locations of type "spindle" ($TC_MPP1) and is thus made known to the tool management.

The value cannot be changed for location type = 1 ($TC_MPP1; i.e. for all locations of internal magazines) if there is a tool at the location.

### $TC_MPP6 (T No.)

- Tools can only be placed in magazine locations when both the tool and the magazine, plus its magazine locations, have been defined.

The tool may occupy only one magazine location!

Procedure:

It first attempts to find the tool associated with the T No.

- If it is already defined, then an attempt is made - subject to appropriate check procedure - to add it to the magazine location.
- If it is not yet defined, then an error has occurred.

Checks:

- The type of the tool to be placed must match the type of the location. If the type has not been set explicitly at the time of writing (default = 9999 = "Not defined"), then the tool is not placed.
- The state of the location must be "Free" and must not be "Disabled".
- If the value T No.=0 is programmed, then this means that the present tool will be removed from the magazine location.

  Notice: $TC_MPP6 = 0 also changes the state of the location: a tool can only be placed in a magazine location if the location does not already contain a tool. The old tool might first have to be removed with $TC_MPP6 = 0.

**Note**

Because of this dependency of the individual data, it is mandatory for the T number of the tool to be written as the last data in a magazine configuration. If you do not adhere to this sequence, default values might be set which may result in unwanted data.

## 5.4.5 Magazine location user data

### $TC_MPPCx[n,m]

Magazine location user data

Up to 10 user data can be additionally created for each magazine. Setting for number of parameters in MD18092 MM_NUM_CC_MAGLOC_PARAM and enable with MD18080 MM_TOOL_MANAGEMENT_MASK (set bit 2)

x: = Parameter 1...10

n: = Magazine number 1...30

m: = Magazine number 1...32000

### OPI block TUP

Calculation of line: (m-1)*numMagLocParams_u+ParameterNo.

Calculation of column: Magazine number

| OEM user magazine location data | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| $TC_MPPC1 | INT | | userplaceData | DINT | 0 |
| ... | INT | | userplaceData | DINT | 0 |
| $TC_MPPC10 | INT | | userplaceData | DINT | 0 |

## 5.4.6 Magazine location type hierarchy

### $TC_MPTH[n,m]

Magazine location type hierarchy

The location types can be organized in a hierarchy by programming these system variables.

n: = Index of hierarchy, from 0...7

m: = Index within hierarchy n, location type 0...7

Magazine location types, refer also to $TC_TP7 and $TC_MPP2.

### OPI block TT

Calculation of line: Number of location type+1

Calculation of column: Number of the location hierarchy+1

| Magazine data: Magazine location type hierarchy | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| $TC_MPTH[n,m] | INT | Location type hierarchy<br>n: Hierarchy 0-7<br>m: Location type 0-7 | placeType | WORD | 9999 |

If a tool is to be loaded into the magazine, then the location type determines the availability of locations, i.e. $TC_TP7 and $TC_MPP2 must be defined.

If the location type of the tool is part of the location type hierarchy, then the location assignment is carried out in accordance with this hierarchy.

Several such hierarchies can be set up in one TO-area unit, but a location type can only be entered in one hierarchy.

**Example**

A chain magazine is to be split into 6 location types and the following hierarchy defined (the magazine No. is "1", the numbers of the location types are selected at random).

Location type_124 < Location type_3 < Location type_15 < Location type_1080 < Location type_5 <Location type_18

Definitions:

Magazine:

$TC_MPP2[Magazine No, location]
$TC_MPP2[1,1...6] = 124
$TC_MPP2[1,7...12] = 3
$TC_MPP2[1,13...18] = 15
$TC_MPP2[1,19...24] = 1080
$TC_MPP2[1,25...30] = 5
$TC_MPP2[1,31...36] = 18

Hierarchy:

$TC_MPTH[0,0] = 124
$TC_MPTH[0,1] = 3
$TC_MPTH[0,2] = 15
$TC_MPTH[0,3] = 1080
$TC_MPTH[0,4] = 5
$TC_MPTH[0,5] = 18

If a tool of type_15 ($TC_TP) is loaded, it is preferable for it to be stored at locations 13...18. If none of these locations are free, the search for an empty location continues, in accordance with the hierarchy, at locations of type_1080.

## 5.4.7 Distance to change position

### $TC_MDPx[n,m]

Distance from magazine zero

$TC_MDPx[n,m]=value

x: = 1: Loading magazine: Loading points, loading station (1st int. mag.)

x: = 2 : Buffer magazine: Spindle, gripper,..(2nd int. mag.)

n: = Magazine No. of real magazine

m: = Location No. of internal magazine (loading point,..).

Value: = Distance in number of locations

### OPI block TPM

Calculation of line:

(LocNo.-1)*numPlaceMulti*numPlaceMultiParams+ParameterNo.

Calculation of column: Magazine number

| Magazine data: Distance to change position | | | | |
|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI VAR | Type |
| $TC_MDP1 | INT | Distance between tool change position of magazine n and location m of 1st internal magazine (loading magazine, 9999) | multiPlace | WORD |
| $TC_MDP2 | INT | Distance between tool change position of magazine n and location m of 2nd internal magazine (loading magazine, 9998) | multiPlace | WORD |

## Description

Magazine position

The current magazine position is required for tool change, loading and unloading. This position refers to the magazine zero point established by the machine manufacturer. This is usually at the change position.

The number of the location at the magazine zero point has to be given during initialization. Otherwise, it is assumed that the non-existent location 0 is at the change position.

If the magazine is moved by a task, the current position is changed accordingly. The NC does not know how many positions the magazine has moved but knows the targets of the relevant commands. On the basis of the defined distance between and object (e.g. spindle 2) and the change position, the NC is able to update the current position.

Comment:

The value of the distance and the current magazine position is also evaluated for box magazines.

For empty location searches and tool searches, search strategies based on reference to the current magazine position convert the position contained in system variable $TC_MAP8 to the change position, loading point in each case at which the search is started. With search tasks, the NCK always specifies internally which change position, loading point is to be used as reference for the search.

Assignment

By defining $TC_MDPx[n,m], a connection or assignment (distance relationship) is established between the real magazine and the buffers or the loading points. HMI Advanced can only display assigned buffer locations and loading points. A tool transport within the scope of a t preparation or a change can only be realized via an assigned buffer (exception: asynchronous transfers). The tool search, for T preparation and change is also only made in those magazines assigned to a spindle or toolholder.

The maximum number of these distance relationships can be defined with machine data $MN_MM_NUM_LOCS_WITH_DISTANCE. Example: 1. TO unit, 1 magazine, 1x spindle, double gripper, 2x loading point. This is a total of 5 distance relationships (3x $TC_MDP2 to assign the real magazine to the 3 buffers, 2x $TC_MDP1 to assign the real magazine to the two loading points.

**Note**

Command $TC_MDP2[n,m]=9999 can be used to dissolve a distance relationship.

## Example:

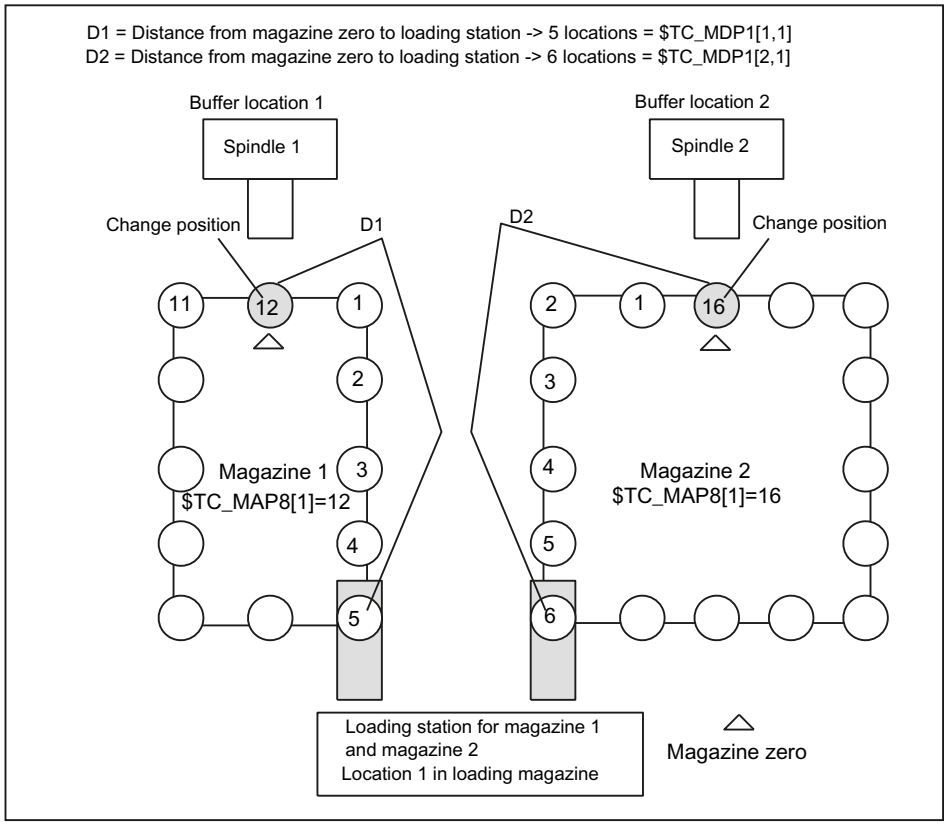



Figure 5-7 Distance to change position $TC_MDPx[y,z]=value

The magazine zero point is usually the change position of the spindle. Therefore, the following applies:

- If location 1 is located at zero position, the current magazine position = 1 ($TC_MAP8[1]).

Examples for programming the distance to the zero position:

| | |
|---|---|
| $TC_MDP1[1,1] = 5 | Distance between location 1 of the loading station and the zero position of magazine 1 |
| $TC_MDP1[2,1] = 6 | Distance between the same location and the zero position of magazine 2 |
| $TC_MDP2[1,1] = 0 | Distance between location 1 of 2nd internal magazine and zero position of magazine 1 |
| $TC_MDP2[2,2] = 0 | Distance between location 2 of 2nd internal magazine and zero position of magazine 2 |

## 5.4.8 Magazine blocks

### $TC_MAMPx

Magazine block data

x: = Parameter 1, 2, 3

### OPI block TMC

Calculation of line: n.a.

Calculation of column: n.a.

| Magazine block data, magazine control block | | | | | |
|---|---|---|---|---|---|
| **NCK identifier** | **Type** | **Designation** | **OPI variables** | **Type** | **Default setting** |
| $TC_MAMP1 | String | Identifier of the configuration magazine | magCBIdent | String | " " |
| | | Number of the loading magazine | magBLMag | WORD | |
| | | Number of the buffer magazine | magZWMag | WORD | |

| Magazine block data, magazine control block | | | | | |
|---|---|---|---|---|---|
| **NCK identifier** | **Type** | **Designation** | **OPI variables** | **Type** | **Default setting** |
| $TC_MAMP2 | INT | Type of tool search (bits 0...7) and type of empty location search (bits 8...15)<br>Bit 0=0 default strategy - take the first available tool found in the tool group. First search in the magazine from which the last change took place.<br>Bit 0=1: Select the "active" tool in the magazine of the previously changed tool; otherwise search for replacement tool with lowest duplo number. If no tool is found in this magazine, continue searching in the other associated magazines<br>Bit 1: Search for next replacement tool at the shortest possible distance from the current magazine position<br>Bit 2: Select the "active" tool otherwise replacement tool with the smallest number contained in $TC_TP10<br>Bit 3: Search for tool in the group with the **lowest actual value** for the monitored quantity<br>Bit 4: Search for tool in the group with the **largest actual value** for the monitored quantity | magSearch | | 0 |

| Magazine block data, magazine control block | | | | | |
|---|---|---|---|---|---|
| **NCK identifier** | **Type** | **Designation** | **OPI variables** | **Type** | **Default setting** |
| $TC_MAMP2 | INT | Bit 5: Only consider those tools whose actual value is at least the factor $AC_MONMIN of the set value away from the limiting value<br>Bit 6: First search in the magazine currently being considered (this is only effective in conjunction with bit 7=1)<br>Bit 7=0: Start the tool search in that magazine where the tool last changed came from<br>Bit 7=1: Always start the search in the 1st magazine of the distance table<br>Bit 7= 1 + bit 0=1 or bit 2=1, if no "activeTL" is found in the magazine, then - if available - the active tool is selected from another magazine linked with the toolholder | magSearch | | 0 |
| $TC_MAMP2 | | Bit 8<br>Search forwards starting at first location number<br>Bit 9<br>Search forwards starting at current magazine position<br>Bit 10<br>Search backwards starting at last location number | | | |

| Magazine block data, magazine control block | | | | | |
|---|---|---|---|---|---|
| **NCK identifier** | **Type** | **Designation** | **OPI variables** | **Type** | **Default setting** |
| $TC_MAMP2 | | Bit 11<br>Search backwards starting at current magazine position<br>Bit 12<br>Symmetrical search starting at the current magazine position<br>Bit 13<br>(1:1 exchange) behavior<br>If the 1:1 exchange is not possible, the search strategy for an empty location is considered "symmetrical".<br>The 1:1 exchange acts in addition to other set search strategies. If possible, the 1:1 exchange is treated as a priority.<br>Bit 14 = 0 (hierarchy)<br>First searches the magazine with a search run across the location types of the hierarchy of the tool type. If a location type is not found, then a search run is performed across the magazine.<br>Bit 14 = 1 (hierarchies)<br>Search the location type of the tool in the magazine, if nothing is found, search run across the magazine. If a location is still not found, then a search run is repeated across all magazines with the next location type from the type hierarchy. | | | |

| Magazine block data, magazine control block | | | | | |
|---|---|---|---|---|---|
| **NCK identifier** | **Type** | **Designation** | **OPI variables** | **Type** | **Default setting** |
| | | Bit 15 = 0 (type, location type hierarchy)<br>Each location type can be included as a maximum in one location type hierarchy.<br>Bit 15 = 1 (type, location type hierarchy)<br>For the listed location types, 1, ...8, location type hierarchies can be defined so that one **location type may be contained in several hierarchies**. The hierarchies for location type 1 are defined with $TC_MPTH[0,m], those for location type 8 with $TC_MPTH[7,m]. | | | |
| $TC_MAMP3 | INT | Procedure for tools in a wear group (bit 0...7)<br>Search strategies for wear groups (bit 8...15)<br>Bit 0=0: When a wear group is activated, the tool status remains unchanged<br>Bit 0=1: When a wear group is activated, the tool status is changed. One tool from each tool group becomes active | modeWearGroup | WORD | 0 |

| Magazine block data, magazine control block | | | | | |
|---|---|---|---|---|---|
| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
| $TC_MAMP3 | | Bit 1=0: When a wear group is disabled, the tool status remains unchanged<br>Bit 1=1: When a wear group is disabled, the tool status is changed<br>Bit 2...7 reserved<br>Search strategy for next wear group<br>Bit 8=0: Find the next possible wear group<br>Bit 8=1: Find the wear group with the next highest group number that can be activated<br>Bit 9...11 reserved | | | |
| $TC_MAMP3 | | Search strategy within the tool group for the tool to be set to active (language command SETTA or PI_SETTST)<br>Bit 12=0: Lowest possible duplo number<br>Bit 12=1: Lowest possible magazine location number<br>Bit 13=1: Lowest number contained in $TC_TP10 | | | |

## Interaction of the bits for the tool search strategy

The following strategies always start the search in the first magazine of the distance table.

| $TC_MAMP2 = | | Meaning |
|---|---|---|
| Bit | Hex value | |
| 7 + 0 | 'H80' | Otherwise, the same as value 0 |
| 7 + 0 | 'H81' | Otherwise, the same as value 1 - however, if an "active" tool is not found in the magazine, then - if available - the "active" tool is selected from another magazine linked with the toolholder. If no tool with the "active" state is available, then a search is made for the replacement tool with the lowest duplo number. (This definition applies for NCK SW releases higher than 70 and replaces the previous definition.) |
| 7 + 6 + 0 | 'HC1' | Otherwise, the same as value 1 - however, if an "active" tool is not found in the magazine, then a search is made in the same magazine for any tool that can be used; if no tool is available, then a search is made in another magazine linked with the toolholder. (this applies for NCK SW releases greater than 75.05, 78.05 or 80.00) |
| 7 + 1<br>7 + 6 + 1 | 'H82'<br>'HC2' | Otherwise the same as bit 1 =1 ('H2') |

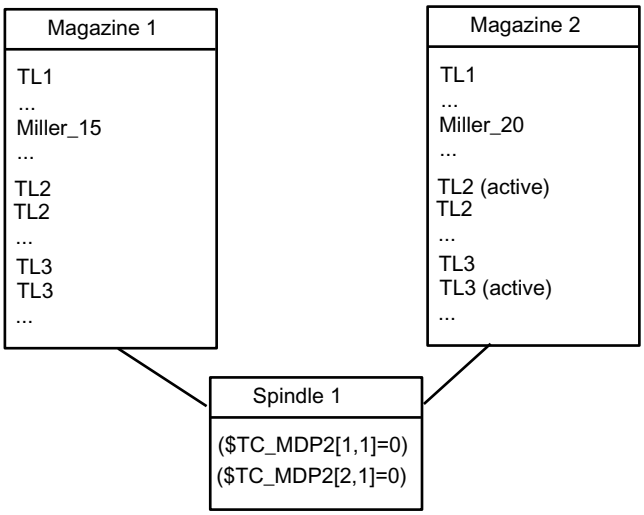
| $TC_MAMP2 = | | Meaning |
|---|---|---|
| 7 + 2 | 'H84' | Otherwise, the same as bit 2 = 1 ('H4') - however, if an "active" tool is not found in the magazine, then - if available - the "active" tool is selected from another magazine linked with the toolholder. If no tool with the "active" state is available, then a search is made for the replacement tool with the lowest number in $TC_TP10.<br>(This definition is applicable for NCK SW releases higher than 70 and replaces the previous definition.) |
| 7 + 6 + 2 | 'HC4' | Otherwise, the same as bit 2 =1 ('H4') - however if no "active" tool is found in the magazine, then a search is made in the same magazine for a tool that can be used; if available, then a search is made for the replacement tool in another magazine linked with the toolholder with the lowest number in $TC_TP10.<br>(This definition is valid for NCK SW releases greater than 75.05, 78.05 or 80.00) |
| 7 + 3<br>7 + 6 + 3 | 'H88'<br>'HC8' | Otherwise the same as bit 3 =1 ('H8') |
| 7 + 4<br>7 + 6 + 4 | 'H90'<br>'HD0' | Otherwise the same as bit 4 =1 ('H10') |

**Search operation for $TC_MAMP2, bit 0=1, bit 6=0, bit 7=1**
A search is made for the appropriate tool in the magazine according to the tool search strategy that has been set (defined using parameter $TC_MAMP2). The search is considered to have been successful if a tool was found according to the search strategy.

**Search operation for $TC_MAMP2, bit 0=1, bit 6=1, bit 7=1**
A search is initially made for the appropriate tool in the magazine according to the tool search strategy that has been set (defined using parameter $TC_MAMP2). The search is considered to have been successful if a tool according to the search strategy was found - or all tools of the group were checked and no tool was found according to the search strategy - but in spite of this, a tool that can be used was found among the tools that were searched.

If a search is made according to the strategy, bit 2=1 (sequence of use $TC_TP10) then the same principle applies. The criterion is also "active tool" and instead of the duplo number, the number in $TC_TP10.

## Example to clarify the principle of operation of bit 6 and bit 7




Assumption:

- All tools can be used
- Basic setting of the search strategy is bit 0 = 1 - search for the active tool, if there is no active tool, take the tool with the lowest duplo No.
- Spindle_1 is linked to both magazines, magazine_1 is the first in the distance table

Example_1:
Bit 6 = 0
Bit 7 = 0

| | | |
|---|---|---|
| T="Miller_15"M06 | | There is only one "miller_15" tool, it was found in magazine_1 and was loaded |
| ... | | |
| T="TL3" 06 | M | The last change was performed from magazine_1. Therefore, the search is first made in magazine_1. There is no active "TL3" there, but there are 2 tools in this group that can be used. The tool with the lowest duplo No. is selected. Magazine_2 is no longer considered. |

Example_2:
Bit 6 = 0
Bit 7 = 1

| | | |
|---|---|---|
| T="Miller_20"M06 | | There is only one "Miller_20" tool, it was found in Magazine_2 and was loaded |
| ... | | |
| T="TL3" 06 | M | The last change was performed from Magazine_2. As a result of bit 7 = 1, the tool search is however started in Magazine_1. However, this setting also means that the search strategy "active tool" has priority over a magazine-specific approach. This means that: No active tool from the group "TL3" was found in Magazine_1, i.e. the search is continued in the next magazine (corresponding to the sequence in the distance table). An active "TL3" is there - and this is selected. |

Example_3:
Bit 6 = 1
Bit 7 = 1

| | | |
|---|---|---|
| T="Miller_20"M06 | | There is only one "Miller_20" tool, it was found in Magazine_2 and was loaded |
| ... | | |
| T="TL3" 06 | M | The last change was performed from Magazine_2. As a result of bit 7 = 1, the tool search starts in Magazine_1. However, no tool of this group is present there. As a result of bit 6 = 1 (considers the actual magazine with priority), a search is now made for a "TL3" that can be used in Magazine_1 (for this search, this is also the actual magazine); this tool is also found. |

## $TC_MAMP2

For software release less than 2.5, the tool search is always made magazine for magazine, starting in the magazine from which the last change was made.

With bit 7 there is an additional option to select the tool search.

Bit 7=1

The search always starts in the 1st magazine of the distance table. If the search for the active tool is set using either bit 0 or bit 2, then a search is made for the active tool across all of the magazines linked with the spindle. A search is only made for a replacement tool if no active tool was found in all of these magazines.

**Note**

The tool sequence in a tool group is not defined (e.g. ascending duplo number). This means, if the default strategy is used for the search (MAMP2=0), then any tool that is capable of being used is found.

## 5.4.9 Assigning buffers to spindles

### $TC_MLSR[x,y]

Assignment of buffer locations to spindles - $TC_MLSR[x,y]

x: = Location No. in buffer 1... 32000

y: = Location No. of the spindle in buffer magazine 1... 32000

### OPI block n.a.

Calculation of line: n.a.

Calculation of column: n.a.

| NCK identifier | Type | Designation | OPI variables | Type | Default setting |
|---|---|---|---|---|---|
| $TC_MLSR[x,y] | INT | System variable for assigning magazine locations of the buffer magazine to the spindle | - | - | 0 |

### Description

This assignment is important when searching for tools. The search is always made, viewed from the requesting spindle, initially in the associated buffers, then in the assigned magazines. This means that a tool, which is located in the buffer, can only be found if there is an assignment to the spindle via parameter $TC_MLSR.

The number of possible links between the spindle and the buffer can be set using machine data $MN_MM_DIST_REL_PER_MAGLOC.

Example: 1. TO unit, 1 magazine, 1x spindle, double gripper, 2x loading point. The double gripper is linked to the spindle via $TC_MLSR[2,1]=0 and $TC_MLSR[3,1]=0. The correct value for the MD is "2".

The sequence when programming is decisive for the sequence when automatically returning tools.

**Note**

The content value of the system variable is not evaluated. The assignment is defined via indices x and y. In order to check via the part program whether a certain assignment exists, a read operation has to return the value zero.

**Note**

No more than 16 magazines or buffer locations can be assigned to one spindle.

## Magazine distance to buffer via toolholder/spindle

$TC_MDP2 and $TC_MLSR establish a relation between the buffer locations and magazines (see the following diagram).

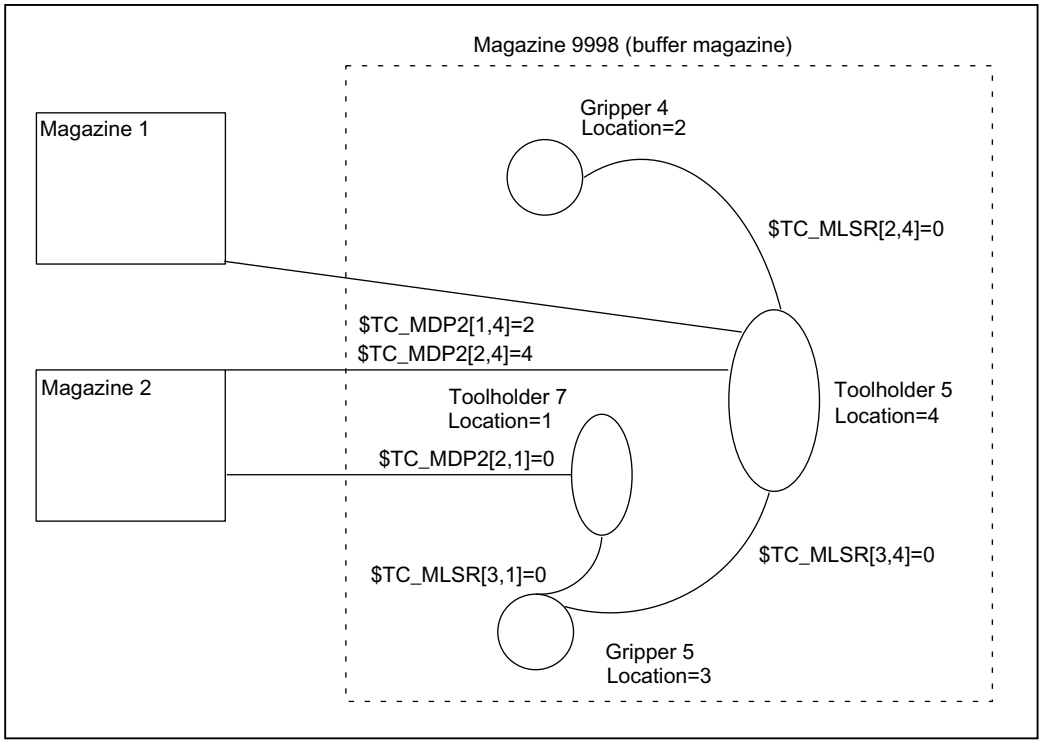



Figure 5-8 Magazine distance to the buffer

### Configuration

Two magazines are defined with numbers 1 and 2.

Four locations 1, 2, 3 and 4 are defined in buffer 9998; two toolholders 5, 7 and two grippers 4, 5.

```
$TC_MPP1[9998,1] = 2        ; Location type = spindle or toolholder
$TC_MPP5[9998,1] = 7        ; Toolholder No. = 7
$TC_MPP1[9998,2] = 3        ; Location type = Gripper
$TC_MPP5[9998,2] = 4        ; Gripper No. = 4
$TC_MPP1[9998,3] = 3        ; Location type = Gripper
$TC_MPP5[9998,3] = 5        ; Gripper No. = 5
$TC_MPP1[9998,4] = 2        ; Location type = spindle or toolholder
$TC_MPP5[9998,4] = 5        ; Toolholder No. = 5
```

Both grippers are linked to toolholder 5 via $TC_MLSR. They do not require their own distance definition for the magazines. They are linked to the magazines via toolholder 5 with the distance relations defined there. However, it is also possible to define separate distance relations for the grippers.

Toolholder 5 is linked with both magazines via $TC_MDP2.

Toolholder 7 is only linked with magazine 2; gripper 5 is assigned to it.

# 5.5 Adapter data

## $TC_ADPTx[n]

If machine data $MN_MM_NUM_TOOL_ADAPTER is set to a value = -1 or > 0, the adapter data is defined, deleted, read and written via the following variables

x: = Parameter 1...3, T

n: = Adapter number

## OPI block AD

Calculation of line: Length 1, 2, 3 = line 1, 2, 3, transformation = line 4

Calculation of column: Adapter number

| Adapter data | | | | |
|---|---|---|---|---|
| **Name** | **Type** | **Designation** | **OPI VAR** | **Type** |
| $TC_ADPT1 | Double | Adapter geometry: Length 1 | adaptData | REAL |
| $TC_ADPT2 | Double | Adapter geometry: Length 2 | adaptData | REAL |
| $TC_ADPT3 | Double | Adapter geometry: Length 3 | adaptData | REAL |
| $TC_ADPTT[n] | Double | Adapter transformation number | adaptData | REAL |

The adapter geometry values act on the geometry values of the cutting edge in the same way as system variables $TC_DP 21, $TC_DP 22 and $TC_DP 23. These parameters are available only when the tool management is active.

Transformation numbers 1 to 8 can be programmed for the adapter transformation function. The parameter is available only when the tool management is active.

$TC_MPP7[m,p]: Number of adapter assigned to magazine location

Value=0 : No adapter assigned to location

Value>0 : Number of the assigned magazine

# 5.6 Toolholder data

## Overview

The orientation of the tool can be changed for a class of tool machines. The orientation once set is however subsequently fixed during operation and in particular cannot be changed during traversing. Therefore, a kinematic orientation transformation for this type of machine is neither necessary nor meaningful.

It is however necessary to consider the changes in the tool length components attributable to the change in the orientation. These calculations are assumed by the PLC.

The following must be available to calculate the change of tool length components:

- **Tool** data (geometry, wear ...)
- Toolholder data (data for the geometry of the toolholder with orientation capability).

A defined toolholder must be specified for the control for the function "orientable toolholder":

## $TC_CARRx

x: = Parameter 1...33

The maximum number of toolholders can be defined in machine data 18088 MM_NUM_TOOL_CARRIER. The value is divided by the number of active TO units. The integer result indicates how many toolholders can be defined per TO unit. Values not set by the user are preset to 0.

## OPI block TC

Calculation of line: Number of the toolholder

Calculation of column: n.a.

| Toolholder data | | | | |
|---|---|---|---|---|
| **Name** | **Type** | **Explanation/description** | **OPI VAR** | **Type** |
| $TC_CARR1 | Double | No. of toolholder<br>x component of offset vector L1 | TcCarr1 | REAL |
| $TC_CARR2 | Double | No. of toolholder<br>y component of offset vector L1 | TcCarr2 | REAL |
| $TC_CARR3 | Double | No. of toolholder<br>z component of offset vector L1 | TcCarr3 | REAL |
| $TC_CARR4 | Double | No. of toolholder<br>x component of offset vector L2 | TcCarr4 | REAL |
| $TC_CARR5 | Double | No. of toolholder<br>y component of offset vector L2 | TcCarr5 | REAL |
| $TC_CARR6 | Double | No. of toolholder<br>z component of offset vector L2 | TcCarr6 | REAL |

| Toolholder data | | | | |
|---|---|---|---|---|
| **Name** | **Type** | **Explanation/description** | **OPI VAR** | **Type** |
| $TC_CARR7 | Double | No. of toolholder<br>x component of rotary axis V1 | TcCarr7 | REAL |
| $TC_CARR8 | Double | No. of toolholder<br>y component of rotary axis V1 | TcCarr8 | REAL |
| $TC_CARR9 | Double | No. of toolholder<br>z component of rotary axis V1 | TcCarr9 | REAL |
| $TC_CARR10 | Double | No. of toolholder<br>x component of rotary axis V2 | TcCarr10 | REAL |
| $TC_CARR11 | Double | No. of toolholder<br>y component of rotary axis V2 | TcCarr11 | REAL |
| $TC_CARR12 | Double | No. of toolholder<br>z component of rotary axis V2 | TcCarr12 | REAL |
| $TC_CARR13 | Double | No. of toolholder<br>Angle of rotation alpha1 | TcCarr13 | REAL |
| $TC_CARR14 | Double | No. of toolholder<br>Angle of rotation alpha2 | TcCarr14 | REAL |
| $TC_CARR15 | Double | No. of toolholder<br>x component of offset vector L3 | TcCarr15 | REAL |
| $TC_CARR16 | Double | No. of toolholder<br>y component of offset vector L3 | TcCarr16 | REAL |
| $TC_CARR17 | Double | No. of toolholder<br>z component of offset vector L3 | TcCarr17 | REAL |
| $TC_CARR18 | Double | No. of toolholder<br>x component of offset vector L4 | TcCarr18 | REAL |
| $TC_CARR19 | Double | No. of toolholder<br>y component of offset vector L4 | TcCarr19 | REAL |
| $TC_CARR20 | Double | No. of toolholder<br>z component of offset vector L4 | TcCarr20 | REAL |
| $TC_CARR21 | Axis | No. of toolholder<br>Axis name of 1st rotary axis | TcCarr21 | String |
| $TC_CARR22 | Axis | No. of toolholder<br>Axis name of 2nd rotary axis | TcCarr22 | String |
| $TC_CARR23 | Char | No. of toolholder<br>Kinematic type | TcCarr23 | String |
| $TC_CARR24 | Double | No. of toolholder<br>Offset of 1st rotary axis in degrees | TcCarr24 | REAL |
| $TC_CARR25 | Double | No. of toolholder<br>Offset of 2nd rotary axis in degrees | TcCarr25 | REAL |
| $TC_CARR26 | Double | No. of toolholder<br>Offset of Hirth gears in degrees for 1st rotary axis | TcCarr26 | REAL |

| Toolholder data | | | | |
|---|---|---|---|---|
| **Name** | **Type** | **Explanation/description** | **OPI VAR** | **Type** |
| $TC_CARR27 | Double | No. of toolholder<br>Offset of Hirth gears in degrees for 2nd rotary axis | TcCarr27 | REAL |
| $TC_CARR28 | Double | No. of toolholder<br>Increment of Hirth gears in degrees for 1st rotary axis | TcCarr28 | REAL |
| $TC_CARR29 | Double | No. of toolholder<br>Increment of Hirth gears in degrees for 2nd rotary axis | TcCarr29 | REAL |
| $TC_CARR30 | Double | No. of toolholder<br>Minimum position of 1st rotary axis | TcCarr30 | REAL |
| $TC_CARR31 | Double | No. of toolholder<br>Minimum position of 2nd rotary axis | TcCarr31 | REAL |
| $TC_CARR32 | Double | No. of toolholder<br>Maximum position of 1st rotary axis | TcCarr32 | REAL |
| $TC_CARR33 | Double | No. of toolholder<br>Maximum position of 2nd rotary axis | TcCarr33 | REAL |

Additional references:

/FB1/ Description of Functions, Basic Machine; Tool Offset (W1) and

/PGA/ Programming Guide Advanced

# 5.7 User-definable variables

## User-definable parameters

These programmable variables provide the user with three user-definable parameters. These system variables are transferred to the PLC over the user interface with the T selection signal and the change command to the PLC. They allow the user to send additional tool management information to the PLC. The parameters can be read and written by the NC program. They are not buffered and are set to "0" on Reset or end of program.

## $P_VDITCP[x]

x: = Parameter 0, 1, 2

| NCK identifier | Description | Format |
|---|---|---|
| $TC_VDITCP[0] | Tool management VDI user-definable parameter 0 | int |
| $TC_VDITCP[1] | Tool management VDI user-definable parameter 1 | int |
| $TC_VDITCP[2] | Tool management VDI user-definable parameter 2 | int |

## Interface DB 72, DB 73

The user parameters are output in DB 72 and DB 73 on the tool management interface. They are only valid when the status of the interface is active. The format is DINT.

## Example

$P_VDITCP[0]=12; DB72.DBD(n+4) =12 or

$P_VDITCP[1]=33; DB72.DBD(n+8) =33 or

$P_VDITCP[2]=2000; DB72.DBD(n+12) =2000

T="Tool"

The variables must be set in the part program before the T call or M06 if these shall transferred for a tool to the PLC as well.

## Programming

The parameters can be programmed as required in the NC program. The output to the PLC is however always realized in conjunction with the tool preparation or change command programmed in the following.

Example:

```
T= "TL1"
$P_VDITCP[0] = 1
M06
$P_VDITCP[0] = 2
T= "TL2"
```

Exactly the value = 2 is also given to the PLC with the command output of T = "TL2" to the PLC and not the value 1 when the M06 command is output to the PLC.

The output of the programmed value also takes place when M6 is programmed, i.e. the output can now also be realized with the command number 3 provided $MC_CHANGE_MODE=1 has been set.

# 5.8 NC language commands

## 5.8.1 CHKDNO - Uniqueness check for D number

### Overview

D number uniqueness is understood here (not for replacement tools) as being that the D numbers of all tools defined in the TO unit may occur exactly only once => the D numbers are unambiguous and absolute. This is known in the tool-management function as the possibility of assigning "unique" D numbers only. The distinction is made on the basis of replacement tools that are generally present.

**Status = CHKDNO (T1, T2, D)**

Parameters used:

| | |
|---|---|
| TRUE | Unique D numbers have been assigned for the checked area |
| FALSE | A D-number collision is the result or the parameterization is invalid |

The parameters are optional.

| | |
|---|---|
| CHKDNO (T1,T2) | All D numbers of the specified tools are checked. |

### D numbers of replacement tools

Replacement tools can be defined and used when tool management is active. The machining part program does not generally indicate whether any replacement tools are available. As a rule, the machining program addresses tools with T="Identifier". (Programming T="location number" is referred back to T="identifier" internally). The program otherwise only contains the actual programming of the offset (the D number). Therefore, the D number for the tool and replacement tool must be identical.

### Example

Active tool and replacement tools for T="drill_5mm"

- T No. = 10 with D numbers 1, 2, 3 (active)
- T No. = 11 with D numbers 1, 2, 3 (replacement)
- T No. = 12 with D numbers 1, 2, 3 (replacement)

Active tool and replacement tools for T="drill_3mm"

- T No. = 20 with D numbers 1, 2, 3 (active)
- T No. = 21 with D numbers 1, 2, 3 (replacement)
- T No. = 22 with D numbers 1, 2, 3 (replacement)

**CHKDNO** without parameters specified, detects a collision of D numbers 1, 2 and 3 for "drill_5mm" with D numbers 1, 2 and 3 for "drill_3mm", but not between the D numbers of the active and replacement tools.

The collisions are displayed as individual alarms, e.g.:

- "Channel 1 D number 1 defined for tool T no. 10 and 20""
- "Channel 1 D number 1 defined for tool T no. 10 and 21"

The state = FALSE is also returned in the event that the parameterization is invalid (the T or D number called is not defined in the channel).

If the following applies: MAX_CUTTING_EDGE_NO <= MAX_CUTTING_EDGE_PER_TOOL, CHKDNO always returns the TRUE state, irrespective of the parameter settings.

## 5.8.2 CHKDM - Uniqueness check within a magazine

With active tool management, the command CHKDM checks the data in NCK for D number uniqueness within one or more magazines. The functionality corresponds to CHKDNO. The parameters are optional.

state = CHKDM (magazine No., D No., toolholder No.)

Result of check:

Value = TRUE: Checked D numbers are unique.

Value = FALSE: Check not OK.

Meaning of the parameters:

| | |
|---|---|
| MagNo | Magazine number of magazine to be checked<br>Omitting the parameters or programming with a value=0 means that the tools of all of the magazines, linked with the spindle no. or toolholder toolholder number specified in the 3. parameter, are checked. |
| D No. | The D number against which the check will be made.<br>Omitting the parameter or programming with a value=0 means that all D numbers of the specified magazine are checked for uniqueness. |
| Toolholder No. | Indicates which spindle numbers or toolholder numbers the magazines shall be checked for.<br>Omission of the parameter means that the magazines are obtained for the check from the distance table of the spindle location for the master spindle or the master toolholder. |

## 5.8.3 GETACTTD - Determining the T No. for a unique D No.

For an active tool management (e.g. measuring-cycle programs), this command serves to conclude the associated T number **of the tool active in the tool group** starting from a D number.

**status = GETACTTD (T No., D No.)**

| | | |
|---|---|---|
| D No. | D number for which the T number shall be searched. The D numbers are not checked for uniqueness.<br>If the same D numbers are defined in different tool groups of the same TO unit, then the T number of the first tool group that is found determines the tools that have the specified number. | |
| T No. | T number found | |
| status | Result of search | |
| | 0 | T number found, T No. is assigned the value |
| | -1 | No T number exists for the specified D number, T No. assigned the value 0. |
| | -2 | D number is not unique; T No. is assigned the value of the D number that was first determined. |
| | -3 | The tool group does not contain any tools that have the desired status and the specified D number. T No. assigned the value 0. |
| | -4 | The tool group contains several tools that have the desired status and the D number that has been searched.<br>T No. is assigned the value of the first tool be found with the desired D number. |
| | -5 | Function could not be executed for other reasons. |

## 5.8.4 GETDNO - Rename D numbers

The language command

d = GETDNO(t, ce)

allows the offset number d to be read for the cutting edge ce of the tool with the T number t. If t or ce are parameters which have no data record, d=0 is returned. Any parameters violating the syntax rules will generate an alarm.

The command is only available if $MN_MAX_CUTTING_EDGE_NO > $MN_MAX_CUTTING_EDGE_PER_TOOL.

$MN_MAX_CUTTING_EDGE_NO <= $MN_MAX_CUTTING_EDGE_PER_TOOL returns GETDNO d=ce as D number.

## 5.8.5 SETDNO - Rename D numbers

The language command

state = SETDNO(t, ce, d) allows the offset number d of cutting edge ce of tool t to be set or changed. If t or ce are parameters which have no data record, state = FALSE is returned. Any parameters violating the syntax rules will generate an alarm.

t, ce, d must be specified > 0; d=0 cannot be set.

## 5.8.6 DZERO - Invalidate D numbers

Marks all D numbers of the TO unit as invalid. This command is used for support during conversion or re-equipping.

Offset data records tagged with this command are no longer verified by the CHKDNO language command. The D numbers have to be set with SETDNO again in order to make these accessible again.

## 5.8.7 DELDL - Delete additive offsets

This command deletes the additive offsets for the cutting edge of a tool (to release memory space). Both the defined wear values and the setup values are deleted.

status = DELDL( t, d )

Explanation of the parameters:

| | | |
|---|---|---|
| DELDL(t, d) | All additive offsets of the cutting edge with D number d of tool t are deleted. | |
| DELDL(t) | All additive offsets of all cutting edges of tool t are deleted. | |
| DELDL | All additive offsets for all cutting edges of all tools of the TO units are deleted (of the TO unit of that channel where the command is programmed) | |
| status | Result of search | |
| | 0 | Offsets have been successfully deleted |
| | -1 | Offsets have not been deleted (if the parameter settings specify exactly one tool edge), or not deleted completely (if the parameter settings specify several tool edges) |

## 5.8.8 NEWT - Create a new tool

### Overview

A new tool can bet set up in a number of ways by NC commands in NCK. Either by programming T No.=**NEWT**("TL", Duplo no.) or by programming a system variable **$TC_**...

Note that NEWT automatically generates a cutting edge with CE No. = 1, D No. = 1. If you want the tool to have a different CE no., you need to change this number after it has been generated.

The NEWT function allows a new tool to be created without specifying a T No. The function returns the automatically generated T No. with which the tool can subsequently be addressed. The 1st cutting edge is automatically created when a new tool is created. All offsets are set to 0 by default.

Return parameter = NEWT ("TL", duplo No.)

If it is not possible to create a new tool for any reason, the NEWT(...) function generates an alarm.

Specification of a duplo number is optional. It is generated in the NCK if it is not specified. (duplo No.= old duplo No. +1)

### Examples

**Example 1:**

Create a new tool with NEWT and the CE/D numbers = 2, 47

```
def int tno
tno = NEWT("tool", 111)      ; Tool with Ident/DuploNo.="Steel"/111, T No.=tno=1 in
                             ; the example and a cutting edge CE=1, D=1 is created
                             ; The cutting edge is to be named CE=2, D=47
$TC_DPCE[tno, 1]=2           ; Rename the CE number
SETDNO(tno,2,47)             ; Rename the D number
                             ; Assign the remaining data for the tool/cutting edge
```

**Example 2:**

Create tool "tool"/111, T No.=tno=1 with $TC... and CE numbers = 2 4 (let us assume that T No.=1 does not yet exist)

```
$TC_TP1[1] = 111             ; Create tool with T No.=1, duplo No.=111
$TC_TP2[1] = "Steel"         ; Assign tool Ident="steel"
$TC_TPCE[1,47] = 2           ; Newly create offset, D=47, assign CE No.=2
                             ; Assign the remaining data for the tool/cutting edge
```

The function is used for creating tools in a loading program (load cycle).

## 5.8.9 NEWMT - create new multitool

The language command is available with TMMG.

Using the NEWMT language command, a new multitool is created with the specified name "name" and the MT location number = "location number".

mtNr = NEWMT(name, location number

An implicit STOPRE is initiated at the end of the block. The MT number is automatically created and is returned as result value. If the "Several tools at magazine location" function is not activated, Alarm 6436 "Command cannot be programmed. Function is not activated." is output. If the parameter name is already being used, then Alarm 17050 "impermissible value" is output.
If the parameter location number is outside the permitted range, then Alarm 17050 "impermissible value" is output. If the command is interrupted with alarm, then for mtNo the value equal 0 is returned.

Example:

There is already a tool with the name "A" and the tool number 1 and a magazine with the name "B" and the number 2. The following is now programmed:

```
def int mtNr
mtNr = NEWMT("C", 2)
```

The command is successfully executed, mtNo has the value 3. The multitool was created for 2 locations. However, the locations were still not created. A call with the name "A" or "B" would have resulted in an alarm, as the names have already been allocated to a tool and a magazine.

After creating using NEWMT additional parameters of the multitool can be defined, e.g.

```
$TC_MTP7[ 3 ] = 12 ; multitool can be loaded to the magazine location with this location type number
$TC_MTP_POS[ 3 ] = 2 ; position value= location 2
$TC_MTP_KD[ 3 ] = 3 ; angle-coded distance
$TC_MTPPA[ 3, 1 ] = 0.0 ; the two locations are created with this write operation
$TC_MTPPA[ 3, 2 ] = 180.0
$TC_MTP8[ 3 ] = 2 ; enabled (multitool has been defined)
```

The two parameters $TC_MTPN and $TC_MTP2 were already defined it using the NEWMT command. Parameters $TC_MTP3,..., 6 were not programmed. The default values are effective.

## 5.8.10 DELT - Delete tool

A tool can be deleted with the DELT(...) function by specifying the tool identifier and duplo number. Only tools that have been unloaded can be deleted.

DELT("TL",DUPLO_NO)

All tool-related data is set to 0 (user data, hierarchy data, ...).

Example:

DELT("DRILL", DUPLO_NO)

The function is for deleting tools in the part program.

## 5.8.11 DELMT - deleting a multitool

The language command is available with TMMG.

The DELMT command can delete a multitool.

DELMT (name)

Deletion is only possible if the multitool is not contained in a magazine (is unloaded) and none of the tools contained in the multitool is an active tool regarding offset selection. If, at the time of deletion, tools are still contained in the multitool, then before the delete operation, these are automatically removed from the multitool. This means that the tools are not deleted.

If a name is specified, for which a multitool has not been defined, then the command is rejected with Alarm 17220 "Tool does not exist".

**Note**

After the multitool was unloaded, the tools contained in it are also unloaded. After the multitool has been deleted, the tools contained in it are again available to be loaded into a magazine - or into another multitool.

## 5.8.12 GETT - Read T No.

The GETT function returns the associated T number on the basis of the tool identifier and its duplo number.

The command can be used for tools as well as for multitools. A duplo number cannot be programmed for multitools.

Result value = GETT("TOOL", DUPLO_NO);

Result value

| | |
|---|---|
| > | Tool or multitool number associated with the programmed name |
| -1 | The name is neither a tool nor a multitool name |
| -2 | A multitool name was programmed with duplo number |

If the tool identifier or duplo number cannot be assigned to a tool, value -1 is returned. Specification of the duplo number is optional.

If a duplo number has not been specified, the T number of any tool from the group of tools with the specified identifier or the number of a multitool is returned (the sequence is not defined within a tool group).

Example:

Determine the T number for drill with duplo number

```
R10=GETT("DRILL", DUPLO_NO)                    ; The T number is in R10
$TC_TPx,[GETT("DRILL",DUPLO NO)]=value         ; Write tool-related data
```

This function is used for example to retroload tools via the part program.

## 5.8.13 SETPIECE - decrementing the workpiece counter

### Overview

With the SETPIECE function, the user can update the count monitoring data of the tools associated with the machining process. Each tool that has been loaded since the last activation of SETPIECE is acquired. The function serves as a rule for programming at the end of the NC main program to decrement the count from all the tools associated with count monitoring.

**Note**

The command is not active in the block search (with/without calculation). If the value for the count = 0, the internal table for flagged tools/cutting edges is deleted.

### Programming

SETPIECE(x,y)

| | |
|---|---|
| x := 0 ... 32000 | Value used when decrementing |
| y := 0...8 | Spindle index, value 0 means index of main spindle<br>(must not be programmed) |

Example:

| | |
|---|---|
| SETPIECE(1); | Workpiece counter of main spindle is decremented by 1 |
| SETPIECE(1,1); | Workpiece counter of spindle No. or toolholder No. 1 is decremented by 1 |
| SETPIECE(4,2); | Workpiece counter of spindle No. or toolholder No. 2 is decremented by 4 |

### Example of SETPIECE with M06 tool change command:

The tools involved in a workpiece (program) should be decremented by a value of 1.

```
T1              ;  T1 is preselected (with regard to main spindle)
M06             ;  T1 is changed
D1              ;  D1 is activated
T2              ;  T2 is preselected
:               ;  Machining program
:
M06             ;  T2 is changed
D1              ;  D1 from T2 is activated
T3              ;  T3 is preselected
:               ;  Machining program
:
:
M06
T0              ;  Preparation for clearing the spindle
:
M06             ;  Clearing the spindle
SETPIECE(1)     ;  SETPIECE on all tools
M30
```

### The counter is to be decremented for each tool

In this example, tools T1, T2 and T3 are to machine a program. All three tools are monitored for workpiece count. The aim is to decrement tool T1 by the value 1, T2 by the value 2 and not to decrement T3.

The following programming is required:

```
N500 T1
N600 M06
N700 D1                    ; With the offset selection, the tool that was loaded
                           ; at change is stored in the SETPIECE memory
N900 T2                    ; Preparation of next tool
                           ; Machining command
:
N1000 setpiece(1)          ; SETPIECE acts on T1, Setpiece memory is cleared
N1100 M06
N1200 D1
N1400 T3
:                          ; Machining commands
:
N1500 setpiece(2)          ; Only acts on T2
N1600 M06
N1700 D1
:                          ; Machining commands
:
N1800 setpiece(0)          ; Only acts on T3, not decremented
N1900 T0
N2000 M06
N2100 D0
N2300 M30
```

## 5.8.14 GETSELT - Read the selected T No.

The function is available with TMMG and provides the T number of the tool preselected for the spindle. This allows, for example, the offset data to be accessed prior to M06.

GETSELT (return parameter, x);

x: = 1-16 spindle number

x: = 0 index for main spindle

Specification of "x" is optional. If "x" is not specified the function refers to the main spindle.

*Return parameters*

| | |
|---|---|
| > 0 | T No. of prepared tool |
| = 0 | No preparation or T0 was programmed |
| = -1 | Preparation failed (e.g. no tool ready to use) |

Example:

T="DRILL"

...

...

GETSELT(R10) ; reading the loaded T No. for the main spindle

This function compares in the tool change cycle whether the preselected tool is already placed in the spindle.

## 5.8.15 GETEXET - Reading of the loaded T number

The command GETEXET is specifically designed for block search. Its parameters are set in the same way as for GETSELT. It returns the T number of the tool that is active from the point of view of the NC program.

GETEXET(return parameter, x)

Return parameters:

0: No tool active

> 0: T No. of active tool

x: 1 – 20 spindle number

0: Master spindle

Specification of the spindle number is optional. If it is not specified, GETEXET refers to the current master spindle.

Example:

The following has been set: Change with M06.

There is no tool in the spindle.

There are 2 tools "Drill_10 mm" (T No. 1), "Drill_4.2 mm" (T No. 4)

```
…
N30 T="Drill_10mm"        ;  T No. 1
…                                        ->    GETSELT=1 (T1 is prepared)
…                                        ->    GETEXET=0 (no tool active)
N40 M06
N42 G90 G00 D1 …
…                                        ->    GETSELT=1 (last prepared tool)
…                                        ->    GETEXET=1 (active tool)
N50 T="Drill_4.2mm"       ;  T No. 4
…                                        ->    GETSELT=4 (new preparation: T4)
…                                        ->    GETEXET=1 (T1 is active)
N60 M06
N62 G90 G00 D1 …
…
```

## 5.8.16 GETACTT - Read the active internal T No.

This function provides the possibility, from a tool group with the identifier "name", to obtain the T No. of the tool with the status "active" (a tool becomes "active" immediately before it is loaded into the toolholder) and "was in use" via parameter "TNo.".

status=GETACTT(Tno,name)

The return parameter "status" indicates whether the call was successful or not:

| | |
|---|---|
| 0 | Function successful; T No. contains the desired value |
| -1 | No tool matching the specified identifier exists; T No. contains value = 0 |
| -2 | The tool group does not contain a tool with the desired status; T no. contains value = 0 |
| -3 | There are several tools with the desired status in the in tool group; T No. contains the value of the first tool with the desired status |

**GETACTT can have several meanings!** It is always conceivable there are several tools in the tool group that have the same status. The command will only then meaningfully function when the user ensures there is exactly one tool with the desired status in the tool group.

The command does not initiate a main run synchronization. It may be necessary to enter STOPRE before the call.

**Example:**

Tool group "Drills" contains three tools with the duplo numbers 1, 2, 3 and the T numbers 1, 2, 3:

```
def int Tno, status                ; Initially, there is no active tool in the tool group
                                   ; "Drill"
status=GETACTT(Tno, "Drill")       ; status=-2, Tno=0
T="Drill"                          ; Preparation sets tool status to "active"
status=GETACTT(Tno, "Drill")       ; status=0, Tno=0
                                   ; the tool is active, but the identifier "was in use" is
                                   ; not yet applied
M06                                ; change
T="Hugo"                           ; Preparation
status=GETACTT(Tno, "Drill")       ; status=-2, Tno=0
                                   ; the tool is active, but the identifier "was in use" is
                                   ; still not yet applied
M06                                ; change
status=GETACTT(Tno, "Drill")       ; status=0, Tno=1
                                   ; Read request is performed
                                   ; The tool "Drill" is now assigned the status "was in
                                   ; use" as it was removed and the "active" status
                                   ; remains unchanged
```

**Note**

GETACCT cannot detect a tool which is positioned in the spindle for its first use.

The tool sequence is not defined for a group. This means that GETACCT will read any random tool in the group where the status bits "active" and "was in use" are set.

## 5.8.17 SETMS - Spindle can be declared a master spindle

Available with TMBF, TMFD, TMMO, TMMG.

Command SETMS(n) declares the spindle specified in n to be the master spindle. A spindle can also be defined as the master via a machine data.

The programmed values from SETMS can remain active beyond program end/reset/Start.

When SETMS is programmed without a spindle name, the spindle programmed in the machine data used instead.

## 5.8.18 SETMTH - Set master toolholder number

Available with TMMG.

Machine data **MD20124 TOOL_MANAGEMENT_TOOLHOLDER** can be set to determine whether a toolholder number can be assigned to define the location of the tool to be loaded instead of a spindle number. It only makes sense to use this language command if MD is > 0.

Programming example:

| | |
|---|---|
| T="Miller" M06 | No address extension programmed -> this refers to the master toolholder; i.e. toolholder 1 (value of machine data TOOL_MANAGEMENT_TOOLHOLDER).<br>The tool change is performed at the buffer location with $TC_MPP5=1.<br>The path is corrected with the tool offsets. |
| ... | |
| T2="Drill" ..M2=6 | Address expansion for the secondary toolholder was programmed.<br>The tool is changed at buffer location 2. The path is not corrected. |
| ... | |
| **SETMTH** (2) | Declare toolholder 2 to the **master toolholder** |
| T="Miller_2""M06 | No address extension programmed -> this refers to the master toolholder; i.e. toolholder 2.<br>Tool change is performed at buffer location 2.<br>The path is corrected with the tool offsets. |
| ... | |
| T1="Drill_1" M1=6 | Address extension for the secondary toolholder has been programmed.<br>The tool change is performed at the buffer location with $TC_MPP5=1.<br>The path is not corrected. |
| ... | |
| SETMTH | Declare the toolholder specified in TOOL_MANAGEMENT_TOOLHOLDER as the master toolholder |
| T="Miller_3" M06 | No address extension programmed -> this refers to the master toolholder; i.e. toolholder 1 (value of MD TOOL_MANAGEMENT_TOOLHOLDER).<br>Tool change is performed at buffer location 1.<br>The path is corrected with the tool offsets. |

**Note**

SETMTH does not change the active tool. The new master toolholder definition cannot be taken into account until the tool change is then programmed.

The programmed values from SETMS can remain active beyond program end/RESET/START.

**Example 1:**

The following applies:

$MC_RESET_MODE_MASK = "H18041"

$MC_SPIND_DEF_MASTER_SPIND = 1

$MC_TOOL_MANAGEMENT_TOOLHOLDER = 2

After the end of program/RESET both the active tool offset and the programmed values for SETMTH and SETMS remain active. The tool change still does not take place at the spindle but at the toolholder instead.

```
T="Drill" M06 D2            ; Tool change on master toolholder=2
SETMS(3)                    ; New master spindle=3
SETMTH(1)                   ; New master toolholder=1
T="Miller" M06 D1           ; Tool change on master toolholder=1
M17
```

After end of program or RESET, is
spindle No. = 3 the master spindle
toolholder number =1 the master toolholder and a
TL = "Miller" with offset D1 defines the path correction.

After Power On, the settings for the machine data become effective:
Spindle No. = 1 is the master spindle,
toolholder number = 2 is the master toolholder.

The tool offset is derived from the smallest D number of the tool that is located in the master toolholder; i.e.

T="Drill" with D1

(assuming that the tool has two D offsets D1, D2).

**Example 2:**

The following applies:

$MC_RESET_MODE_MASK = "H41"

$MC_SPIND_DEF_MASTER_SPIND = 1

$MC_TOOL_MANAGEMENT_TOOLHOLDER = 0

After the end of program/RESET both the active tool offset and the programmed value for SETMS remain active. The tool change takes place at the spindle which now becomes the toolholder.

```
T="Drill" M06 D2            ; Tool change on master toolholder=1
SETMS(3)                    ; New master spindle = master toolholder=3
T="Miller" M06 D1           ; Tool change on master toolholder=3
M17
```

After end of program or RESET, is
spindle No. = 1 the master spindle and a
TL = "Miller" with offset D1 (that is on the spindle with No. = 3) defines the path correction.

After Power On the settings for the machine data become effective:
Spindle No. = 1 is the master spindle/master toolholder.

The tool offset is derived from the smallest D number of the tool that is located in the master toolholder; i.e.

T="Drill" with D1

(assuming that the tool has two D offsets D1, D2).

## 5.8.19 POSM - Positioning the magazine

### Overview

This NC language command enables you to initiate a magazine positioning operation to a particular location in an internal magazine (e.g. spindle, toolholder, loading magazine), irrespective of how the location is assigned or the status of the tool it contains. The language command includes parts of the OPI PI service _N_TMPOSM.

The complete command is: **POSM (p, m, ip, im)**

### Description of function

**p:** Location number which is to be positioned to.

**m:** Magazine number of the magazine that is to be moved.
The parameter is optional.
If it is not specified, it refers to the location number in the magazine that is contained as the first to the specified internal location in the distance table.

**ip:** Location number of the specified internal magazine (spindle location, loading magazine etc.)
The parameter is optional.
If it is not specified, then the positioning operation refers to the main spindle location or the main toolholder location.

**im:** Magazine number of internal magazine in relation to location number ip to which the magazine must be moved. An internal magazine is either a loading or buffer magazine.
The parameter is optional.
If it is not specified, then the command refers to the buffer magazine.

The magazine (number m) must be linked by a distance relationship with the selected loading or buffer-magazine location. Alarms are generated when incorrect parameters are specified (e.g. undefined location numbers).

## Example of parameter settings

Specified configuration:

- Magazine (magazine number = 1),
- Spindle (buffer magazine = 9998, location 1),
- Loading magazine (loading magazine = 9999, location 2).

It should be moved from magazine 1, location number 4 to the spindle.

Command:

N100 POSM(4, 1, 1, 9998)

Command for traversing to loading magazine:

N100 POSM(4, 1, 1, 9999)

## Example with result check

A magazine is specified as shown in the following diagram.

Location 12 is to be positioned at the change position and the program must not be continued until positioning has been successfully completed (simplest case with only one magazine and one defined change position).

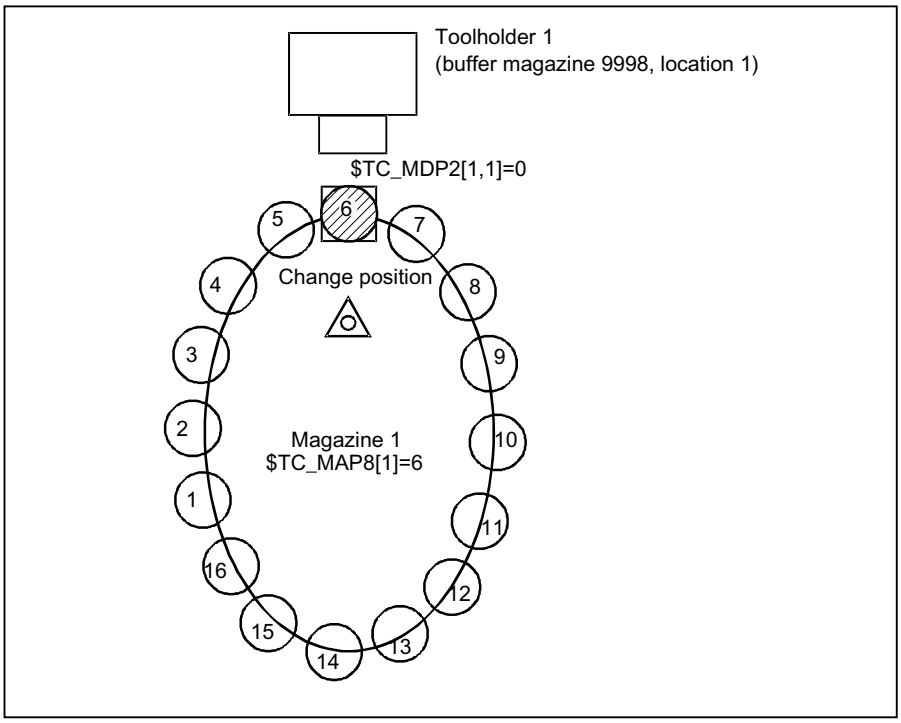



Figure 5-9 Magazine positioning with a check of the positioning operation result

In this example, the magazine zero point is the location in front of toolholder 1. It is defined by system variable $TC_MDP2. Toolholder 1 is assigned to the master spindle of the channel.

```
N100 POSM(12)          ; Moves location 12 to the change position, any unprogrammed
                       ; parameters are set internally to POSM (12, 1, 1, 9998)
N200 wait:
N300 G4 F1             ; waiting time according to the conditions prevailing at the machine
                       ; (exit possibly necessary if reaction is required to positioning errors)
N400 if ( $TC_MAP8[1] <> 12 ) goto wait;
                       ; after POSM(12) is executed, the current magazine position must
                       ; be equal to 12.
```

**Note**

The language command POSM(...) is terminated without waiting for an acknowledgment from the PLC.

**Multitool**

The definition of the language command POSM remains unchanged. The magazine location to be positioned to is programmed independent of whether the location is empty, contains a tool or a multitool.

The PI service _N_TMPOSM offers various options to program magazine positions; for instance, a tool can be programmed using its tool number or its name and duplo number. If this tool is at a magazine location, then the system positions to this magazine location. If the tool is in a multitool, which in turn is at a magazine location, then the system positions to this magazine location. If, instead of a tool number, an MT number is programmed and the multitool is at a magazine location, then the system positions to this magazine location.

## 5.8.20 POSMT - positioning a multitool on a toolholder to the location number

### Overview

This function is available for TMMG.

The POSMT positions a multitool, which is located on a toolholder, to the programmed MT location number. At the time that the command is executed, it is not permissible that any tool offset is active for the programmed toolholder, i.e. D0 must have been previously executed.

The complete command is: **POSMT(state, MTlocno, THno)**

| | | |
|---|---|---|
| **state** | Success status of command | |
| | 0 | Successful execution of the command. Command successfully completed at the PLC. (PLC acknowledgement may still be pending). |
| | -1 | Command cannot be used because TMMG and/or multitool function is not active. |
| | -2 | Function is not executed because of block search, program test. |
| | -3 | MT cannot be positioned, because a tool offset associated with the programmed toolholder is (still) active. |
| | -4 | MT cannot be positioned, because the programmed toolholder does not contain an MT, but a tool. |
| | -5 | MT cannot be positioned, because the programmed toolholder neither contains an MT nor a tool. |
| | -6 | MTlocno has an invalid value. |
| | -7 | THno has an invalid value. |
| **MTlocno** | MT location number of the MT, which is located on the programmed toolholder. | |
| **THno** | Toolholder number on which the MT to be positioned is located. This parameter is optional. If it is not programmed, then the number of the master toolholder is automatically used. | |

**Note**

Selecting an offset or deselecting a possibly active tool offset is not linked with the command.

The command initiates an implicit STOPRE.

## Example 1

The tool with the name "Tool1" / duplo number = 5 or T number = 33 is loaded in multitool 555 at MT location = 2. The MT has been created with 6 locations.

```
DEF INT state = 0
                          ;
T="TL1" M06 D1
                          ; The PLC changes MT 555 on toolholder 1 and
                          ; positions it to MT location 2
                          ; The PLC acknowledges the change, axis movements
                          ; are programmed ...
D0                        ; Deselect tool offset
POSMT(state, 5, 1)
                          ; position the MT to location 5
                          ; The previously active tool with tool number 33
                          ; is still active (however, due to the POSMT
                          ; command is no longer in the machining position)
M17
```

The following is still configured - "activate tool of the toolholder and activate its offset D1".

With RESET (end of program) a tool change command is generated for the PLC, which has the following initial data:

- Bring the multitool from toolholder 1 from the toolholder to toolholder 1 (i.e. the MT is already located on the toolholder)
- position the multitool at location 5

In the NCK, after the input, the PLC final acknowledgment is initiated:

- activate the tool with tool number 34 and select its offset D1

## Example 2

The same data apply as in example 1, with the difference that now there is no tool at location 5 of the multitool.

```
DEF INT state = 0
                          ;
T="TL1" M06 D1
                          ; The PLC changes MT 555 on toolholder 1 and
                          ; positions it to MT location 2
                          ; The PLC acknowledges the change, axis movements
                          ; are programmed ...
D0                        ; Deselect tool offset
POSMT(state, 5, 1)
                          ; position the MT to location 5
                          ; The previously active tool with tool number 33
                          ; is still active (however, due to the POSMT
                          ; command is no longer in the machining position)
M17
```

The following is still configured - "activate tool of the toolholder and activate its offset D1".

With RESET (end of program) a tool change command is generated for the PLC, which has the following initial data:

- Bring the multitool from toolholder 1 from the toolholder to toolholder 1 (i.e. the MT is already located on the toolholder)
- position the multitool at location 5

In the NCK, after the input, the PLC final acknowledgment is initiated:

- activate the tool with tool number 0 (tool deselection) and deselect its offset D0.

**The multitool remains on the toolholder - and neither a tool nor D offset are active.**

## Example 3

If, in example 1, POSMT is not programmed before the end of the program, but only the MT position is set to the value 5 in the NCK with $TC_MTP8, then the command to the PLC - generated in the init block - would specify this MT position and the PLC would have to position the MT according to the position data. When acknowledging the MT position specified by the NCK in the init block, the PLC must not change this.

## PLC

To process the command, NCK command = 1 to the PLC is prepared, which is output via the tool management interface. The PLC must handle and acknowledge this command, in order that it can be correctly completed by the NCK.

### PLC acknowledgment

In the NCK, the language command generates the command for the PLC - and outputs the command within the scope of executing the active block to the PLC. The active block is only considered to have been executed if the final acknowledgement of the command is available from the PLC. This can be PLC status = 3 or 5. Only then can a new block be loaded for execution.

Status = 5, "The sequence has been completed. The MT is in position."

### Example of parameter settings

The following configuration applies:

| | | |
|---|---|---|
| Multitool | MT-No. | =5, MT locations 1, ...10, |
| | | The multitool has location coding |
| | | The tool with tool number = 4711 and tool name "4711" is at location 4 |
| | | The tool with tool number 815 and tool name "815" is at location 7 |
| | | There is no tool at location 8 |
| Toolholder | Buffer magazine No. = 9998, location 1 is the master toolholder with No.=3 | |
| | | The MT with MT No.=5 is on the toolholder |
| | | Tool 4711 is active, active D No.=0 ( no offset active) |
| | Buffer magazine No. = 9998, location 2 is toolholder with No.=9 | |
| | | There is no tool and no MT at toolholder 9 |

At the start, the MT position is equal to 4 (tool with tool number=4711 from MT location 4 is the active tool), this means that MT location 4 is in the machining position.

def int state

POSMT(state, 7, 3) ; position MT of toolholder 3 to location 7 (with tool "815")

has the same contents as

POSMT(state, 7) ; position MT of toolholder 3 to location 7

The two commands are correctly programmed. The status value is state = 0.

The block remains active in the HL until the final acknowledgment from the PLC is available.

Tool "815" with tool number=815 at location 7 does not become active with the positioning.

In order that tool "815" becomes active (and an offset D), then

- either a program must be started (and $MC_START_MODE_MASK appropriately set), or
- RESET executed ($MC_TOOL_MANAGEMENT_MASK, bit 14 = 1 and $MC_RESET_MODE_MASK appropriately set, or
- in the program after POSMT, the tool should be programmed to the positioned MT location with a tool change command (T="815" M06 D1).

With

POSMT(state, 8, 3) ; position MT of toolholder 3 to location 8

the empty MT location is positioned to the machining position, if a D offset is still not active. The following init blocks are implicitly programmed with"T0 M06 D0" if the corresponding machine data have been appropriately set. The mechanical MT transport "MT from toolholder back into the magazine" is associated with this.

Programming of

POSMT(state, 3, 9) ; position MT of toolholder 9 to location 3

Supplies the status value state=–5, as there is no MT and no toolholder at the programmed toolholder 9.

POSMT(state, 77, 3) ; position MT of toolholder 3 to location 77

Supplies the status value state=-6, as MT location number=77 on toolholder 3 is not defined.

## 5.8.21 MVTOOL - Language command to move tool

### Overview

This function is available for TMMG.

The function MVTOOL allows tools to be loaded and unloaded via NC programming only. It can also be used to transport a tool from one magazine location to another - regardless of where.

It is mandatory for a tool to be positioned at the source magazine location.

This language command does not generate an alarm.

Whether MVTOOL was carried out with or without error(s) must be checked via the return value of parameter "state".

The command can also be applied to multitools.

**MVTOOL (state, magFrom, locFrom, magTo, locTo)**

| **state** | Success status of command | |
|---|---|---|
| | 0 | Execution was successful (PLC acknowledgement may still be pending) |
| | -1 | Command cannot be used because TMMG is not active |
| | -2 | Function is not carried out because of block search, program testing |
| | -3 | Tool cannot be moved (because e.g. tool status "being changed" is set) |

| | | |
|---|---|---|
| | -4 | No tool located in source location |
| | -5 | magFrom has invalid value |
| | -6 | locFrom has invalid value |
| | -7 | magTo has invalid value |
| | -8 | locTo has invalid value |
| | -9 | No distance relation defined (if exactly one magazine is an internal magazine) |
| | -10 | No empty location found (if parameter locTo is not programmed) |
| | -11 | Target location for tool not free |
| | -12 | The parameter locTo must be programmed, as magTo is an internal magazine |

| | |
|---|---|
| **magFrom** | Magazine number of magazine in which the tool to be moved is located |
| **locFrom** | Location number of location in which the tool to be moved is located |
| **magTo** | Target magazine number of magazine to which the tool is to be moved. This can be a loading magazine, buffer magazine or another real magazine.<br>This parameter is optional.<br>If it is not programmed, the value from magFrom is used. |
| **locTo** | Target location number of location to which the tool is to be moved.<br>This parameter is optional.<br>If it is not programmed or the value = 0 is programmed, a empty location search is conducted in magazine magTo - if this is a real magazine. A location search cannot be performed in an internal magazine. If magTo is the number of an internal magazine and locTo is not programmed or programmed with a value=0, then the status=-8 is set. |

**Note**

The command MVTOOL always reserves the target location with "reserved for tool to be loaded".

The command sets the tool status of the tool to be moved to "tool is being changed", bit value "H20" from the command preparation to the command completion (acknowledgment with status 1 or 3).

Command completion means the successful completion with PLC status = 1 or 10 - or the command is interrupted with PLC status = 3.

If a tool is moved from a real magazine to an internal magazine (or vice versa), the respective magazine distance relation must be defined.

If the programmed parameters are invalid or if a tool is not located at the source magazine location, or if the programmed target location cannot be occupied by the tool, or if the empty location search does not find a location because parameter locTo has not been programmed, or if a magazine distance relationship that is required has not been defined, then the appropriate error code is returned via state.

Deselecting an active tool offset is not linked with the command.

## PLC

In the NCK, the language command generates the command for the PLC, outputs the command within the scope of executing the active block to the PLC. The active block is only considered to have been executed if the final acknowledgement of the command is available from the PLC. This can be the PLC status = 1 or 10 - or also 3. Only then can a new block be loaded for execution.

## Example of parameter settings

The following configuration is present:

Magazine (magazine number = 5, locations 1,...10),

One spindle (buffer magazine number = 9998, location 1),

one loading point (loading magazine number = 9999, location 1)

The magazine is linked to the spindle and the loading point via a distance relation (see $TC_MDP1/$TC_MDP2).

Example 1

The tool from loading location 9999/1 is to be loaded in magazine 5. The following is programmed to this effect:

```
def int state
$TC_MPP6[9999, 1] =123; place tool with internal T no.=123 onto loading location
MVTOOL(state, 9999, 1, 5);search for a suitable empty location in magazine 5
```

If the tool is to be loaded onto precisely location 7:

**MVTOOL(state, 9999, 1, 5, 7)**;before loading a check is performed to ensure location 7 is empty

Example 2

The tool with T No.=123 is to be loaded from the loading location to spindle 1 (magazine No.=9998, location No.=1):

$TC_MPP6[9999, 1] =123

**MVTOOL(state, 9999, 1, 9998, 1)** ;

Example 3

With the same configuration, a tool that is loaded on location 7 is to be moved to another suitable location in the same magazine.

**MVTOOL(state, 5, 7, 5)**

or to location 3 in the same magazine

**MVTOOL(state, 5, 7, 5, 3)**

or to any location in magazine 11

**MVTOOL(state, 5, 7, 11)**

## 5.8.22 SETTIA - Deactivate tool from wear group

The SETTIA function cancels the "active" status for all active tools in the selected wear group. By parameterizing the language command, this can be either magazine-specific or wear group-specific.

**SETTIA(STATUS, MNR, VNR,USEKT)**

| **STATUS** | Return parameters | |
|---|---|---|
| | 0 | Function was not able to be executed correctly. |
| | -1 | Function has not been executed because there is no active wear group in the selected magazines. |
| | -2 | Function was not executed as the programmed wear group number does not exist. |
| | -3 | Function was not executed as the programmed magazine number does not exist. |
| | -4 | Function was not executed as the function "wear group" is not enabled (MN_TOOL_MANAGEMENT_MASK). |
| | -5 | Function was not executed. |

All parameters are optional.

If SETTIA is not parameterized, the inactive setting refers to all loaded tools in the TO area which are in "active" state.

| | | |
|---|---|---|
| **MNR** | Magazine number | |
| | 0 | The inactive setting refers to all magazines regardless of any assignment to a spindle. In this case, the tools in the buffer are also considered as well as the toolholder. |
| | > 0 | Magazine number in which the inactive setting is to be applied. Tools in this magazine which are in the buffer are not considered. This means that if these tools are placed back into the magazine, they still have "active" status. |
| | -1 | All magazines with a distance relationship to a spindle or toolholder. |
| **VNR** | Wear group number | |
| | 0 | The inactive setting refers to all tools which are not assigned to a wear group. If no wear group is defined, the inactive setting is applied to all tools in the magazine. |
| | > 0 | Wear group number in which the active setting is to be applied. |
| | -1 | Active wear group ($TC_MAP9). |
| **USEKT** | Tool subgroup | |
| | 0 | All tools in the group are considered. |
| | > 0 | The tools are considered that have a bit set in the value programmed in USEKT in parameter $TC_TP11. |
| | -1 | The currently programmed value of USEKT is used. |

A search strategy can be set in parameter $TC_MAMP3 for the tool to be activated by SETTIA.

| | |
|---|---|
| Bit 12 = 0 | Smallest possible duplo number (default) |
| Bit 12 = 1 | Smallest possible magazine location |
| Bit 13 = 1 | Smallest possible number contained in parameter $TC_TP10 (sequence of use) |

**Note**

It is mandatory to set the wear group for the function SETTIA.

### Multitool

If SETTIA is programmed for a multitool, instead of for a magazine, Alarm 6462 "[Channel %1:] block %2 command %' can only be programmed for magazines. '%4' does not designate a magazine.

## 5.8.23 SETTA - Activate tool from wear group

### Overview

With the function SETTA all non-blocked tools from the desired wear group are activated. However, from a tool group, a max. of one tool referred to a spindle or toolholder becomes active.

If, at the call instant, no wear groups have been defined or if the function "wear group" via machine data has not been activated, then the command can still be used. The call parameters must then be set accordingly.

If the selection criteria of the SETTA command match several tools within a tool group, then selection criterion $TC_MAMP3, bits 12-15 is applied.

### Description of function:

**SETTA (STATUS, MNR, VNR, USEKT)**

| **STATUS** | Return parameter which can consist of the following values: | |
|---|---|---|
| | 0 | Function was not able to be executed correctly. |
| | 1 | Function was carried out, but another tool is active in the group (e.g. an unloaded tool). |
| | -1 | Function has not been executed because there is no active wear group in the selected magazines. |
| | -2 | Function has not been executed because the programmed wear group number does not exist. |
| | -3 | Function was not executed as the programmed magazine number does not exist. |
| | -4 | Function was not executed as the function wear group is not enabled (MN_TOOL_MANAGEMENT_MASK). |
| | -5 | Function was not executed for other reasons. |

All parameters are optional.

If SETTA is not parameterized, the active setting refers to all loaded tools that are ready for use in the TO area.

| **MNR** | Magazine number | |
|---|---|---|
| | 0 | or, not specifying the parameter means that activation refers to all magazines - independent of whether a distance relationship to a spindle location exists. |
| | -1 | All magazines with a distance relationship to a spindle or toolholder. |

| | | |
|---|---|---|
| | -2 | An active tool from every tool group represented in the magazine is set in the magazine of each spindle or each toolholder. (corresponds to calling SETTA a multiple number of times with the specific magazine numbers that are involved). This means there can be e.g. 2 toolholders with 1 magazine assigned to each. The tools of a group can be distributed in any configuration among the two magazines. If both magazines include tools of a group, then this means that 2 tools from the tool group are allocated the active state. |
| If several magazines are addressed (MNR <= 0), then the magazines are regarded as a unit and a tool from the tool group is activated across all of the magazines that are being considered. Magazines ($TC_MPP4 Bit 1=1) are not taken into account. | | |
| **VNR** | Wear group number | |
| | 0 | The active setting refers to the entire magazine. |
| | -1 | Active wear group ($TC_MAP9). If there is no active wear group in any of the magazines, then status -1 is returned and the status of the tools is not changed. |
| | -2 | or if the parameter is not specified, then this means that activation applies to the whole magazine. Especially parameter VNR is not specified or set to -2, if the system does not operate with the wear group function. |
| **USEKT** | Tool subgroup | |
| | 0 | or if the parameter is not specified, then all tools in the group are considered. |
| | -1 | The currently programmed value of USEKT is used. |

A search strategy can be set in parameter $TC_MAMP3 for the tool to be activated by SETTA.

**Note**

It is mandatory to set the wear group for the function SETTA.

If SETTA is programmed for a multitool, instead of for a magazine, Alarm 6462 "[Channel %1:] block %2 command %' can only be programmed for magazines. '%4' does not designate a magazine.

## 5.8.24 RESETMON - Language command for setpoint activation

**RESETMON (state, t, d, mon, resetStates)**

Sets the actual value of tool to the setpoint.

The command is used for tools as well as for multitools.

| state | Return parameter which can consist of the following values: | |
|---|---|---|
| | 0 | Command was successfully executed |
| | -1 | The cutting edge with the specified D number d does not exist. |
| | -2 | The tool with the specified T number t does not exist. |
| | -3 | There is no monitoring function defined for the specified tool. This status is only possible if t has been specified explicitly. |
| | -4 | Monitoring function is not active in the NCK, i.e. the command has not been executed. |

| | | |
|---|---|---|
| t | Internal T number | |
| | t = 0 | All tools are handled. |
| | t > 0 | Precisely this tool is handled. |
| | t < 0 | The absolute value of t is formed and all replacement tools of this tool are handled. |
| d | D number of the tool (optional parameter).<br>If the parameter is not specified at all or is assigned the value 0, all D numbers or all cutting edges of the tool are handled. | |
| | d > 0 | The command applies specifically to the specified D number. |
| mon | Optional bit-coded parameter.<br>If the parameter is either not specified at all or assigned the value 0, all actual values of the active, tool-specific monitoring functions for the designation edge(s) are set to the setpoints. | |
| | mon > 0 | Precisely the actual value of the specified monitoring type is handled.<br>Possible values are the positive values of the system parameter **$TC_TP9** (1, 2, 4, 8) or the corresponding bit combinations when several monitoring types are activated. |
| | mon < 0 | Precisely the actual value in the monitoring type specified in "absolute value mon" is handled. There is no restriction by the system variable values $TC_TP9. The values of non-activated monitoring types can be reset in this way too. In particular, it is also possible to simultaneously reset the actual values of wear and additive offset monitoring values. |
| resetStates | Optional bit-coded parameters | |
| | Bit 0 | Tool status "active" is deleted |
| | Bit 1 | Tool status "enabled" is set |
| | Bit 2 | Tool status "disabled" is reset if<br>a) the monitoring data permit this<br>b) parameter "mon" is set accordingly |
| | Bit 3 | Tool status "measure" is set |
| | Bit 4 | Tool status "prewarning limit" is reset if<br>c) the monitoring data permit this<br>d) parameter "mon" is set accordingly |
| | Bit 5 | Not permitted |
| | Bit 6 | Not permitted |
| | Bit 7 | Tool status "was in use" is deleted |
| | Bit 8 | Not permitted |
| | Bit 9 | Not permitted |
| | Bit 10 | Tool status "to unload" is deleted |
| | Bit 11 | Not permitted |
| | Bit 12 | Not permitted |
| | Bit 13 | Not permitted |
| | Bit 14 | Not permitted |

The parameter "resetStates" allows selective modification of the tool status in addition to the monitoring parameters. The bit coding for "resetStates" corresponds to that for the tool status parameter $TC_TP8[x].

If this parameter is not specified, machine data $MN_TOOL_RESETMON_MASK is accessed. The bit coding for this data is identical to that for parameter "resetStates". With the analog PI service PI_TRESMO, this machine data is also effective.

**Note**

There is no explicit generation of alarms. The user can carry out the error handling himself/herself via the **state** parameter.

### Multitool

The command is extended for a multitool:

**RESETMON (state, MTno, d, mon, resetStates)**

State specifies the status of the command execution:
0 = command successfully executed
-1 = the cutting edge with the specified number Dno does not exist
-2 = the multitool with the specified number MTno does not exist

In this case, MTno is the multitool number with the following values:

| | |
|---|---|
| MTno = T-no. = 0 | Or tools are handled and therefore also all multitools. |
| MTno > 0 | Precisely this multitool is handled. |
| MTno < 0 | Not defined. |

d is an optional parameter and designates the D number of the tool cutting edges in the multitool that should be reset.

| | |
|---|---|
| Dno = 0 | If the parameter is not specified, or if the tool is programmed with 0, then all cutting edges of the tools are handled in the multitool. |
| Dno > 0 | The command refers precisely to the cutting edges of the tools in the multitool with the specified D number. |

mon refers to the tools in the multitool.

resetStates refers on one hand to states of the individual tool, which when reset to the setpoints must be additionally changed; however here, for this special programming, also the corresponding MT states, that are changed if at least the same state was changed in one of the tools loaded in the multitool. This includes:

| Bit | Value | Meaning |
|---|---|---|
| 1 = | 0 | Multitool status "enabled" remains unchanged |
| | 1 | Multitool status "enabled" is set |
| 2 = | 0 | Multitool status "locked" remains unchanged |
| | 1 | Multitool status "locked" is deleted if permitted by the monitoring data and the 4th parameter is set accordingly. |
| 10 = | 0 | Multitool status "to unload" remains unchanged |
| | 1 | Multitool status "to unload" is deleted |

**Note**

If this optional parameter is not programmed, then the value of MD $MN_TOOL_RESETMON_MASK is valid as implicit value.

Analog to this, the MT number can be programmed for the parameter T number of the corresponding PI service _N_TRESMO.

The MD $MN_TOOL_RESETMON_MASK available to parameterize the RESETMON command, with the description "behavior of the tool data for RESETMON", keeps its effect on the tools - even if they are located in a multitool and are reset using RESETMON.

The selectable state changes also affect the multitool, if this has been programmed and the appropriate state has been defined.

| | | T | MT |
|---|---|---|---|
| Bit 0 | Delete "active" status | X | - |
| Bit 1 | Set the "enabled" status | X | X |
| Bit 2 | Conditionally delete "Locked" status if monitoring data permit this | X | X |
| Bit 3 | Set the "measured" status | X | - |
| Bit 4 | Conditionally delete "Pre-warning limit" status if monitoring data permit this | X | - |
| Bit 7 | Delete "was in use" status | X | - |
| Bit 10 | Delete "to unload" status | x | x |

## 5.8.25 DELTC - Delete toolholder data record

The function "Toolholder orientation" must be active. The function can additively superimposed over the functions TMBF, TMFD, TMMO and TMMG.

**DELTC(n,m)**

| | |
|---|---|
| n | First number of the toolholder data area the values of which shall be set to zero.<br>This parameter is optional. If it is not specified, all toolholder data records are set to zero starting at the lowest through to the highest number. |
| m | Last number of the toolholder data area the values of which shall be set to zero.<br>This parameter is optional. If it is not specified, then the toolholder data record specified by n is set to zero.<br>If m is greater than the highest number of a toolholder data record in this channel, then those data records up to the highest number are set to zero. |

The toolholder data records are defined by the system variables $TC_CARRx. Only the command $TC_CARR1[0] was available up to now for setting all data records to zero. With DELTC a range of numbers for the toolholder data from n to m for the toolholder data can now be set to zero.

In particular, the contents of DELTC() and $TC_CARR1[0]=0= set all data records to zero, are the same.

The parameters n, m have to be programmed with values larger than zero. Other values lead to an alarm.

Parameter n must be smaller than m. Programming otherwise leads to an alarm.

Also, n must lie in the range of numbers permitted for toolholder data.

The selected range of numbers must include the range of numbers for the toolholder data records on the channel. Programming is otherwise rejected and an alarm is issued.

If the function "Toolholder data" is not activated ($MN_MM_NUM_TOOL_CARRIER 0 0), then DELTC will also generate an alarm.

## Example

In the TO unit there are 14 toolholder records defined with the numbers 1 to 14.

DELTC(5,8) ; sets the values of the data records 5, 6, 7, 8 to zero

DELTC(5,20) ; sets the values of the data records 5, 6, 7, ..., 14 to zero

DELTC(9) ; sets the values of the data record 9 to zero

DELTC() ; sets the values of the data records 1, ..., 14 to zero

DELTC(0,1);error -> alarm - n, m must be greater than zero

DELTC(0,-2) ; error -> alarm - n, m must be greater than zero

DELTC(0) ; error -> alarm - n must be greater than zero

DELTC(15,20) ; error -> alarm - n may be max. 14

DELTC(20) ; error -> alarm - n may be max. 14

## 5.8.26 TCA - Tool selection/tool change irrespective of tool status

### Overview

This function is only available for TMMO and TMMG.

It is necessary for certain routines (e.g. measuring cycles) to load a specific tool onto the spindle/the toolholder for tool change regardless of its status (e.g. a disabled tool).

**TCA("TL name", duplo No., toolholder No.)**

| | |
|---|---|
| "TL name" | Identifier of the tool to be loaded at change |
| Duplo No. | Duplo No. of tool to be loaded.<br>This parameter is optional.<br>If it is not specified, then the tool with the smallest duplo number is loaded at change. |
| Toolholder No. | Toolholder or spindle on which the change is to take place.<br>This parameter is optional.<br>If it is not specified, the change refers to the currently set or programmed master spindle/master toolholder.<br>The following applies for TMMO without TMMG:<br>The parameter corresponds to the address extension of the T command.<br>(The setting for MD $MC_T_M_ADDRESS_EXT_IS_SPINO is taken into account.) |

TCA behaves like the T command in respect of alarm and command output.

If neither TMMG nor TMMO are active, an alarm is generated.

Any alarms occurring during programming are handled in the same way as the alarms during T programming.

**Note**

Offset selection, in accordance with $MC_CUTTING_EDGE_DEFAULT, acts in the same way as for the T command. TCA and D must not be programmed in the same block.

## Examples

1. **Preparation and change with T command (i.e. $MC_TOOL_CHANGE_MODE=0)**

   Configuration 1x turret, 1x toolholder

   There are 2 tools with the identifier "Finish cutter" and duplo numbers 1 and 2.

   **TCA("Finish cutter", 1.1)**

   The tool "Finish cutter" with duplo number 1 is loaded onto toolholder 1 at change.

   With the machine configuration assumed above, the following programming would have the same result:

   **TCA("Finish cutter")**

   The duplo number is not specified, this means that the tool with the smallest duplo number is changed, i.e. duplo "1".

   The toolholder no. is not specified. Therefore, the change is effective for the current master toolholder, i.e. "1".

2. **Change with M06 ($MC_TOOL_CHANGE_MODE=1)**

   Configuration: 1x chain magazine, 2x spindles, spindle_1 is the master spindle. 4 tools are loaded, "MILLER_20MM", with duplo numbers 4, 5, 8 and 15.

   "MILLER_20MM", duplo "8" was disabled and must be measured. Measuring takes place on spindle 2.

   **TCA("MILLER_20MM", 8.2)**

   **M2=6**

   The tool "MILLER_20MM", duplo "8" is prepared for spindle "2" and changed.

   Here the following programming would lead to a different result:

   **TCA("MILLER_20MM")**

   **M06**

   Tool "MILLER_20MM" with duplo "4" (smallest duplo number) is prepared for spindle "1" (this is the master spindle) and changed with M06.

---

**Note**

The following special issues apply for TCA when compared to T commands:

TCA and D cannot be programmed in the same block.

TCA renders the set search strategies ($TC_MAMP2 and/or $TC_MAP10) ineffective and ignores the programmed valued of $P_USEKT.

The tool must have status "enabled".

The PLC interface signals "Transition to new replacement tool" and "Last replacement tool of group" are not set.

---

### PLC

The PLC is not allowed to reject a tool prepared with "TCA".

Notice: Currently the interface does not have any criteria as to whether a tool may be rejected or not.

If this function is being used, an additional identifier must be used to indicate this to the PLC.

| | | |
|---|---|---|
| Example: | $TC_VDITCP[2]=101 | (101" - identifier that the PLC is not allowed to reject) |
| | TCA("Miller",1) | |

**Supplement to the definition if the programmed tool is a multitool**

Using the TCA command, a specific tool with "tool name"/"duplo number" can be changed to the toolholder independent of the tool state. If this tool is a multitool, the state of the multitool as well as the state of the tool is ignored for the command. This especially allows a tool to be selected and/or removed from a locked multitool.

**Note**

The command can only be programmed for tools - also those that are loaded in a multitool; however it cannot be programmed for a multitool. If the programmed name is e.g. an MT name, then Alarm 6460 "[Channel%1: ] block %2 command %3 can only be programmed for tools. %4 does not designate a tool." is output.

## 5.8.27 Replacement of the TCA command

With the TCA command, it is possible to select a tool by specifying the duplo number.

Substitution of the command is possible, a description of this can be found in Chapter 3.3.14 "T-function replacement".

Up until then, it is only possible to substitute using the procedures predefined using the general replacement function MD10712 $MN_NC_USER_CODE_CONF_NAME_TAB.

In order to use the same replacement subroutine for the TCA and T replacement, the following replacement is inserted for the TCA command – analog to the T function:

With MD15710 $MN_TCA_CYCLE_NAME, the replacement of the TCA command can be activated by specifying a program name. The parameters of the TCA command are transferred to the replacement subroutine in the following system variables:

| | |
|---|---|
| $C_TS | Tool identifier (as in the existing T replacement) |
| $C_DUPLO | Duplo number |
| $C_THNO | Toolholder/spindle number |

In addition, there are system variables, which can be used to query whether the substitution of the TCA command is active and which parameters have actually been programmed:

| | |
|---|---|
| $C_TCA | TRUE : Replacement of the TCA command is active |
| $C_TS_PROG | TRUE : $C_TS contains the programmed tool identifier |
| $C_DUPLO_PROG | TRUE : $C_DUPLO contains the programmed Duplo number |
| $C_THNO_PROG | TRUE : $C_THNO contains the programmed toolholder / spindle number |

Behavior regarding other replacements:

In the TCA replacement subroutine, tool programing replacement is not carried out. All other replacements are carried out. Conversely, no TCA replacement is carried out in a replacement subroutine for tool programming.

If the TCA command is programmed when the tool management or tool monitoring is not active, then the part program processing is interrupted with Alarm 6431 "Tool management or tool monitoring not active" (this is the existing behavior). If TCA replacement is configured, then in this case, part program processing is also interrupted with Alarm 6431.

Note regarding MD10712 $MN_NC_USER_CODE_CONF_NAME_TAB:
If the TCA command is renamed, e.g. "_TCA", by appropriately configuring MD10712, then the TCA replacement is realized with the interpretation of the "_TCA" command.

**Example with a common replacement cycle for T and TCA replacement:**

Machine data:
$MN_T_NO_FCT_CYCLE_NAME = "T_SUB_PROG"
$MN_TCA_CYCLE_NAME = "T_SUB_PROG"

Replacement subroutine for T and TCA replacement:

```
N1000 PROC T_SUB_PROG DISPLOF SBLOF
; common part
...
; different tool selection:
N2000 IF ($C_TCA == 1)
N2010            ; TCA–replacement active
N2020           IF ( $C_DUPLO_PROG == 1) AND ( $C_THNO_PROG == 1)
N2030                   TCA( $C_TS, $C_DUPLO, $C_THNO )
N2040           ELSE
N2050                   IF ( $C_DUPLO_PROG == 1) AND ( $C_THNO_PROG == 0)
N2060                           TCA( $C_TS, $C_DUPLO)
N2070                   ELSE
N2080                           IF ( $C_DUPLO_PROG == 0) AND ( $C_THNO_PROG == 1)
N2090                                   TCA( $C_TS, ,$C_THNO)
N2100                           ELSE
N2110                                   TCA( $C_TS)
N2120                           ENDIF
N2130                   ENDIF
N2140           ENDIF
N2150 ELSE
N2160          IF ( $C_T_PROG == 1) OR ( $C_TS_PROG == 1)
N2170                   ; T–replacement active
N2180                  IF ( $C_T_PROG == 1)
N2190                           T[ $C_TE ] = $C_T
N2200                  ELSE
N2210                           T[ $C_TE ] = $C_TS
N2220                  ENDIF
N2230          ENDIF
N2240 ENDIF
...
M17
```

## 5.8.28 TCI - Change tool from buffer into magazine

### Overview

This function is available for TMMG.

The command TCI returns the tools from buffer locations back to the magazine. Toolholder locations are however excepted from this. Generally, applications are for complex machines with several grippers.

The necessary empty-location search is carried out in the same way as for a programmed tool change with T (see index entry "prepare tool change").

**Note**

TCI cannot be programmed together with M06 in one NC block. Tool change preparation and execution are carried out in one operation.

**The TCI command cannot be substituted (T function replacement).**

**TCI(locNo, toolholder no.)**

| | |
|---|---|
| locNo | Number of the buffer whose tool is to be returned to the magazine.<br>Since the locNo cannot be the location number of a toolholder, returning the tool has no effect on active tool offset. |
| Toolholder No. | This specifies the number of the toolholder from where the tool is to be removed. This parameter is optional. If this parameters is not specified, then the current master toolholder is automatically selected. |

Alarm 6403 is generated if an invalid location number is programmed.

The location number locNo is invalid

- if locNo indicates a toolholder / spindle (alarm 6450)
- if locNo indicates a non-defined buffer location (alarm 6403)
- if locNo is not linked with the programmed toolholder or master toolholder by $TC_MLSR (alarm 6454)
- if no distance table is defined either for the buffer locNo or the toolholder/spindle (alarm 6454)

Alarm 6451 is generated if no buffer magazine has been defined.

Alarm 6452 is generated if the specified toolholder is not defined.

Alarm 6431 is generated if TMMG is not active.

In order to successfully program TCI it is necessary that the specified location number locNo is assigned to the toolholder via $TC_MLSR. Empty locations are searched for in the magazines defined in the distance table (defined by $TC_MDP2) of the buffer locNo or of the toolholder. If both the buffer locNo and the toolholder have a distance table, the buffer distance table is the one that is used. Alarm 6454 is generated if neither has a distance table.

**Note**

The command TCI contains as parameter, the number of a location (gripper, loader, transfer point) of the buffer magazine. In order to use this language command in your own cycle programs, the location number can be identified using the system variable $P_MAGNREL, $P_MAGREL.

## Example

The following magazine configuration is present:

- Magazine 1

in the buffer magazine with 5 locations, the following is defined:

- Spindle 2 (location 1) with grippers 1 and 2 (locations 3 and 4 coupled with the spindle through $TC_MLSR[3,1] = 0 and $TC_MLSR[4,1] = 0)
- Spindle 1 (location 2) with gripper 3 (location 5 coupled with the spindle through $TC_MLSR[5,2] = 0)

The following is programmed:

TCI(2): generates alarm 6450

TCI(5): changes the tool from location 5 (gripper 3) back to the magazine

TCI(9): alarm 6403 (buffer only has the numbers 1 to 5

The user determines the sequence in which the buffer locations are cleared by programming.

## PLC

TCI is executed in the PLC like the programming of T0 M06.

The buffer number transferred in the DB72 has to be evaluated.

**Multitool**

The TCI command also changes multitools from internal magazines into the magazine.

## 5.8.29 GETFREELOC - Search for empty location

### Overview

This function is available for TMMG.

For a given tool, search for an empty location in those magazines assigned to the specified loading location or the specified spindle / toolholder by an entry in the distance table. The strategy set by $TC_MAMP2 or $TC_MAP10 is used as the search strategy.

Defined location type hierarchies are taken into consideration when searching for an empty location by the PI service or for a programmed tool change.

**Note**

GETFREELOC only reserves the empty location that is found if the 6th parameter is programmed with "L".

**GETFREELOC(magNo&, locNo&, T No., refMag, refLoc, withReserv)**

Search / check empty location for specified tool regarding specified loading / buffer magazine and location number. Reserve the location found corresponding to the programming of the parameter withReserve.

| magNo | | Input value |
|---|---|---|
| | > 0 | Magazine number of the magazine in which the search is to be made.<br>In so doing, it should be noted that only magazine numbers are valid that can be reached from the programmed reference location (parameter refMag/refLog). |
| | 0 | The magazine in which the search is to be made is not specified. Search starts in the magazine, which corresponding to the selected search strategy, is the first. |
| | | Result value |
| | > 0 | Magazine number of the magazine where the empty location is found. |
| | 0 | If no empty location is found. |
| | -1 | TMMG not active |
| | -2 | invalid magazine number specified |
| | -3 | invalid magazine location number specified<br>The location number is also regarded as invalid if the magazine number is invalid. |
| | -4 | invalid T number specified |
| | -5 | invalid letter for "refMag"" |
| | -6 | if "refMag" = = "S", invalid toolholder number "refLoc" specified<br>if "regMag" = = "L", invalid loading location number "refLoc" specified |
| | -7 | Parameter "withReserv" does not have a defined value |
| | -8 | Parameter "withReserv" cannot be programmed in the given context. |

| **locNo** | | **Input value** |
|---|---|---|
| | > 0 | Magazine location number of the location which should be checked for accepting the specified tool.<br>If magNo=0 is programmed, then a value locNo=0 is ignored.<br>Result value<br>Magazine location number of the empty location that was found. |
| | 0 | Magazine location not specified<br>Search starts with the location, which is the first corresponding to the selected search strategy. |
| | | **Result value** |
| | > 0 | Magazine location number of the empty location that was found or checked. |
| | 0 | If no empty location is found. |
| | -1 | TMMG not active |
| | -2 | invalid magazine number specified |
| | -3 | invalid magazine location number specified<br>The location number is also regarded as invalid if the magazine number is invalid. |
| | -4 | invalid T number specified |
| | -5 | invalid letter for "refMag"" |
| | -6 | if "refMag" = = "S", invalid toolholder number "refLoc" specified<br>if "regMag" = = "L", invalid loading location number "refLoc" specified |
| | -7 | Parameter "withReserv" does not have a defined value |
| | -8 | Parameter "withReserv" cannot be programmed in the given context. |
| **T No.** | T number of the tool for which an empty location is to be searched. The searched location must be suitable for the tool size and the type of magazine location defined in the tool.<br>If an invalid T number is programmed, parameters magNo, locNo each return the value -4. | |
| **refMag** | Reference magazine regarding which the empty location search is to be made (optional parameter).<br>"S" = buffer magazine<br>"L" = loading magazine<br>"-" = no reference magazine. Is used if a magazine definitely has to be specified.<br>If a value not equal to "S", "L" is programmed, parameters magNo, locNo each return the value -5. If the specified reference magazine is not yet defined, parameters magNo, locNo also return the value -5. | |

| | |
|---|---|
| **refLoc** | If refMag equals "S", then the spindle number/toolholder number is specified here for empty location search.<br>If an invalid toolholder number is programmed, parameters magNo, locNo each return the value -6.<br>If refMag equals "L", then the number of the location in the loading magazine is specified for which a search should be made for an empty location.<br>This parameter is optional. If it is not programmed then the search for the master toolholder is carried out for refMag = "S".<br>When refMag = "L", the search for location number = 1 is carried out in the loading magazine.<br>When refMag = "-", the parameter is not taken into account. |
| **withReserv** | "L" = reserve the found/checked empty location with "reserved for tool to be loaded" (this is in system parameter $TC_MPP4, bit value of the new "H8) |

**Note**

If several parameters are incorrect, the value of magNo, locNo will depend on which parameter NCK checks first.

An alarm is generated if the TMMG is not active.

## Examples

There are two magazines 1 and 2 - each having 5 locations. Further, there are two spindles and two loading locations. Both magazines are linked to the spindles through the distance relationship.

```
def int magNo=0, locNo=0
def int tNo=4       ;Tool with T No. = 4 is defined

GETFREELOC ( magNo, locNo, tNo, "S" )
      ; for the defined tool with T No. = 4, regarding the master spindle, a search is made for an empty location.
      ; the suitable empty location is in magazine 1, location 3. The references magNo/locNo return
      ; values 1/3.

tNo = 44        ;tool with T No. = 44 is defined
GETFREELOC ( magNo, locNo, tNo, "L", 2 )
      ; for the defined tool with T No. = 44 regarding loading location 2, a search is made for an empty location.
      ; The suitable empty location is in magazine 2, location 5. The references magNo/locNo return
      ; values 2/5.
```

Search for an empty location and reserve for loading via loading location
tNo = 44 ;tool with T No. = 44 is defined
**GETFREELOC ( magNo, locNo, tNo, "L", 2, "L" )**
; for the defined tool with T No. = 44, regarding loading location 2, a search is made for an empty location.
; The suitable empty location is in magazine 2, location 5. References magNo/locNo return
; values 2/5. Location 2/5 is reserved "for tool to be loaded".

Search for empty location and reservation for loading via toolholder/spindle
tNo = 44 ;tool with T No. = 44 is defined
**GETFREELOC ( magNo, locNo, tNo, "S", 1, *"L"*)**
; for the tool defined with T No. = 44, regarding the toolholder with location number = 1, an empty location ; is searched for. The suitable empty location is in magazine 2, location 5. The references magNo/locNo ; return the values 2/5. Location 2/5 is *reserved "for tool to be loaded"*.

## 5.8.30 DELMLRES - Delete location status "reserved for tool in the buffer"

### Overview

This function is available for TMMG.

Cancel the location reservation, type resType of the location with the number magNo.

**DELMLRES (magNo, locNo, resType)**

| | | |
|---|---|---|
| state | Result of the command execution | |
| | 0 | Command successfully executed (even if the location was not reserved). |
| | -1 | TMMG is not active |
| | -2 | invalid magazine number specified |
| | -3 | invalid magazine location number specified |
| | -4 | invalid letter for resType |
| magNo | Magazine number of the magazine that contains the location. | |
| locNo | Magazine location number of the location whose reservation should be deleted. | |
| resType | Type of reservation that is to be deleted.<br>"**L**" reservation "for tool to be loaded" ("L"= "Tool to be **L**oaded")<br>"**S**" reservation "for tool in the buffer" ("S" = tool in **S**pindle" or general tool in the buffer)<br>The parameter is *optional*. If it is not programmed, then the reservation that is set is deleted - either "L" or "S". If no reservation is set, then the command has no effect. | |

If the reservation of adjacent locations is also reserved for an oversized tool, then also these (sub) location reservations are cancelled.

**Example 1**

For the oversized tool located in gripper 1 (magazine No. 9998, location No. = 4), the location reservation, for tool in the buffer, is to be deleted.

```
def int tNo, magNo, locNo
tNo = $TC_MPP6[ 9998, 4 ]
magNo = $A_MYMN[ tNo ]          ; owner magazine
locNo = $A_MYLN[ tNo ]          ; owner magazine location, which was
reserved
                                ; when loading the tool
state = DELMLRES ( magNo, locNo, "s" )
                                ; the same meaning would be
"DELMLRES(magNo, locNo)"
if (state < 0 ) gotof error
```

If it should be ensured that the location is also reserved for the tool that is intended to be loaded on change, then the following additional check can be made:

```
if ( $TC_MPP66[ magNo, locNo ] GOTOF ERROR
```

**Example 2**

Load programmed tool via toolholder (magazine No. 9998, location No. = 2). The loading operation is programmed using the commands GETFREELOC, MVTOOL.

```
def int tNo, magNo, locNo
tNo = 3   ; this tool should be loaded
```

```
GETFREELOC (magNo, locNo, tNo, "S", 2, "L") ; search for empty location with reservation
if ( (magNo > 0) and (locNo > 0)
 and ( "something is not as required") )
 state = DELMLRES ( magNo, locNo, "L" )
 if ( state < 0 ) GOTOF ERROR
endif
MVTOOL( state, 9998, 2, magNo, locNo )
```

## 5.8.31 DELMLOWNER - Delete owner magazine location of the tool

### Overview

This function is available for TMMG.

Delete the tool or the multitool in the buffer magazine - owner magazine location.

**DELMLOWNER(t)**

| state | Result of the command execution | |
|---|---|---|
| | 0 | Command was successfully executed. |
| | -1 | TMMG is not active |
| | -2 | TL with the T No. = t does not exist - not for t = 0 either |
| | -3 | The TL is not loaded (does not have an owner location) |
| | -4 | The TL is not in the buffer magazine |
| t | T number of the tool in which the owner location is deleted | |

If the owner location is reserved for this tool, then implicitly, the location reservation "for tool in buffer" is also deleted.

The system parameters $A_MYMN [ t ] and $A_MYMLN [ t ] read, after the delete operation, the value = 0.

Comment:
If the t number of the tool is not known, then it can be determined with one of the following commands:

```
def int tNo
tNo = GETT( name, duplo )
       ; if only the name and duplo number of the tool are known
tNo = $TC_MPP&[ magNo, locNo ]
       ; if only the magazine location is known, where the tool is
contained
tNo = $TC_MPP&&[ magNo, locNo ]
       ; if only the magazine location is known,
         ; whose reservation is to be deleted
```

**Multitool**

The command can also be programmed for multitools.

state = DELMLOWNER(INT MTno)

In multitool with number MTno, delete the owner magazine location in the buffer magazine

Therefore, also delete the owner location of the tools - contained in the multitool - with numbers Tnoi; i=1, ..., $P_MTOOLNT.

After the deletion operation, system parameters $A_MYMN [MTno] / $A_MYMLN [MTno] and $A_MYMN [Tnoi] / $A_MYMLN [Tnoi] read the value = 0.

**Note**

After the deletion operation, system parameters $A_TOOLMTN [Tnoi], $A_TOOLMTLN [Tnoi] and $A_MYMTN [Tnoi], $A_MYMTLN [Tnoi] still read the value of the multitool, MT location on which the tool with T number Tnoi is loaded.

**Note**

The command cannot be programmed with the T number of a tool, which is loaded in a multitool. This programming is rejected with Alarm 17050 "illegal value".

## 5.8.32 $P_USEKT - Tool change only with tools of subgroup

### Overview

This function is only available for TMMO and TMMG.

This command selects a subset of a tool group which is then taken into account for the subsequent tool change.

The subgroups are set via system variables $TC_TP11[t].

| Name | $P_USEKT | | | |
|---|---|---|---|---|
| Meaning | $P_USEKT is a bit-coded value. Only the contents of the bits 0 - 3 are of significance.<br>The following tool changes are available for all tools, whose parameter $TC_TP11 have set one of the bits of $P_USEKT. The value 0 means that "all bits are set".<br>An alarm is generated if there is no such tool in a tool group for which a tool change was programmed. | | | |
| Data type | INT | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | x | x | - | - |
| Implicit preprocessing stop | - | - | | |

It is only when $P_USEKT has been programmed that the selection takes effect. The selection is disabled by end of program or by a reset.

Bit coding makes it possible for a tool to belong to several tool subgroups. A maximum of 4 different tool subgroups is possible, i.e. only bits 0, 1, 2 and 3 are taken into consideration.

**Note**

The system variable $TC_TP11 was not evaluated in NCK up to now. The value is automatically assigned 0. A check should be made in existing data records whether the values included here are suitable.

The programming $P_USEKT = 0 means that all tools of the tool group are considered in the tool selection.

The value $TC_TP11[t] = 0 means "the tool belongs to all defined tool groups". This ensures compatibility with existing data records.

If working with the function T=location, $P_USEKT **cannot** be programmed.

$P_USEKT is set automatically at each tool change. At Power On, reset and end of program, $P_USEKT = 0 is set.

If the value of $P_USEKT is to be kept after a reset or be effective after Power On, then this can be set using machine data $MC_USEKT_RESET_VALUE.

## Example

The tool group "Miller_25" comprises 4 tools.
(the following applies: Tool_Change_Mode=1)

| | | | |
|---|---|---|---|
| Miller_25 | Duplo 1 | T_No. 1 | TP11=1 |
| Miller_25 | Duplo 2 | T_No. 2 | TP11=2 |
| Miller_25 | Duplo 3 | T_No. 3 | TP11=4 |
| Miller_25 | Duplo 4 | T_No. 4 | TP11=8 |

```
%MPF
…
T="Miller_25"
```

| | |
|---|---|
| M06 | Every tool in this group can be loaded, as no selection has been made. The search strategy that has been set prevails. |

```
…
$P_USEKT=2
…
T="Miller_25"
```

| | |
|---|---|
| M06 | "Miller_25", duplo 2 loaded at change |

```
…
$P_USEKT=9
…
T="Miller_25"
```

| | |
|---|---|
| M06 | "Miller_25", duplo 1 or duplo 4 loaded at change (depending on the selected search strategy) |

```
…
$P_USEKT=0
…
T="Miller_25"
```

| | |
|---|---|
| M06 | Every tool in this group can be loaded, as USEKT=0 has canceled the selection. The search strategy that has been set prevails. |

```
…
$P_USEKT=15
…
T="Miller_25"
```

| | |
|---|---|
| M06 | Every tool in this group can be loaded, as all bits are set. The search strategy that has been set prevails. |

### T=location, automatic tool selection

First the attempt is made to load the tool from the programmed magazine location, independently of the value in $TC_TP11.

If this tool is disabled, then the $TC_TP11 value of the tool at the programmed magazine location is considered in order to access the replacement tool. Only tools that have one of the bits of the disabled tool in $TC_TP11 can be replacement tools.

## 5.8.33 TOOLGNT/TOOLGT - Tool groups

### Comment

This function is only available for TMMO and TMMG.

The abbreviation TOOLGNT means: **TOOLG**roup**N**umberOf**T**ools - number of tools of the group.

The abbreviation TOOLGT means: **TOOLG**roup**T**oolNumber - T No. of the i-th tool of tool group with i = 1, ...TOOLNTG.

The language commands allow information to be obtained about the tools in the tool group.

**TOOLGNT("identifier")**

**TOOLGT("identifier", i)**

| Result | Result value | |
|---|---|---|
| | > 0 | Successful read access |
| | 0 | i is a value outside of the permitted range |
| | -1 | Neither function TMMG nor function TMMO active |
| | -2 | No tool exists for the name "identifier" |

The NCK defines the sequence of the tools in the tool group and this changes in the course of the programmed tool change with tools from this group.

Example

The following tool is available "Drill_6mm"/Duplo_1, "Drill_6mm"/Duplo_2 and "Drill_6mm"/Duplo_3.

The number of tools of the group "Drill_6mm" is first read-out.
R1=TOOLGNT("Drill_6mm") R1=3

The T number of this tool is then determined.
R11=TOOLGT("Drill_6mm,1)
R12=TOOLGT("Drill_6mm,2)
R13=TOOLGT("Drill_6mm,3)

## 5.8.34 $P_TMNOIS - is a number, T number, magazine number or MT number

This function is available with TMBF, TMFD, TMMO and TMMG.

Individual tools, magazines as well as multitools use the number range 1–32000 for numbering. As a consequence, a distinction must be made as to what the number actually refers to. This system parameter does this.

```
def int result
def int no=4711
result = $P_TMNOIS[ no ] ; is no of a T No., an MT No., or a magazine No. ?;
```

| Result | Description |
|---|---|
| 3 | no is the number of a defined tool and the number of a defined magazine |
| 2 | no is the magazine number of a defined magazine |
| 1 | no is the T number of a defined tool |
| 0 | no is the MT number of a defined multitool |
| -3 | invalid number. no. is neither the number of a tool, a magazine nor a multitool. If the command is programmed in the TMFD function, then the result is also –3. If no. = 0 then the result is –3 |

## 5.8.35 $P_TOOLEXIST - define the existence of a tool

$P_TOOLEXIST is parameterized with the internal T number. Either true or false is returned. If the T number of a multitool supplies $P_TOOLEXIST=false, then the T-No. of an existing tool supplies $P_TOOLEXIST=true. $P_TMNOIS can be used as an alternative.

## 5.8.36 $A_TOOLMN - Read magazine No. of tool

Comment: TOOLMN stands for = "**tool m**agazine **n**umber". The name component $A_TOOL was selected to show the association with the existing system variables.

| **Name** | **$A_TOOLMN[t]** | | | |
|---|---|---|---|---|
| Meaning | Returns the magazine number of the tool with T No.=t. If the tool is not assigned to a magazine, 0 is returned. If the tool management function is not active, -1 is returned. If there is no tool with T No.=t, -2 is returned.<br>An alarm is issued if the value range for the T number was violated. | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | The index specifies the T number | | | 1-32000 |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | x | - | x | - |
| Implicit preprocessing stop | x | - | | |

## 5.8.37 $P_MTOOLN / $P_MTOOLMT - determine the number of multitools/MT number

This function is available for TMMG.

The following system parameters can be used to obtain an overview of the multitools defined in the TO unit assigned to the channel.

**result = $P_MTOOLN** number of multitools, which are known in the channel.
**M**ulti**TOOLN**umberOf

| Result | Result value |
|---|---|
| > 0 | Number of defined multitools |
| 0 | No multitool defined |
| -1 | TMMG function not active |
| -2 | Multitool function not active |

Example

```
def int number = 0
def int i = 0
def string[32] mtName
number = $P_MTOOLN
for i = 1 to number
    r[i] = $P_MTOOLMT[i]              ;write all MT numbers of the defined multitool
                                      ;in consecutive R parameters
endfor
mtName = $P_MTP2[$P_MTOOLMT[i]] ;write the name of the last multitool after mtName
```

## 5.8.38 $P_MTOOLNT / $P_MTOOLT - number of tools in the multitool

This function is available for TMMG.

**Note**

Also refer to the analog tool-specific system parameters $P_TOOLNT, $P_TOOLT.

The following system parameters can be used to obtain an overview of the multitools defined in the TO unit assigned to the channel.

**result = $P_MTOOLNT**[mt] number of tools in the multitool
mt = multitool number
**M**ulti**TOOLN**umber Of **T**ools

Result value

| Result | Result value |
|---|---|
| > 0 | Number of tools in the multitool |
| 0 | No tool contained in the multitool with the number mt |
| -1 | TMMG function not active |
| -2 | Multitool function not active |
| -3 | mt is not the number of a defined multitool |

**result = $P_MTOOLT**[mt , i] T number of the i-th tool in the multitool mt
mt = multitool number
i = i-th tool in the multitool; i = 1, ..., $P_MTOOLNT
**M**ulti**TOOLT**number

| Result | Result value |
|---|---|
| > 0 | Number of the i-th tool in the multitool |
| 0 | i is a value outside of the permitted range |
| -1 | TMMG function not active |
| -2 | Multitool function not active |
| -3 | mt is not the number of a defined multitool |

Example

Multitool with number 500 has 6 locations. 3 tools with T numbers 11, 22, 33 are loaded at locations 1, 2, 5.

```
def int number = 0
def int i = 0
number = $P_MTOOLNT[500]      ;the number of tools is 3
for i = 1 to number           ;loop across 3 tools and not across 6 MT locations
r[i] = $P_MTOOLT [500, i]     ;write the T numbers of loaded tools in
                              ;consecutive R parameters
                              ;r1=11, r1=22, r3=33
endfor
```

## 5.8.39 $A_TOOLMLN - Read magazine location No. of tool

### Comment

TOOLMLN stands for = "**toolm**agazine **l**ocation **n**umber".

| **Name** | **$A_TOOLMLN[t]** | | | |
|---|---|---|---|---|
| Meaning | Returns the magazine location number of the tool with T No.=t. If the tool is not assigned to a magazine, 0 is returned. If the tool management function is not active, -1 is returned. If there is no tool with T No.=t, -2 is returned.<br>An alarm is issued if the value range for the T number was violated. | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | The index specifies the T number | | | 1-32000 |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | x | - | x | - |
| Implicit preprocessing stop | x | - | | |

Comment: It is not possible that the following applies $A_TOOLMLN[t]==0 and $A_TOOLMN[t]>0, or $A_TOOLMLN[t]>0 and $A_TOOLMN[t]==0.

## 5.8.40 $P_TOOLND - Read number of cutting edges for tool

### Comment

TOOLND stands for = "**tool n**umber of **D**s".

| **Name** | **$P_TOOLND[t]** | | | |
|---|---|---|---|---|
| Meaning | Returns the number of cutting edges for tool with T No.=t. A tool always has at least one cutting edge.<br>Default: If there is no tool with T No.=t, -1 is returned.<br>The value 0 is rejected as index error. | | | |
| Data type | INT | | | |
| Value range | Default: -1, 1 - 9<br>Function "flat D number": -1, 1 - "Machine data value for the maximum number of D numbers" | | | |
| Indices | Meaning | | | Value range |
| | The index specifies the T number | | | 1-32000 |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | x | - | - | - |
| Implicit preprocessing stop | - | - | | |

### Function "flat D numbers" (only without active tool management)

If the function "flat D numbers" is active, the behavior differs somewhat. With parameter t=1 the total number of offset data records of the TOA unit is returned. Other values for t return -1. If no offset data record is defined in the TOA unit, -1 is returned.

## 5.8.41 $A_MONIFACT - Factor for reading tool life monitoring

### Overview

If different tool materials are to be machined with the same tool, it may be necessary to increase or reduce the time intervals for monitoring in order to detect the varying degrees of tool wear. The factor is set accordingly before the tool is used. The write operation is performed synchronously with the main run.

A channel-specific parameter, used to multiply the actual time measurement, has been defined.

Setting a value = 0 deactivates the time monitoring function for all tools used on the channel via the part program.

| Name | $A_MONIFACT | | | |
|---|---|---|---|---|
| Meaning | Only relevant when time monitoring is active in the tool management.<br>Factor for influencing the time measurement for tracking time for time-monitored tools.<br>Values < 1 and > 0 slow down time measurement (the clock "runs slower").<br>Values > 1 speed up the time measurement (clock "runs faster"). Value 1 is active after the control has been powered up, after Reset and M30 (default) and corresponds to real time. Value 0 is also permitted and disables time measurement of all time-monitored tools that are operated on a time-monitored spindle on this channel.<br>Comment: You can get the monitoring time to "run backwards" by using negative values. | | | |
| Data type | REAL | | | |
| Value range | Value range of type REAL | | | |
| Indices | Meaning | | | Value range |
| | | | | - |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | x | x | x | x |
| Implicit preprocessing stop | - | x | | |

## Tool life counter on monitor

If system variable $A_MONIFACT is set accordingly, the tool life counter on the monitor can run at a speed other than real time. The time values of the OPI block TS are thereby converted at the interface. In the NCK, the values are retained as before. These values are real-time values.

Read OPI:
The time values are divided by the actual value of $A_MONIFACT and transferred.

Write OPI:
The time values output by the OPI are multiplied by the actual value of $A_MONIFACT and stored in the NCK.

## Example

The actual values are specified (units in real time, i.e. normalized to $A_MONIFACT = 1).

Setpoint tool life: 10 minutes

Actual tool life: 2 minutes - in **one minute**, the pre-warning limit is reached

Prewarning limit: 1 minute

The values 10, 2, 1 are displayed on the screen.

**$A_MONIFACT = 2** is programmed in the part program (clock runs faster). The actual tool life displayed on the monitor jumps and continues to run in real time. The setpoint tool life and prewarning limit displayed also jump as soon as **$A_MONIFACT = 2** takes effect.

Setpoint tool life: 5 minutes

Actual tool life: 1 Minute - in **half a minute** the prewarning limit is reached

Prewarning limit: 0.5 minutes

## 5.8.42 $AC_MONMIN - Factor for tool search

### General

The following is defined by the variable $AC_MOMIN:

Only consider those tools whose actual value is at least a factor $AC_MONMIN (0, ...1) of the setpoint away from the limiting value.

### Definition of smallest/largest actual value

**Absolute** smallest/largest **actual values** are, in accordance with the tool-search strategy "Search for the tool with the smallest/largest actual value" used for the tool search exactly then when **all tools of a tool group have the same monitoring type defined** (via $TC_TP9).

This means all tools of the tool group are either time-monitored or count-monitored, or are wear or alternatively additive offset monitored.

**Relative** smallest/largest **actual values** are, in accordance with the tool-search strategies "Search for the tool with the smallest/largest actual value" used for the tool search exactly then when **the tools of a tool group have different monitoring types defined** in $TC_TP9.

This means one tool can be time-monitored, the other tool can be count-monitored. A third tool could be both wear as well as time-monitored.

### Smallest/largest actual value for exactly one monitoring type

This is the standard application.

Each smallest/largest actual value here of the monitored variable ($TC_MOP2, $TC_MOP4, $TC_MOP6 for time, count, wear or additive offset) corresponds to smallest/largest actual value of the tools in the tool group.

Example:

A tool group "TL1" is defined. e.g. $TC_MAMP2="H108" applies - smallest actual value:

| Duplo No.<br>$TC_TP1 | Actual value<br>$TC_MOP2 | Setpoint<br>$TC_MOP11 | Absolute<br>Smallest actual value = $TC_MOP2 |
|---|---|---|---|
| 1 | 9 | 10 | 9 |
| 2 | 8 | 10 | 8 |
| 3 | 6 | 6 | 6 smallest actual value in the tool group |

Therefore the order of tools for use is: Duplo No.= 3 -> 2 -> 1.

### Smallest/largest actual value with several parallel monitoring types

Tools in a tool group can be monitored in different ways.

Or different types of tool monitoring can be defined for a tool. These situations are detected by the NCK and handled accordingly:

The definition of the smallest/largest actual value is determined for these cases by the quotient of dividing actual value and setpoint; i.e.

Quotient (Q)= actual value / setpoint

The tool with the smallest quotient has the **smallest actual value** of the tools in the tool group.

The tool with the largest quotient has the **largest actual value** of the tools in the tool group.

Example 1:

Tool group "millers" has two tools with T Nos. =1 and 2 each with a cutting edge D1.

Time monitoring is active for T1; $TC_TP9[1]=1.

Workpiece count monitoring is active for T2; $TC_TP9[2]=2.

Q(T1) = $TC_MOP2[1,1] / $TC_MOP11[1,1] is = 0.5
Q(T2) = $TC_MOP4[2,1] / $TC_MOP13[2,1] is = 0.9

Therefore, T1 has the smaller actual value.

Example 2:

A tool group "TL1" is defined. e.g. $TC_MAMP2="H108" applies - smallest actual value:

| Duplo No.<br>$TC_TP1 | Actual value<br>$TC_MOP2 | Setpoint<br>$TC_MOP11 | Absolute<br>Smallest actual value = $TC_MOP2 |
|---|---|---|---|
| 1 | 9 | 10 | 0.9 |
| 2 | 8 | 10 | 0.8 smallest actual value |
| 3 | 6 | 6 | 1 |

Therefore the order of tools for use is: Duplo No.=2->1->3.

## $AC_MONMIN

The above definition of the actual value applies for the actual value that is checked against the setpoint where a factor of $AC_MONMIN has been applied.

The following check is made for the absolute actual-value comparison (time monitoring taken here as the example):

$TC_MOP2 >= $AC_MONMIN * $TC_MOP11.

This is the criterion for the usability of the tool.

The following check is made for the relative actual value comparison (time monitoring taken here as the example):

$TC_MOP2 / $TC_MOP11 >= $AC_MONMIN

This is the criterion for the usability of the tool.

The result is the same in each case.

**Note**

The smallest of the actual values (both absolute as well as relative) of the cutting edges of a tool is used for the comparison with the actual values of other tools.

| Name | $AC_MONMIN | | | |
|---|---|---|---|---|
| Meaning | Only when tool management is active<br>Gives the factor for the tool-search strategy "Only consider those tools whose actual value is at least a factor $AC_MONMIN* of the setpoint away from the limiting value".<br>The programmed value is ignored if the tool status "disabled" shall be ignored during the tool search. This can be initiated either by the command TCA, PLC signal or machine data for start/reset.<br>See also the system variables $TC_MOPx, $TC_MAMP2. | | | |
| Data type | REAL | | | |
| Value range | 0-1 | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | X | X | X |
| Implicit preprocessing stop | - | X | - | |

### Boundary conditions

If different types of tool monitoring are selected for the tools of a tool group, then the decision has to be made whether it is meaningful for the specific application to use the tool-search strategy "Search tool with smallest or largest actual value" in this tool group.

Similar conditions apply when working with multiple-edge tools. Also, it is necessary to consider whether it is meaningful to apply the tool search strategy "Search tool with smallest or largest actual value" in this tool group.

**Note**

As for the other tool search strategies, that tool is preferred for use that is on the spindle or in one of the assigned buffer at the time of the tool search; i.e. the tool search strategy is not applied.

The PLC signal "Do not disable tool" renders the tool search strategy ineffective in accordance with $AC_MONMIN.

### Activation

The following must apply so that the tool-monitoring-specific tool search strategies can be effective:

- The sub-function "Tool-monitoring function" must be active within the tool management function
- The appropriate monitoring parameter values ($TC_MOP1, ....) must have been set for the cutting edges of the tools
- The monitoring must be activated for the appropriate tool (system variable $TC_TP9)
- $AC_MONMIN can be programmed in the part program as well. The programmed value is only meaningful if points 1, 2, and 3 are met.

## 5.8.43 $P_TOOLNG - Number of tool groups

This function is only available for TMMO and TMMG.

| Name | $P_TOOLNG | |
|---|---|---|
| Meaning | Number of defined tool groups that are assigned to the channel.<br>> 0: Successful read access<br>0: no tool group defined<br>(tool group is defined by writing the tool name)<br>-1: neither function TMMG nor TMMO active | |
| Data type | INT | |

| Name | $P_TOOLNG | | | |
|---|---|---|---|---|
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

## 5.8.44 $A_MYMN / $A_MYMLN - Owner magazine/location of the tool

This function is available for TMMG.

System variables $A_TOOLMN and $A_TOOLMLN contain definitions which magazine/magazine location the specified tool is currently located at. This can be a real or an internal magazine.

The system variables $A_MYMN and $A_MYMLN indicate the magazine/magazine location (real magazine only), at which the specified tool was loaded or from which a tool contained in an internal magazine was loaded.

| Name | $A_MYMN[t] / $A_MYMLN[t] | | | |
|---|---|---|---|---|
| Meaning | Use:<br>$A_MYMN[t] - number of the owner magazine of the tool with the T No. = t<br>> 0: Tool is loaded<br>0: Tool is not loaded<br>-1: Function TMMG is not active<br>-2: Tool with the T No. = t does not exist - not for t = 0 either<br>$A_MYMLN[t] - number of the owner-magazine location of the tool with the T No. = t<br>> 0: Tool is loaded<br>0: Tool is not loaded<br>-1: Function TMMG is not active<br>-2: Tool with the T No. = t does not exist - not for t = 0 either | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | X | - |
| Implicit preprocessing stop | - | - | - | |

1. The following applies for tools that have not been loaded:
   $A_MYMN = $A_MYMLN = $A_TOOLMN = $A_TOOLMLN = 0
2. For manual tools that have been loaded or tools that have been newly loaded onto the toolholder, the following applies:
   $A_MYMN = $A_MYMLN = 0
   $A_TOOLMN 1 = 0, $A_TOOLMLN 1 = 0
3. For tools, which are loaded and are not in an internal magazine, the following applies:
   $A_MYMN = $A_TOOLMN > 0
   $A_MYMLN = $A_TOOLMLN >0
   For fixed location-coded tools in buffers, the two parameters specify where the particular tools should be returned to in the magazine.

## 5.8.45 $A_MYMTN / $A_MYMTLN - $A_TOOLMTN / $A_TOOLMTLN - tools in the multitool

In addition to the already defined parameters $A_MYMN / $A_MYMLN and $A_TOOLMN / $A_TOOLMLN parameters

$A_MYMTN / $A_MYMTLN - or with the same contents $A_TOOLMTN / $A_TOOLMTLN - specify in which MT and at which location in the MT the tool is located.

The following applies:

$A_MYMTN = $A_TOOLMTLN

and

$A_MYMTLN = $A_TOOLMTLN.

This therefore states that the tool remains permanently in the MT.

| | |
|---|---|
| result = $A_MYMTN [t] | tool–Tno. t = 1, ..., 32000<br>MYMultiToolNumber |
| result = $A_TOOLMTN [t] | tool–Tno. t = 1, ..., 32000<br>TOOLisOnMultiToolNumber |

| Result | Result value |
|---|---|
| >0 | The tool with T number t is located in the multitool with the number, result |
| 0 | The tool with Tno.= t is not in a multitool |
| -1 | TMMG function not active |
| -2 | Multitool function not active |
| -3 | is not a tool T No. (outside the range, not defined or it is an MT No. or a magazine No.) |

| | |
|---|---|
| result = $A_MYMTLN [t] | tool–Tno. t = 1, ..., 32000<br>MYMultiToolLoactionNumber |
| result = $A_TOOLMTLN [t] | tool–Tno. t = 1, ..., 32000<br>TOOLisOnMultiToolLoactionNumber |

| Result | Result value |
|---|---|
| >0 | The tool with T number t is at a location with the number, result within a multitool |
| 0 | The tool with Tno.= t is not in a multitool |
| -1 | TMMG function not active |
| -2 | Multitool function not active |
| -3 | is not a tool T No. (outside the range, not defined or it is an MT No. or a magazine No.) |

## 5.8.46 $P_TOOLNT / $P_TOOLT - T numbers

This function is available for TMMO, TMMG, TMFD and TMBF.

| Name | $P_TOOLNT / $P_TOOLT[i] | | | |
|---|---|---|---|---|
| Meaning | These system variables enables an overview of the tools defined in NCK.<br>$P_TOOLNT<br>Number of defined tools that are assigned to the channel.<br>> 0:Successful read access<br>0: No tool defined<br>$P_TOOLT[i]<br>i-th tool number T<br>> 0: T number<br>0: i is a value outside of the permitted range | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | N = number of tools that are assigned to the channel<br>i = i-th T No.; i=1, ..., $P_TOOLNT | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

The following applies specifically for TMFD:

$P_TOOLNT returns value 1 provided D offsets have been defined and returns value 0 when there are no D offsets.

The system variable $P_TOOLT returns value 1 for index i = 1 if at least one D offset has been defined and returns value 0 for other values of i.

## 5.8.47 $P_TOOLD - D numbers

This function is available for TMMO, TMMG, TMFD and TMBF.

| Name | $P_TOOLND / $P_TOOLD[t,i] | | | |
|---|---|---|---|---|
| Meaning | Determine the defined D numbers of a tool. The command can generally be programmed.<br>i-th number of tool compensations D of the tool with the T No. = t<br>> 0: D number<br>0: i is a value outside of the permitted range<br>-2: t is the value of a non-defined tool | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | t = T number<br>i = i-th T No.; i=1, ..., $P_TOOLND | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

## 5.8.48 $P_TOOLNDL - Number of defined DL offsets

This function is available for TMMO, TMMG, TMFD and TMBF. The function "additive offset" must have been activated via MD.

| Name | $P_TOOLNDL[t,d] | | |
|---|---|---|---|
| Meaning | Determine the number of defined DL numbers of a D offset. The command can generally be programmed.<br>Number of DL offsets for D offset provided by T No. = t, D No. = d<br>> 0: Number of DL offsets<br>0: No DL offsets for this D offset<br>-1: Additive offset function not active<br>-2: t is the value of a non-defined tool<br>-3: d is the value of a non-defined D offset | | |
| Data type | INT | | |
| Value range | 1-32000 | | |
| Indices | Meaning | | Value range |
| | t = T number<br>d = D number | | |

| Name | $P_TOOLNDL[t,d] | | | |
|---|---|---|---|---|
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

## 5.8.49 $A_USEDND - Workpiece counting

This function is available for TMMO.

| Name | $A_USEDND[s] | | | |
|---|---|---|---|---|
| Meaning | Number of different cutting edges used on toolholder s since the last workpiece count including the currently used active cutting edge on s. Each tool used is included at least once. Index s means:<br>*TMMG + TMMO*<br>Spindle number/toolholder number<br>s = 0 means that the currently active master toolholder is selected.<br>*TMMO active without TMMG*<br>a) $MC_T_M_ADDRESS_EXT_IS_SPINO = FALSE: s is not evaluated. It is not possible to count the workpieces separately according to toolholders.<br>b) $MC_T_M_ADDRESS_EXT_IS_SPINO = TRUE: Spindle number. s = 0 means that the currently active master spindle is selected.<br>> 0: Number of cutting edges used<br>0: No more tools used since the last workpiece count<br>-1: TMMO is not active<br>-2: s is the value of a non-defined toolholder | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | s = 1, ...., MAXNUM_AXES_PER_CHAN<br>s = 0 indicates the master toolholder | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

Example, see $A_USEDT - workpiece counting

## 5.8.50 $A_USEDT - Workpiece counting

### Overview

This function is available for TMMO.

| **Name** | **$A_USEDT[i,s]** | | | |
|---|---|---|---|---|
| Meaning | T number of the tool of the i-th cutting edge that has been used on toolholder s since the last workpiece count or is still being used.<br>Example: For i=$A_USEDND, the T number of the first cutting edge or D offset is obtained, which was selected on the programmed toolholder s since the last workpiece count. Index s means:<br>*TMMG + TMMO*<br>Spindle number/toolholder number<br>s = 0 means that the currently active master toolholder is selected.<br>*TMMO active without TMMG*<br>a) $MC_T_M_ADDRESS_EXT_IS_SPINO = FALSE: s is not evaluated. It is not possible to count the workpieces separately according to toolholders.<br>b) $MC_T_M_ADDRESS_EXT_IS_SPINO = TRUE: Spindle number. s = 0 means that the currently active master spindle is selected.<br>>0: T number (can also exist multiple times if different D offsets of the tool were in use)<br>0: No more cutting edges used since the last workpiece count<br>-1: TMMO is not active<br>-2: s is the value of a non-defined toolholder | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | S = 1, ...., MAXNUM_AXES_PER_CHAN<br>I = 1, ...., $A_USEDND | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

## Example

Two toolholders are defined with numbers 1 and 2. Toolholder No. 1 is the master toolholder. On toolholder 1 up to now 3 tools with T numbers 10, 20, 30 were used; on toolholder 2 one tool was used with T number 666. Each tool only has offset D1 defined.

The following program section is run in the status:

```
def int n1, n2, i, tNo
n1 = $A_USEDND[1]               ; n1 = 3 same content would have been $A_USEDND[0]
n2 = $A_USEDND[2]               ; n2 = 1
for i = 1 to n1
tNo = $A_USEDT[1,i]
MSG ("to T No. participating in workpiece machining =" << tNo
endfor
                                ; The loop displays T numbers 10, 20, 30
T2=0                            ; Bits 7, 8, 19 are set for synchronization in
                                ; $MC_TOOL_MANAGEMENT_MASK. (automatic read-in
                                ; disable until tool change is acknowledged with
                                ; "End".)
setpiece(5,2)
if (n2 == 1) tNo = $A_USEDT[1,1]
                                ; sets tNo to value 0. Setpiece was programmed since
                                ; determination of n2. This deletes the list of
                                ; tools used and there is currently no entry for the
                                ; specified Index1 in the list of tools used.
```

## 5.8.51 $A_USEDD - Workpiece count

This function is available for TMMO.

| **Name** | **$A_USEDD[i,s]** | | | |
|---|---|---|---|---|
| Meaning | D number of the i-th cutting edge that has been used on the toolholder s since the last workpiece count or is still being used.<br>Example: For i=$A_USEDND, the D number is obtained for the first cutting edge or D offset that was selected after the last workpiece count on the programmed toolholder. Index s means:<br>*TMMG + TMMO*<br>Spindle number/toolholder number<br>s = 0 means that the currently active master toolholder is selected.<br>*TMMO active without TMMG*<br>a) $MC_T_M_ADDRESS_EXT_IS_SPINO = FALSE: s is not evaluated. It is not possible to count the workpieces separately according to toolholders.<br>b) $MC_T_M_ADDRESS_EXT_IS_SPINO = TRUE: Spindle number. s = 0 means that the currently active master spindle is selected.<br>>0: D number<br>0: No more tools used since the last workpiece count<br>-1: TMMO is not active<br>-2: s is the value of a non-defined toolholder | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | S = 1, ...., MAXNUM_AXES_PER_CHAN<br>I = 1, ...., $A_USEDND | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

## 5.8.52 $P_MAGN / $P_MAG - Magazine

This function is available for TMMG.

| Name | $P_MAGN / $P_MAG[i] | | | |
|---|---|---|---|---|
| Meaning | $P_MAGN<br>Number of defined magazines that are assigned to the channel.<br>> 0: Successful read access<br>0: No magazine defined<br>-1:TMMG is not active<br>$P_MAG<br>i-th magazine number<br>> 0: Successful read access<br>0: i is outside of the permitted range<br>-1: TMMG is not active | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | i = 1, ...., $P_MAGN | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

Example, see "Example of the magazine configuration system variables".

## 5.8.53 $P_MAGNDIS / $P_MAGDISS / $P_MAGDISL - magazine distance tables

This function is available for TMMG.

| **Name** | **$P_MAGNDIS[n,m] / $P_MAGDISS[l,i] / $P_MAGDISL[l,i]** | | | |
|---|---|---|---|---|
| Meaning | $P_MAGNDIS**[n,m]**<br>Number of magazines that are linked to the internal magazine n by the location m<br>> 0: Successful read access<br>0: no magazine linked with the buffer<br>-1: TMMG is not active<br>-2: n is not the number of an internal magazine<br>-3: m is not the number of an internal magazine location<br>$P_MAGDISS[l,i]<br>Number of the i-th magazine that is linked with location l of the buffer magazine.<br>> 0: Successful read access<br>0: i is outside of the permitted range<br>-1: TMMG is not active<br>-2: m is not the number of a buffer location<br>-3: No buffer location defined<br>$P_MAGDISL[l,i]<br>Number of the i-th magazine that is linked with location l of the loading magazine.<br>> 0: Successful read access<br>0: i is outside of the permitted range<br>-1: TMMG is not active<br>-2: m is not the number of a loading magazine location<br>-3: No buffer location defined | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | i = 1, ...., $P_MAGNDIS | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

Examples, see "Example of the magazine configuration system variables".

## 5.8.54 $P_MAGNS / $P_MAGS - Toolholder

This function is available for TMMG.

| **Name** | **$P_MAGNS / $P_MAGS[n]** | | | |
|---|---|---|---|---|
| Meaning | $P_MAGNS<br>Number of spindle locations/toolholder locations in the buffer assigned to the channel.<br>> 0: Successful read access<br>0: no spindle location defined<br>-1: TMMG is not active<br>-2: No buffer magazine defined<br>$P_MAGS[n]<br>n-th number of the spindle/toolholder in the buffer<br>> 0: Successful read access<br>0: n is outside of the permitted range<br>-1: TMMG is not active<br>-3: No buffer magazine defined | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | n = 1, ...., max. toolholder number | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

Example, see "Example for magazine configuration system variables".

## 5.8.55 $P_MAGNREL / $P_MAGREL - Assigned buffer

This function is available for TMMG.

| **Name** | **$P_MAGNREL[n] / $P_MAGREL[n,m]** | | | |
|---|---|---|---|---|
| Meaning | $P_MAGNREL[n]<br>Number of buffers assigned to the spindle No./toolholder No.<br>> 0: Successful read access<br>0: Spindle location has not been assigned buffer location<br>-1: TMMG is not active<br>-2: n is not the number of a spindle location<br>-3: No buffer magazine defined<br>$P_MAGREL[n,m]<br>m-th buffer number of the n-th spindle No./toolholder No.<br>> 0: Successful read access<br>0: m is outside of the permitted range<br>-1: TMMG is not active<br>-2: n is not the number of a spindle location<br>-3: No buffer magazine defined | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | m = 1, ...., $P_MAGNREL<br>n = 1, ...., max. toolholder number | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

Example, see "Example for magazine configuration system variables".

## 5.8.56 Example of magazine configuration system variables

### Specifications

The magazine configuration selected in the following example is selected. Information about the current magazine configuration can be obtained by reading the system variables described here.

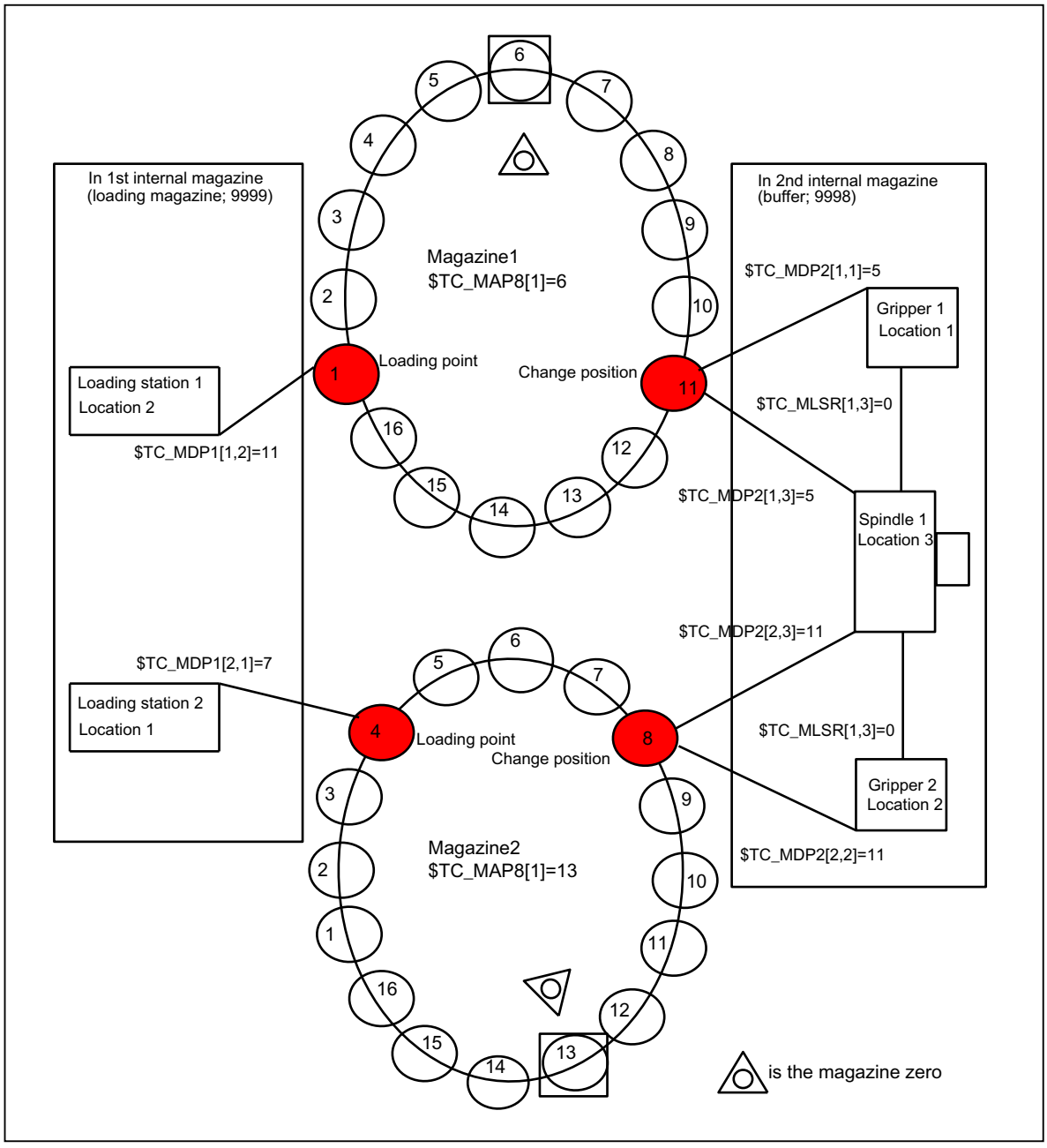



Figure 5-10 Magazine configuration

N10 def int noOfMag=0, noOfLoc=0, noOfDist=0, noOfRel=0,

noOfSpindles=0, spindleNo=0

N20 def int i=0

*; Total number of defined magazines*

```
N100 noOfMag = $P_MAGN          ; noOfMag is assigned value =4 - 2 real magazines
                                ; 1, 2+2 internal magazine 9998, 9999
```

*; Display all magazine numbers*

```
N200 for i=1 to noOfMag
N220 MDG ("Magazine No.="<<$P_MAG[i])
                                ; Display numbers 1, 2, 9998, 9999
N240 endfor
```

*; Total number of defined magazine locations*

```
N300 for i=1 to noOfMag
N320 noOfLoc=noOfLoc + $TC_MAP7[$P_MAG[i]]
N340 endfor                     ; noOfLoc is now assigned value 16+16+3+2=37
```

*; Number of magazines linked with Spindle 1*

```
N400 noOfDist=$P_MAGNDIS[9998,3]
                                ; noOfDist is assigned value=2 - Mag.1, 2 are linked
                                ; with the spindle location
```

*; Display the magazine numbers linked with Spindle 1 (=location 3)*

```
N500 for i=1 to noOfDist
N520 MSG ("Magazine No.=" << $P_MAGDISS[ i ] )
                                ; Display numbers 1, 2
N540 endfor
```

*; Number of magazines linked with Loading station 2*

```
N410 noOfDist = $P_MAGNDIS[9999,1]
                                ; noOfDist is assigned value=1 - Mag. 2 is linked
                                ; with loading station 2
```

*; Display the magazine numbers linked with loading station 2 (=location 1)*

```
N510 for i=1 to noOfDist
N530 MSG ("Magazine No.="<< $P_MAGDISL[i] )
                                ; Display number 2
N550 endfor
```

*; Total number of defined spindles*

```
N600 noOfSpindles=$P_MAGNS          ; noOfSpindles contains value = 1
                                    ; - one spindle location is defined
```

*; Display the numbers of the spindles defined in the magazine configuration*

```
N620 for i=1 to noOfSpindles
N640 MSG ("Magazine No.="<< $P_MAGS[i])
                                ; Display number 1
N660 endfor
```

*: Total number of buffer locations assigned to spindle 1*

(=gripper in example)

```
N700 noOfRel=$P_MAGNREL[1]
                                ; noOfRel contains value=2 grippers 1 and 2 are
                                ; assigned to the spindle
```

*; Display the numbers of the grippers of spindle No. 1 defined in the magazine configuration*

```
N720 for i=1 to noOfRel
N740 MSG ("Magazine No.="<< $P_MAGREL[1,i] )
                                ; Display numbers 1, 2
N760 endfor
```

## 5.8.57 $P_MAGNH / $P_MAGNHLT / $P_MAGHLT - Location type hierarchies

### Overview

This function is available for TMMG.

| Name | $P_MAGNH / $P_MAGNHLT[n] / $P_MAGHLTn,m] | | | |
|---|---|---|---|---|
| Meaning | $P_MAGNH<br>Number of defined magazine location type hierarchies that are assigned to the channel.<br>> 0 Successful read access<br>0 No location type hierarchies are defined<br>-1 TMMG is not active<br>$P_MAGNHLT[n]<br>Number of the defined location types in the n-the defined hierarchy<br>> 0 Successful read access<br>0 n is outside of the defined range<br>-1 TMMG is not active<br>$P_MAGHLTn,m]<br>m-th location type of hierarchy n<br>> 0 Successful read access<br>0 m is outside of the defined range<br>-1 TMMG is not active<br>-2 Hierarchy n does not have any defined location types | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | n = 1, ...., $P_MAGNH<br>m = 1, ...., $P_MAGNHLT | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

## Example

The following three hierarchies are defined:

*Hierarchy 1: 5 < 4 < 3:*

$TC_MPTH[0,0] = 5

$TC_MPTH[0,1] = 4

$TC_MPTH[0,2] = 3

*Hierarchy 2: 7 < 8:*

$TC_MPTH[1,0] = 7

$TC_MPTH[1,1] = 8

*Hierarchy 3: 1 < 2 < 9 < 6:*

$TC_MPTH[2,0] = 1

$TC_MPTH[2,1] = 2

$TC_MPTH[2,2] = 9

$TC_MPTH[2,3] = 6

We want to know *how many hierarchies* in total are defined and *how many magazine location types are contained in each hierarchy*.

```
N10 def int noOfH, noOfTypes[8], locTypeNo
N100 noOfH=$P_MAGNH                          ; noOfH is assigned value = 3
N220 for i=1 to noOfH
N240 noOfTypes[i - 1]=$P_MAGNHLT[ i ]
                                             ; set the values 3, 2, 4 in the array
N260 endfor
```

Furthermore, we want to know *which magazine location types* are defined in the 2nd hierarchy

```
N220 for i=1 to noOfTypes[1]
N240 MSG ("Magazine No.="<<$P_MAGHLT[2, i])
                                             ; display values 7, 8
N260 endfor
```

## 5.8.58 $P_MAGNA / $P_MAGA - Tool adapter

This function is available for TMMG.

| **Name** | **$P_MAGNA / $P_MAGA[i]** | | | |
|---|---|---|---|---|
| Meaning | $P_MAGNA<br>Number of defined adapters that are assigned to the channel.<br>> 0 Successful read access<br>0 no adapter defined<br>-1 Function "Adapter" or TMMG is not active<br>$P_MAGA[i]<br>i-th adapter number<br>> 0 Successful read access<br>0 n is outside of the defined range<br>-1 Function "Adapter" or TMMG is not active | | | |
| Data type | INT | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | i = 1, ...., $P_MAGNA | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

## 5.8.59 Additional language commands

| **Name** | **$P_TOOLNO** | | | |
|---|---|---|---|---|
| Meaning | Active tool numbers T0 to T32000, with TMFD, T can have eight digits. Generally, the command should not be used when magazine management is active. When magazine management is active GETTEXET should be used instead. For $MC_CUTTING_EDGE_DEFAULT=0, the incorrect T number can be determined. If the programming was implemented after programming D > 0, then it is also reliable | | | |
| Data type | Integer | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

| **Name** | **$P_TOOLP** | | | |
|---|---|---|---|---|
| Meaning | Tool number last programmed<br>Command is available for TMBF, TMFD and TMMO.<br>It is analogous to the TMMG-specific command GETSELT. | | | |
| Data type | Integer | | | |
| Value range | 1-32000 | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

| **Name** | **$P_TOOL** | | | |
|---|---|---|---|---|
| Meaning | Active tool cutting edge (Dx) | | | |
| Data type | Integer | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

| **Name** | **$P_DLNO** | | | |
|---|---|---|---|---|
| Meaning | Active additive offset number DL=0-DL=max;<br>max=value of $MN_MM_MAX_SUMCORR_PER_CUTTEDGE<br>$P_DLNO is analogous to the already existing parameters $P_TOOL, $P_TOOLNP and active D and T numbers. | | | |
| Data type | Integer | | | |
| Value range | 0-6 | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | | |

| **Name** | **$P_TOOLL[n]** | | | |
|---|---|---|---|---|
| Meaning | Active tool total length; n = 1...3 | | | |
| Data type | REAL | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

| **Name** | **$P_TOOLR** | | | |
|---|---|---|---|---|
| Meaning | Active radius | | | |
| Data type | REAL | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

| **Name** | **$P_TC** | | | |
|---|---|---|---|---|
| Meaning | Active toolholder | | | |
| Data type | Integer | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

| **Name** | **$P_TCANG[n]** | | | |
|---|---|---|---|---|
| Meaning | Active angle of a toolholder axis; n = 1-2 | | | |
| Data type | REAL | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

| **Name** | **$P_TCDIFF[n]** | | | |
|---|---|---|---|---|
| Meaning | Difference between calculated and used angle of a toolholder axis for grid (Hirth tooth system) of the angle | | | |
| Data type | REAL | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

| **Name** | **$P_AD[n]** | | | |
|---|---|---|---|---|
| Meaning | Active tool offset; n = 1...31<br>n=1-25 $TC_DP1 to $TC_DP25<br>n=26 $TC_DPCE (optional)<br>n=27 $TC_DPH (optional)<br>n=28 $TC_DPV (optional)<br>n=29 $TC_DPV3 (optional)<br>n=30 $TC_DPV4 (optional)<br>n=31 $TC_DPV5 (optional) | | | |
| Data type | DOUBLE | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | X | - | - |
| Implicit preprocessing stop | - | - | - | |

$P_ADT[n] - Transformed data of the active tool

| **Name** | **$P_ADT[n]** | | | |
|---|---|---|---|---|
| Meaning | When compensation parameters are read, this parameter returns transformed values of the parameters controlled by the tool adapter transformation - if the active tool is attached to an adapter.<br>n=1-25 $TC_DP1 to $TC_DP25<br>n=26 $TC_DPCE (optional)<br>n=27 $TC_DPH (optional)<br>n=28 $TC_DPV (optional)<br>n=29 $TC_DPV3 (optional)<br>n=30 $TC_DPV4 (optional)<br>n=31 $TC_DPV5 (optional) | | | |
| Data type | DOUBLE | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | n: Parameter numbers 1 to 31 | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

| **Name** | **$AC_MSNUM** | | | |
|---|---|---|---|---|
| Meaning | Master spindle, return value<br>0: No spindle configured<br>1...n: Number of master spindle | | | |
| Data type | Integer | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | X | - |
| Implicit preprocessing stop | X | - | - | |

| **Name** | **$P_MSNUM** | | | |
|---|---|---|---|---|
| Meaning | Master spindle<br>0: No spindle configured<br>1...n: Number of master spindle | | | |
| Data type | Integer | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | - | |

| **Name** | **$AC_MTHNUM** | | | |
|---|---|---|---|---|
| Meaning | Master toolholder<br>Value=0 no master toolholder defined<br>Value>0 number of the master toolholder | | | |
| Data type | Integer | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | X | - |
| Implicit preprocessing stop | X | - | X | - |

| **Name** | **$P_MTHNUM** | | | |
|---|---|---|---|---|
| Meaning | Master toolholder<br>Value=0 no master toolholder defined<br>Value>0 number of the master toolholder | | | |
| Data type | Integer | | | |
| Value range | | | | |
| Indices | Meaning | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | - | - | - |
| Implicit preprocessing stop | - | - | | |

| Name | $TC_TP_MAX_VELO | | | |
|---|---|---|---|---|
| Meaning | Maximum tool speed | | | |
| Data type | REAL | | | |
| Value range | [0, DBL_MAX] | | | |
| Indices | Internal T number | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | X | - | - |
| Implicit preprocessing stop | - | - | - | - |

| Name | $TC_TP_MAX_ACC | | | |
|---|---|---|---|---|
| Meaning | Maximum rotary acceleration of the tool | | | |
| Data type | REAL | | | |
| Value range | [0, DBL_MAX] | | | |
| Indices | Internal T number | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | X | - | - |
| Implicit preprocessing stop | - | - | - | - |

| Name | $TC_MPP_SP_MAX_ACC | | | |
|---|---|---|---|---|
| Meaning | Only relevant, if $MC_TOOLHOLDER_MANAGEMENT>0: Spindle No., which is linked to the toolholder. | | | |
| Data type | Integer | | | |
| Value range | [0, MAXNUM_SPIND_PER_CHAN] | | | |
| Indices | Magazine No., magazine location No. | | | Value range |
| | | | | |
| Access | Read in part program | Write in part program | Read in synchronous action | Write in synchronous action |
| | X | X | - | - |
| Implicit preprocessing stop | - | - | - | - |

## 5.8.60 Variables for subroutine replacement technique

| Tool management language command | Functions |
|---|---|
| $C_T | Value of the programmed address T for cycle parameterization and T function replacement |
| $C_T_PROG | Address T is programmed in a block with cycle call of T function replacement |
| $C_TS | For T or TCA replacement, supplies the programmed tool identifier ($C_TS_PROG == TRUE). |
| $C_TS_PROG | Supplies TRUE, if a tool identifier has been programmed for the T or TCA replacement. |
| $C_TE | Address extension for address T for subroutine call per T function |
| $C_D | Value of the programmed address D in the ISO mode for cycle parameterization |
| $C_D_PROG | Address is programmed in a block with cycle call |
| $C_DL | Value of the programmed address DL (additive tool offset) for a subroutine call per M/T function replacement |
| $C_DL_PROG | Interrogates whether, for a subroutine call per M/T function replacement, address DL (additive tool offset) was programmed |
| $C_TCA | Supplies TRUE, if the TCA replacement is active |
| $C_DUPLO_PROG | Supplies TRUE, if the duplo number for the TCA replacement has been programmed |
| $C_DUPLO | Supplies the value of the programmed Duplo number for TCA replacement ($C_DUPLO_PROG == TRUE) |
| $C_THNO_PROG | Supplies TRUE, if the toolholder/spindle number for the TCA replacement has been programmed |
| $C_THNO | Supplies the value of the programmed toolholder/spindle number for TCA replacement ($C_THNO_PROG == TRUE) |

## 5.8.61 Variables for tool change in synchronized action

| Tool management language command | Functions |
|---|---|
| $AC_TC_FCT | Command number<br>-1: At the instant of reading, no tool management command is active<br>1: Move (load, unload,...)<br>2: Prepare change<br>3: Change ON<br>4: Change ON (turret, without M06)<br>5: Prepare change and change ON (with M06) |
| $AC_TC_STATUS | Acknowledgment status of PLC FC 8/ FC 6 |

| Tool management language command | Functions |
|---|---|
| $AC_TC_THNO | Number of the toolholder or the spindle where the new tool shall be loaded |
| $AC_TC_TNO | The internal T number of the tool to be loaded at change<br>0: there is no new tool |
| $AC_TC_MFN | Source magazine number of the new tool<br>0: there is no new tool |
| $AC_TC_LFN | Source location number of the new tool<br>0: there is no new tool |
| $AC_TC_MTN | Target magazine number of new tool<br>0: there is no new tool |
| $AC_TC_LTN | Target location number of the new tool<br>0: there is no new tool |
| $AC_TC_MMYN | Owner magazine of new tool<br>0: there is no new tool |
| $AC_TC_LMYN | Owner location magazine of new tool<br>0: there is no new tool |
| $AC_TC_MFO | Source magazine number of the old tool<br>0: there is no old tool |
| $AC_TC_LFO | Source location number of the old tool<br>0: there is no old tool |
| $AC_TC_MTO | Target magazine number of old tool<br>0: there is no old tool |
| $AC_TC_LTO | Target location number of the old tool<br>0: there is no old tool |
| $AC_TC_CMDT | Trigger variable to NCK command output<br>Set for one interpolation cycle when NCK outputs a new command. |
| $AC_TC_CMDC | Counter for NCK command output<br>This variable is incremented by 1 at each NCK command output. Can also be written (zero setting). |
| $AC_TC_ACKT | Trigger variable to PLC command<br>Set for one interpolation cycle when PLC outputs a command to NCK. Command acknowledgement or independent message (asynchronous transfer). |
| $AC_TC_ACKC | Counter for PLC commands<br>This variable is incremented by 1 at each PLC command. Can also be written (zero setting). |

| Access | Read in part program | Write in part program | Read in synchronous action | Read in synchronous action |
|---|---|---|---|---|
| | X | - | X | - |
| Implicit preprocessing stop | X | - | | |

# 5.9 Definitions when programming data

## 5.9.1 Tool and cutting edge data

### Overview

If a parameter for a cutting edge, tool or magazine that does not exist is written, a new cutting edge, tool or magazine is created.

**Note**

When a tool is created, all the cutting-edge-specific data of cutting edge D1 are created with it. (DP, DPC, MOP, MOPC are preset to "0".) The grinding-specific tool data ($TC_TG1...) is not created until one of the tool types ($TC_DP1) 400-499 has been programmed for one of the cutting edges of the tool.

### Deleting data

When data is deleted the memory area is deleted with it and automatically released again.

A tool can only be deleted if it is not active (offset-determining) and is not in a magazine, i.e. it must have been removed or unloaded.

**Note**

If tool management is active you must ensure that the tool being deleted is not assigned to a magazine location ($TC_MPP6). This assignment must be removed before the tool is deleted.

The grinding-specific tool data ($TC_TG1...) is created as soon as one of the tool types ($TC_DP1) 400-499 has been programmed for any of the cutting edges of the tool.

If the tool type is set from the current value taken from the range 400-499 to a value outside this range, the grinding data memory is enabled again, i.e. the grinding-specific data is lost.

| Action | Program command | Description |
|---|---|---|
| Create a tool | Without tool management:<br>$TC_DPx[y,z] = value; | Create tool T if T does not yet exist!<br>y = T number<br>z = D number |
| | With active tool management:<br>T_NO = NEWT("tool identifier", duplo number)<br>or<br>$TC_TP1[y] = duplo number;<br>$TC_TP2[y] = "tool identifier"; | <br><br><br><br>y = T number |
| Create a cutting edge | $TC_DPx[y,z] = value | Create cutting edge D = z if D = z does not yet exist!<br>y = T number<br>z = D number |
| Set tool data | With active tool management:<br>$TC_TPx[y] = value;<br>or<br>$TC_TPx,[GETT("DRILL",DUPLO NO)] = value<br>or<br>$TC_TPCx[y] = value;<br>$TC_TGx[y] = value; | <br>y = T number<br><br>Write tool-related user data<br><br><br>Write tool-related grinding data |
| Set data of a cutting edge | $TC_DPx[y,z] = value<br>$TC_DPCx[y,z] = value<br>$TC_MOPx[y,z] = value<br>$TC_MOPCx[y,z] = value | Write offset data<br>Write cutting edge-related user data<br>Write cutting edge-related monitoring data<br>Write CC (OEM) cutting edge monitoring data<br>y = T number<br>z = D number |
| Delete cutting edge data | Without tool management:<br>$TC_DP1[0,0] = 0; | All tools of the channel are deleted, the memory is released. |
| | With tool management:<br>$TC_TP1[0,0]; | When deleting tools, the entries for the location data must also be corrected. |
| Delete tool data | Without tool management:<br>$TC_DP1[y,0] = 0; | <br>y = T is deleted, memory is released. |
| | With tool management:<br>$TC_TP1[y] = 0;<br>or<br>$TC_TP1[GETT("tool identifier", duplo number)] = 0;<br>or<br>DELT["tool identifier", duplo number] | <br>All tool-related data is set to "0" (user data, hierarchy data, ...). When deleting a tool, the entries for the location data must also be corrected. |

| Action | Program command | Description |
|---|---|---|
| Delete data for all tools | Without tool management:<br>$TC_DP1[0,0] = 0; | All tools of the channel are deleted and the memory is released. |
| | With tool management:<br>$TC_TP1[0,0] = 0; | When deleting tools, the entries for the location data must also be corrected. |

## 5.9.2 Magazine data

### Sequence for defining data

The "Assign tool to a magazine location" sequence creates an interdependency between the tool data and the magazine/magazine location data.

### Example:

The tool contains the magazine location type for which it is intended. The magazine type contains its own magazine location type. If the tool is assigned to the magazine location, as a rule the location type cannot be changed again as this can cause inconsistencies.

The resulting requirement is for tools and magazines to be loaded by a special routine into the PLC and that the structure-determining definitions may no longer be changed during the preparation (these are e.g. magazine dimension, magazine location type, duplo no., tool name, ...). They do not include: Cutting edge data, magazine location status, tool status, ...

### Loading data

Because tools are linked to magazines via magazine location parameter $TC_MPP6, the following rules for correct definition of tools and magazines must be adhered to:

1. Load tool data
2. Load magazine data
3. Load $TC_MPP6 parameters (=> place tool in magazine location)

The same sequence is used for data backup.

The grinding data of a tool cannot be written until tool type = "grinding tool" has been defined for at least one cutting edge.

The distance parameter ($TC_MDPx) and the buffer assignment parameter ($TC_MLSR) cannot be written until the magazines and their locations have been defined.

## Delete data

A tool cannot be deleted while it is still contained in a magazine. The following sequence of operations must be followed when deleting:

1. Delete the magazine data (this removes tools from the magazine); or remove the tool explicitly from the magazine.
2. Delete tool data

In addition, a magazine cannot be deleted if it has status $TC_MAP3[i]= 8 (motion is active). The delete command is rejected for all magazines even if only **one** magazine is preventing the command from being executed.

**Note**

If a single tool is to be deleted it must first be removed from the magazine location with an unload operation and then it can be deleted.

Tools that are currently selected cannot be deleted! You can ensure that no tool is selected beyond a part program by programming T0 before the end of a part program independently of the settings in the machine data (see MD for selecting tools beyond the end of a program).

| Action | Program command | Description |
|---|---|---|
| Creating a new magazine | $TC_MAPx[y]= value; | Value <>0, y = magazine No. of a magazine not yet set up |
| Delete a magazine | $TC_MAP1[y] = 0; | The data of the magazine and its magazine locations as well as any defined distances to change positions are deleted. The associated memory is released. |
| Delete a magazines and the tools contained in it | $TC_MAP6[y] = 0; | The data of the magazine and its magazine locations as well as any defined distances to change positions are deleted. Any tools contained in the magazine are also deleted.<br>The associated memory is released. |
| Delete all magazines | $TC_MAP1[0] = 0; | All data of all magazines of the selected TO area unit is deleted and the associated memory is released again. The magazine data block is then empty. |
| Create new magazine location | $TC_MPPx[y,z]=value; | Value <>0, y = location number not yet available.<br>Before the data of the first location can be created, the associated magazine must be defined.<br>When the first parameter of the first magazine location to be set up is written, then all magazine locations belonging to the magazine are set up using their default values in accordance with the requirements for number of lines and columns for the magazine. |

| Action | Program command | Description |
|---|---|---|
| Set magazine location type hierarchy | $TC_MPTHx[y]=value; | |
| Set magazine distances (distance to change position) | $TC_MPTHx[y]=value; | |
| Delete magazine distances (distance to change position) | $TC_MDPx[y,0]=0 | Delete all defined distances of the magazine with the number "y", i.e. the magazine is no longer "seen" during a tool search and an empty location search. |
| | $TC_MDPx[0,0]= 0; | Delete all defined distances of all magazines of the TO unit. |
| Delete the assignments of the buffer to the spindles | $TC_MLSR[x,0]= 0; | Delete all defined assignments of a buffer location with the number "x", i.e. the magazine is no longer "seen" during the tool search. |
| | $TC_MLSR[0,0]= 0; | Delete all defined assignments of buffer locations of the TO unit to spindles |
| Set magazine block data | $TC_MAMPx = value; | |

## 5.9.3 Tool change

### Programming the tool selection

Tool selection can be divided into two different steps:

1. Tool change preparation
2. Tool change execution

Steps 1-2 can be programmed separately or together in the NC program (see MD22550 TOOL_CHANGE_MODE).

Examples

Tool change in one step: (turret)

Tx; Make new tool x available and execute tool change

Tool change in two steps:

1. Tx; Prepare tool change (select the tool)
2. M06; Execute tool change

**Note**

If tool management is active, a tool can only be selected with the tool identifier (name). If a T number is now programmed, then the number is used as the identifier (name). The tool must then receive a T number as name during loading.

Tool change with identifier:

T="DRILL"; A search is performed for tool with identifier "DRILL".

Tool change with number as identifier:

T="123"; A search is performed for tool with identifier "123". Alternatively, T123 can also be programmed.

## 5.9.4 Cutting edge selection

### Cutting edge selection after tool change

When a tool change has been completed, the tool cutting edge can be selected in one of the following ways:

1. The offset number D is programmed.
2. The offset number D is not programmed and is preset by MD20270 CUTTING_EDGE_DEFAULT.

   = 0: No automatic cutting edge selection after M06.

   > 0: Number of the cutting edge, which is selected after M06.

   = -1 The cutting edge no. of the old tool remains valid and also selected for the new tool after M06.

   = -2 The offset of the old tool remains valid and also selected for the new tool after M06.

### Examples:

Tool selection with the following cutting edge selection

Cutting edge selection always refers to the tool that is changed with command M06.

| | |
|---|---|
| T1 M06 | Tool change - no D programmed; therefore offset selection according to MD 20270 |
| T5 | Tool preselection |
| X .. Y.. Z... | Working with T1 and the offset from MD 20270 |
| D2 | Offset D2 from T1 !!! |
| M06 | Tool change; T5 is loaded at change - offset selection according to MD 20270 |
| T1 | Tool preselection |
| X.., Y... | Working with T5 and the offset from MD 20270 |

When programming tool commands, main spindles and secondary spindles are programmed differently. Only tool offset values of the main spindle tool are taken into account by the geometry because only one active offset can be processed per channel. Processing of tool commands for a secondary spindle is only relevant for signal output to the PLC and the function GETSELT(...).

Spindle No. 2 = main spindle:

| | |
|---|---|
| T2 = "DRILL" | |
| M2 = 06 | |
| T1 = "MILLER" | Select tool for secondary spindle |
| M1 = 06 | Tool change: load tool in the secondary spindle |
| D1 | Select cutting edge of "DRILL" (main spindle) |

Spindle No. 2 = main spindle:

| | |
|---|---|
| T2 = "DRILL" | Select a tool for the main spindle.<br>As an alternative, T= "DRILL" could also be specified. |
| T1 = x; | Select a tool for a secondary spindle |
| M2 = 06 | Tool change<br>As an alternative, M06 could also be specified. |
| D1 | Select cutting edge of a tool with identifier "DRILL" |

## 5.9.5 Tool transfer from program test

With MD20110 RESET_MODE_MASK, **bit 3** you can set whether the active tool and tool offset are to be taken

- (= 1) from the test program which was last terminated in test mode

  or

- (= 0) from the program which was last terminated before the test program was activated

Precondition: Bits 0 and 6 must be set in MD 20110.

**$P_ISTEST**

The system variable $P_ISTEST is for checking from the part program whether a program test is active. The system variable returns the value TRUE when program testing is active.

## 5.10 Programming T=location number

This function is only available when tool management is active. This type of programming is not only suitable for turrets, but for all other types of magazine.

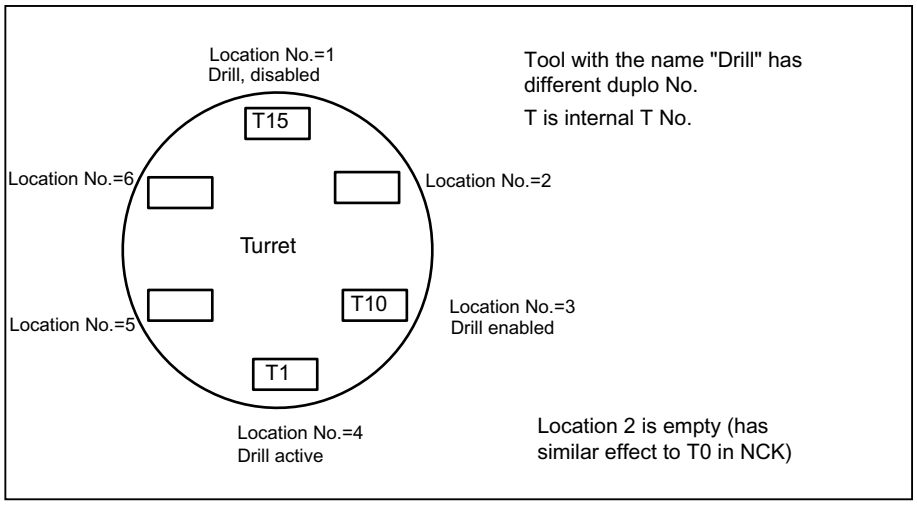



Figure 5-11 Programming of T=location number

The programming type is set using machine data MD20310 TOOL_MANAGEMENT_MASK, bit 16=1:

- T = "**x**" with **x** as tool **identifier**
- Tx, with x as location number of the magazine containing the tool used for machining

When the function is active, **T1** selects the tool in location number 1 instead of the tool with identifier "1". The first magazine linked with the toolholder is accessed here. The identifier of the tool in this location is then determined ("Drill").

The subsequent procedure is as if T="Drill" had been programmed. Which of the three tools from the "Drills" group is determined as the first step of the tool change process.

The set tool search strategy is taken into consideration:

- When the strategy "Take the first available tool from the group" is applied, T10 from location 3 is loaded.
- When the strategy "Take the first tool with *active* status from the group" is applied, T1 is "loaded".

T15 at location no. 1 cannot be used, because it is disabled.

No alarm is generated if the programmed location does not contain a tool. The change is output is output as usual, with T No.=0. As a consequence, e.g. the turret is positioned to an empty location.

If more than one magazine is assigned to the toolholder, then the programmed location number refers to the magazine that is the first magazine defined in the distance table.

If the tools of the tool group are located in different magazines of the toolholder, the search procedure is the same as with the standard TOOLMAN system.

**Note**

With the T=location function, alternatively T= "Drill" can also be programmed.

T=1; Tool
T="Drill"; tool with the identifier, drill

# 5.11 Call multiple turrets with "T=location number"

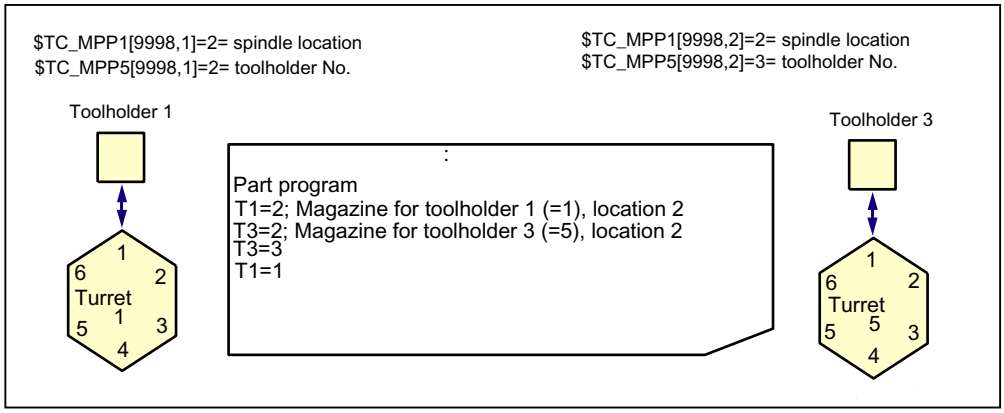



Figure 5-12 T=location number as tool management function on turning machines

The programming option "T = location number" and several magazines can be used to work in one channel or in one TO unit.

- The NC address T can be programmed with an address expansion T1 =...
- Tool management then interprets this as the spindle number or as the toolholder number.
- T without address extension then refers to the main spindle.

# 5.12 Programming examples

## 5.12.1 Programming examples

| Action | Program command | Description |
|---|---|---|
| Create tool | DEF INT DUPLO_NO<br>DEF INT T_NO<br>DUPLO_NO = 7<br>T_NO=NEWT("DRILL", DUPLO_NO) | Create new tool called Drill with duplo No.= 7. The automatically generated T No. is stored in "T_NO". |
| | T_NO = GETT("DRILL", DUPLO_NO)<br>or<br>$TC_TP2[1] = "DRILL" ;<br>$TC_TP1[1] = DUPLO_NO | Determine the T number of tool "DRILL" with duplo No. 7 that has already been created.<br>The T No is however also assigned here by the programming. |
| Tool data<br>read / write | $TC_DP1[GETT("DRILL",<br>DUPLO_NO), 2] = 210 | Write tool type for the 2nd cutting edge of tool "Drill"/DUPLO_NO |
| | $TC_DP1[T_NR, 2] = 210 | Write tool type for the 2nd cutting edge of the tool "T - number" |
| Tool<br>Selecting | T="DRILL"<br>or:<br>T=GETT("DRILL", DUPLO_NO)<br>or<br>Tx | If there are several tools with this identifier, then the T No. is returned for the first tool possible.<br>Determines T number for "DRILL" with duplo = DUPLO_NO and selects it.<br>Call with T No. e.g. T1,T2,T3,.... |
| Delete tool | $TC_TP1[T_NR,0]=0<br>or<br>DELT ( "DRILL", DUPLO_NO)<br>$TC_TP1[GETT("DRILL"),0]=0<br>or alternatively:<br>DELT("DRILL") | Tool with T_NO is deleted,<br>Tool "DRILL",<br>DUPLO_NO is deleted |

# 5.13 Overview of the remaining OPI blocks of tool management

## 5.13.1 Magazine data, directory

### OPI block TMV

Calculation of line: Magazine number, if a field[ ] is present

Calculation of column: n.a.

| NCK identifier | Designation | OPI variables | Type |
|---|---|---|---|
| None | Number of magazines | numActMags | WORD |
| | Number of the magazine | magVNo[ ] | WORD |
| | Identifier of the magazine | magVIdent[ ] | String |

## 5.13.2 Tool data, directory

### OPI block TV

Calculation of line: Sequential No. of the tools, if [ ] present

Calculation of column: n.a.

| NCK identifier | Designation | OPI variables | Type |
|---|---|---|---|
| None | Duplo number | nrDuplo[ ] | WORD |
| | Number of cutting edges | numCuttEdges[ ] | WORD |
| | Number of tools in TO area | numTools | WORD |
| | Last T number assigned for tool management | TnumWZV | WORD |
| | Tool identifier | toolIdent[ ] | String |
| | Current magazine | toolInMag[ ] | WORD |
| | Actual location | toolInPlace[ ] | WORD |
| | T number | toolNo[ ] | WORD |
| | Number of tool groups | numToolsGroups | WORD |

## 5.13.3 Parameterization, return parameters _N_TMGETT, _N_TSEARC

### OPI block TF

Calculation of line: Refer to table

Calculation of column: n.a.

| Designation | OPI variables | Calculation of line | Type |
|---|---|---|---|
| Comparison value for PI TSEARCH of variables of the OPI block TD | parDataTD | Parameter index of block TD | WORD |
| Comparison value for PI TSEARCH of variables of the OPI block TO | parDataTO | Parameter index of block TO | DOUBLE |
| Comparison value for PI TSEARCH of variables of the OPI block TD | parDataToolIdentTD | Parameter index of block TD | String |
| Comparison value for PI TSEARCH of variables of the OPI block TS | parDataTS | Parameter index of block TS | DOUBLE |
| Comparison value for PI TSEARCH of variables of the OPI block TU | parDataTU | Parameter index of block TU | DOUBLE |
| Comparison value for PI TSEARCH of variables of the OPI block TUE | parDataTUE | Parameter index of block TUE | DOUBLE |
| Comparison value for PI TSEARCH of variables of the OPI block TUS | parDataTUS | Parameter index of block TUS | DOUBLE |
| Mask for search criterion of PI TSEARCH (OPI block TD) | parMasksTD | Parameter index of block TD | WORD |
| Comparison value for PI TSEARCH of variables of the OPI block TO | parMasksTO | Parameter index of block TO | WORD |
| Comparison value for PI TSEARCH of variables of the OPI block TS | parMasksTS | Parameter index of block TS | WORD |
| Comparison value for PI TSEARCH of variables of the OPI block TU | parMasksTU | Parameter index of block TU | WORD |
| Comparison value for PI TSEARCH of variables of the OPI block TUE | parMasksTUE | Parameter index of block TUE | WORD |
| Comparison value for PI TSEARCH of variables of the OPI block TUS | parMasksTUS | Parameter index of block TUS | WORD |
| D number of cutting edge used | resultCuttingEdgeNrUsed | Number of cutting edges of tool | WORD |
| Number of cutting edges used | resultNrOfCutEdgesUsed | 1 | WORD |
| Return: found tools | resultNrOfTools | 1 | WORD |
| Return: T numbers of found tools | resultToolNr[ ] | 1... resultNrOfTools | WORD |
| T number of cutting edge used | resultToolNrUsed | Number of cutting edges of tool | WORD |

## 5.13.4 Working offsets

### OPI block AEV

Calculation of line: Cutting edge number if [ ] available

Calculation of column: n.a.

| NCK identifier | Designation | OPI VAR | Type |
|---|---|---|---|
| None | Number of D numbers in block | numActDEdges | WORD |
| | D numbers | Dno[...] | WORD |
| | Internal T number | toolNo[...] | WORD |
| | Cutting edge number | cuttEdgeNo[...] | WORD |
| | Tool identifier | toolIdent[...] | STRING |
| | Duplo number | duploNo[...] | WORD |
| | Magazine | toolInMag[...] | WORD |
| | Location | toolInPlace[...] | WORD |

## 5.13.5 PI services and language commands for tool management

### Overview

FB 4 (PI_SERV) or FB 7 can be used to start program instance services (PI services) in the NCK area. A program section which carries out a particular function (e.g., with tool management, search for empty location in a magazine), is executed in the NCK by making a request via the PI service.

| PI service | Functions | NC language command |
|---|---|---|
| MMCSEM | Semaphores for various PI services | |
| DELETO | Delete tool | DELT("TL", Duplo) |
| DELECE | Delete a cutting edge | $TC_DP1[t,d]=0 |
| CREATO | Generate tool | NEWT("TL", Duplo) |
| CRTOCE | Create tool specifying cutting edge No. | $TC_DPx[t,D]<br>$TC_DPCx[t,D]<br>$TC_DPCSx[t,D]<br>$TC_MOPx[t,D]<br>$TC_MOPCx[t,D] |
| TMCRTO | Create tool | $TC_TPx[t] |
| TMCRTC (not available in PLC) | Create tool by specifying cutting edge No. | $TC_DPx[t,d] |
| CREACE | Create cutting edge | $TC_DP[t,d]=value |
| CRCEDN | Create new cutting edge | $TC_DPx[t,d] |

| PI service | Functions | NC language command |
|---|---|---|
| TMFDPL | Empty location search for loading | GETFREELOC(magNo, locNo, T-No., refMag, refLoc, withReserv) |
| TMMVTL | Prepare magazine location for loading, unload tool | |
| TMPCIT | Set incremental value for workpiece counter, decrement count by y | SETPIECE(SpinNo,y) |
| TMPOSM | Position magazine location or tool | POSM(p,m,ip,im) |
| TMFPBP | Empty location search acc. to properties | |
| TSEARC | Complex search using search screen forms | User cycle program |
| TMRASS | Reset active status | |
| TMGETT | Confirm T number for specified tool identifier with duplo number | GETT("TL", Duplo) |
| | Read the preset T number | GETSELT(SpinNo) |
| CHKDNO (not available in PLC)<br>TMCHKD (not available in PLC) | Check the uniqueness of D numbers of the tool data of the TO unit assigned to the executing channel. Parameters t1, t2,d are optional. | Status=CHKDNO (t1,t2,d) |
| DZERO (not available in PLC) | Set D numbers for all tools of the TO unit assigned to the channel to "invalid". On the OPI, such D numbers are displayed with the value 0. The invalid D number is generated NCK-internally by assigning the value "old D number" + 32000 to the D number. | DZERO |
| | For the offset number D=d, specify the associated internal T No. = t of the tool. The tool that has the status "active" and "was in use" is taken from the tool group. | Status=GETACTTD (t,d) |
| | Specify the D No. for tool t and its cutting edge ce | d=GETDNO(t,ce) |
| | Set the D no. of TL t and its cutting edge ce to value d | Status=SETDNO (t,ce,d) |
| | Read the active T No. and status | Status=GETACTT (Tno,"TL") |
| | Delete command for all location-dependent/setup offsets of a cutting edge or tool if d is not specified | Status = DELDL( t, d ) |
| SETTST (not available in PLC) | Set tool status to "active" | SETTA(Stat,m,vnr) |
| SETTST (not available in PLC) | Set tool status to "not active" | SETTIA(Stat,m,vnr) |
| CHKDM (not available in PLC) | Check uniqueness of D nos. in magazine; m=Magazine | Status=CHKDM(m) |
| | Set toolholder No. (h=holder No.) | SETMTH(h) |
| | Set master spindle (s=spindle No.) | SETMS(s) |
| TRESMO | Activate setpoint for tool life/workpiece count/wear | RESETMON |
| TMAWCO (not available in PLC) | Set a wear group to active | $TC_MAP9 |
| | Location-dependent offsets, coarse | $TC_EPx[t,d] |

| PI service | Functions | NC language command |
|---|---|---|
| | Technological grinding data | $TC_TPGx[t] |
| | Read the loaded T number | GETEXET |
| | Language command to move tool | MVTOOL |
| | Delete toolholder block | DELTC |
| | Tool deselection/tool change irrespective of tool status | TCA |
| | Delete the location status "reserved for tool in the buffer" | DELMLRES |
| | Delete owner magazine location of the tool | DELMLOWNER |

## NC language commands

NCK states are read with the following language commands.

| Functions | NC language command |
|---|---|
| Active TL No. T | $P_TOOLNO |
| Last programmed TL no. (without magazine management) | $P_TOOLP |
| Active tool cutting edge | $P_TOOL |
| Active total tool length; n=1-3 | $P_TOOLL[n] |
| Active toolholder | $P_TC |
| Active angle of a toolholder axis; n=1-2 | $P_TCANG[n] |
| Difference between calculated and used angle of a toolholder axis for Hirth gearing of the angle | $P_TCDIFF[n] |
| Active tool radius; n=1-2 | $P_TOOLR |
| Number of cutting edges for tool t; t=T number 1 32000 | $P_TOOLND[t] |
| Tool with T number t exists | $P_TOOLEXIST[t] |
| Active tool offsets D, n=1...31 | $P_AD[n] |
| Active tool offsets; transformed; n=1-31 | $P_ADT[n] |
| Active additive offset number | $P_DLNO |
| T number of the tool (numerical) | $C_T |
| Tool identifier (string) | $C_TS |
| Bool variable that shows whether a T word is available in $C_T | $C_T_PROG |
| Parameter for tool name as string | $C_TS_PROG |
| Address extension of the T word | $C_TE |
| Programmed D No. | $C_D |
| Bool variable that shows whether an offset number is available in $C_D | $C_D_PROG |
| Programmed additive/setup offset | $C_DL |
| Bool variable that shows whether an offset number is available in $C_DL | $C_DL_PROG |

| Functions | NC language command |
|---|---|
| Command number, specifies the required operation:<br>1: Move (load/unload, relocate..; 2: Prepare change; 3: Change on;<br>4: Change on (turret, without M06); 5: Prepare change and change on (with M06); -1 At the read instant, no tool management command is active | $AC_TC_FCT |
| Acknowledgment status of PLC FC 8/ FC 6 | $AC_TC_STATUS |
| Toolholder or spindle number onto which the new tool should be loaded | $AC_TC_THNO |
| Source magazine number of the new tool | $AC_TC_MFN |
| Source location number of the new tool | $AC_TC_LFN |
| Target magazine number of new tool | $AC_TC_MTN |
| Target location number of the new tool | $AC_TC_LTN |
| Source magazine number of the old tool (to be removed) | $AC_TC_MFO |
| Source location number of the old tool (to be removed) | $AC_TC_LFO |
| Source magazine number of the old tool (to be removed) | $AC_TC_MTO |
| Target location number of the old tool (to be removed) | $AC_TC_LTO |
| Returns the number of the actual master spindle | $AC_MSNUM |
| Returns the number of the master spindle | $P_MSNUM |
| Returns the number of the master toolholder | $AC_MTHNUM |
| Trigger variable to output command of the NCK (is set for one IPO) | $AC_TC_CMDT |
| Trigger variable for acknowledgement of the PLC (is set for one IPO) | $AC_TC_ACKT |
| Counter for the command output | $AC_TC_CMDC |
| Counter for the acknowledgements | $AC_TC_ACKC |
| Owner magazine of the new tool | $AC_TC_MMYN |
| Owner location of the new tool | $AC_TC_LMYN |
| Returns the number of the master toolholder | $P_MTHNUM |
| Magazine number of tool t | $A_TOOLMN[t] |
| Magazine location of tool t | $A_TOOLMLN[t] |
| Number of the owner magazine | $A_MYMN |
| Number of the owner magazine | $A_MYMLN |
| Number of defined magazines that are assigned to the channel | $P_MAGN |
| Number of defined magazines, i-th magazine number | $P_MAG[i] |
| Number of defined adapters that are assigned to the channel | $P_MAGNA |
| Number of defined adapters, i-th adapter number | $P_MAGA[i] |
| Number of magazines n that are linked to location n | $P_MAGNDIS[m,n] |
| Number of the i-th magazine that is linked with location l of the buffer magazine | $P_MAGNDISS[l,i] |
| Number of the i-th magazine that is linked with location l of the loading magazine | $P_MAGDISL[l,i] |
| Number of defined magazine location type hierarchies | $P_MAGNH |
| Number of the defined location types in the n-the defined hierarchy | $P_MAGNHLT[n] |

| Functions | NC language command |
|---|---|
| m-th location type of hierarchy n | $P_MAGHLT[n,m] |
| Number of buffers assigned to the spindle numbers, toolholder numbers n | $P_MAGNREL[n] |
| m-th buffer number of the n-th spindle No., toolholder No. | $P_MAGREL[n,m] |
| Number of spindle locations/toolholder locations in the buffer magazine that are assigned to the channel | $P_MAGNS |
| n-th number of the spindle/toolholder in the buffer | $P_MAGS[n] |
| Determine the defined D numbers of a tool | $P_TOOLD |
| Determine existence of a tool | $P_TOOLEXIST |
| Number of DL offsets of the D offset given by T number T and D number D | $P_TOOLNDL[t,d] |
| Number of defined tool groups that are assigned to the channel | $P_TOOLNG |
| Number of defined tools that are assigned to the channel | $P_TOOLNT |
| i-th tool number T | $P_TOOLT[i] |
| The following tool changes are available for all tools, whose parameter $TC_TP11 have set one of the bits of $P_USEKT. The value zero has the same contents as "all bits are set" | $P_USEKT, $TC_TP11 |
| Factor for tool search | $AC_MONMIN |
| Workpiece count | $A_USEDND |
| Workpiece count | $A_USEDT |
| Workpiece count | $A_USEDD |
| Read factor for tool life monitoring | $A_MONIFACT |

# Machine data

# 6

## 6.1 NC-specific machine data

| 15710 | TCA_CYCLE_NAME | | |
|---|---|---|---|
| MD number | Name of subroutine for TCA replacement | | |
| Default setting: - | Min. input limit: - | Max. input limit: - | |
| Change becomes effective after: POWER ON | Protection level: 7/2 | Unit: - | |
| Data type: STRING | | | |
| Meaning: | Program name for the replacement program when calling the TCA command. If the TCA command is programmed in a part program block, then at the end of the block, the subprogram defined in $MN_TCA_CYCLE_NAME is called. The programmed tool can be queried in the replacement program using the system variables $C_TS_PROG / $C_TS, the Duplo number using $C_DUPLO_PROG / $C_DUPLO and the toolholder/spindle number using $C_THNO_PROG / $C_THNO. In the replacement program, the system variable $C_TCA supplies the value TRUE.<br>If $MN_TCA_CYCLE_NAME contains an empty string, then replacement is deactivated (default setting). | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 17500 | MAXNUM_REPLACEMENT_TOOLS | |
|---|---|---|
| MD number | Maximum number of replacement tools | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 32 |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - |
| Data type: DWORD | | |
| Meaning: | Only meaningful if tool management function or tool monitoring function are active<br>0: The number of replacement tools is not monitored.<br>1: There can be exactly one replacement tool for each identifier.<br>This data does not affect memory requirements, but merely has a monitoring function. | |
| Corresponding to... | MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD20310 TOOL_MANAGEMENT_MASK | |
| Additional references: | Description of functions: Memory configuration (S7) | |

| 17504 | MAX_TOOLS_PER_MULTITOOL | | |
|---|---|---|---|
| MD number | Multitool function. Number of tool locations per multitool | | |
| Default setting: 6 | Min. input limit: 2 | Max. input limit: 32 | |
| Change becomes effective after: POWER ON | Protection level: 1/1 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | "Several tools at a magazine location" function (multitool). Maximum number of locations or tools per multitool. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 17510 | $MN_TOOL_UNLOAD_MASK | | |
|---|---|---|---|
| MD number | Behavior of tool data at unloading | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 0xF | |
| Changes effective after Power On | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | When the tool is unloaded, some tool data can be assigned fixed values:<br>Bit 0 = 0: Tool status "active" remains unchanged<br>Bit 0 = 1: Tool status "active" is deleted ($TC_TP8, bit 0)<br><br>Bit 1 = 0: Tool status "was in use" remains unchanged<br>Bit 1 = 1: Tool status "was in use" is deleted ($TC_TP8, bit 7)<br><br>Bit 2 = 0: Tool parameter $TC_TP10 remains unchanged<br>Bit 2 = 1: Tool parameter $TC_TP10 is set to the value 0. This means that the tool replacement change strategy is reset.<br><br>Bit 3 = 0: Tool parameter $TC_TP11 remains unchanged<br>Bit 3 = 1: Tool parameter $TC_TP11 is set to the value 0. This means that the assignment to the tool subgroup is dissolved (no longer exists).<br>If a multitool is unloaded, then also the tools contained in it corresponding to MD $MN_TOOL_UNLOAD_MASK are unloaded from the magazine location and therefore the tools states are also changed according to the specifications of the MD. When unloading the MT, the tools remain in the MT.<br>Data defined in the MD, which are also defined for the MT - that is previously the MT state $TC_MTP8, bit 7 "was in use" - are also changed for the unloaded MT. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 17515 | $MN_TOOL_RESETMON_MASK | | |
|---|---|---|---|
| MD number | Behavior of tool data at RESETMON | | |
| Default setting: 0x14 | Min. input limit: 0 | Max. input limit: 0x69F | |
| Changes effective after Power On | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | The RESETMON command specifies in the 5th parameter which tool status is to be reset. If the 5th parameter is omitted, it is replaced with the value from this MD. This value is always used with PI service "_N_TRESMON".<br>The bits are assigned like the bits in tool status $TC_TP8[x].<br>Bit 0 = 0: Tool status "active" remains unchanged<br>Bit 0 = 1: Tool status "active" is deleted<br><br>Bit 1 = 0: Tool status "enabled" remains unchanged<br>Bit 1 = 1: Tool status "enabled" is set<br><br>Bit 2 = 0: Tool status "disabled" remains unchanged<br>Bit 2 = 1: Tool status "disabled" is deleted if permitted by the monitoring data and the 4th parameter is set accordingly.<br><br>Bit 3 = 0: Tool status "measured" remains unchanged.<br>Bit 3 = 1: Tool status "measured" is set.<br><br>Bit 4 = 0: Tool status "prewarning limit" remains unchanged<br>Bit 4 = 1: Tool status "prewarning limit" is deleted if permitted by the monitoring data and the 4th parameter is set.<br><br>Bit 5: Not permitted (tool status "tool being changed")<br>Bit 6: Not permitted (tool status "tool is fixed-location-coded")<br><br>Bit 7 = 0: Tool status "was in use" remains unchanged<br>Bit 7 = 1: Tool status "was in use" is deleted<br><br>Bit 8 = 0 not permitted (tool status "being transported back")<br><br>Bit 9: Not permitted<br><br>Bit 10 = 0: Tool status "to unload" remains unchanged<br>Bit 10 = 1: Tool status "to unload" is deleted<br><br>Bit 11: Not permitted (tool status "to load")<br>Bit 12 = 0: Not permitted (tool status "master tool")<br>Bit 13: Not permitted<br>Bit 14: 1:1 exchange (not permitted)<br>The default setting corresponds to behavior up to now.<br>The bits that are not permitted as filtered and hidden by the limit screen. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 17520 | $MN_TOOL_DEFAULT_DATA_MASK | | |
|---|---|---|---|
| MD number | Create new tool: Data default setting | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 0x1F | |
| Changes effective after Power On | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | When a tool is redefined, some tool data can be assigned fixed default values. This way, simple applications do not need to process data which does not necessarily need to be assigned individual values.<br>Bit 0 = 0: Default value of tool status ($TC_TP8), Bit1=0="not enabled"<br>Bit 0 = 1: Default value of tool status ($TC_TP8), Bit1=1="enabled"<br><br>Bit 1 = 0: Default value of tool status ($TC_TP8), Bit6=0="not fixed-location-coded"<br>Bit 1 = 1: Default value of tool status ($TC_TP8), Bit6=1="fixed-location-coded"<br><br>Bit 2 = 0: The tool is only included in the tool group with the explicit write command for the tool name. Only then can it be loaded at change using the appropriate programming.<br>Bit 2 = 1 The tool is automatically included in the tool group when redefined. (Now tool change can be performed with the default name ("t"=t-No.).<br>The "tool name" ($TC_TP2) can be hidden to the user. (This only makes sense if replacement tools are not being used for machining or if the tool name is not explicitly written. Then, data in inconsistency problems could occur.)<br><br>Bit 3 = 0: only with TMMG: Default value of location type ($TC_TP7)=9999=not defined<br>Bit 3 = 1: Significance, only with TMMG: Default value of location type ($TC_TP7)=1 and associated default values of magazine location type (TC_MPP2)=1. All magazine locations can now accept all tools.<br><br>Bit 4 = 0: Only significant with TMMG + active adjacent location consideration: When setting/resetting the magazine location status "disabled", the magazine location status "overlapping permitted" remains unchanged.<br>Bit 4 = 1: Only significant with TMMG + active adjacent location consideration: When setting/resetting the magazine location status "disabled", the magazine location status "overlapping permitted" is also automatically set/reset.<br>If a multitool is generated, then the data defined by MD $MN_TOOL_DEFAULT_DATA_MASK and for the MT are set to the required values. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 17530 | $MN_TOOL_DATA_CHANGE_COUNTER | | |
|---|---|---|---|
| MD number | Identifying tool data change for HMI | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 0xF | |
| Changes effective after Power On | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | HMI display support. This data allows explicit inclusion/exclusion of individual data in the OPI variables (block C/S) toolCounter, toolCounterC, toolCounterM to be taken into account.<br>Bit 0 = 0: Value changes to tool status ($TC_TP8) are not taken into account in toolCounterC<br>Bit 0 = 1: Value changes to the tool status ($TC_TP8) are taken into account in toolCounterC<br><br>Bit 1 = 0: Value changes to remaining tool count ($TC_MOP4) are not taken into account in toolCounterC<br>Bit 1 = 1: Value changes to the remaining tool count ($TC_MOP4) are taken into account in toolCounterC.<br><br>Bit 2 = 0: Value changes to the tool data are not taken into account in the tool data update service<br>Bit 2 = 1: Value changes to the tool data are taken into account in the tool data update service<br><br>Bit 3 = 0: Value changes to the magazine data are not taken into account in the tool data update service<br>Bit 3 = 1: Value changes to the magazine data are taken into account in the tool data update service<br>"Value changes to tool status" and "Value changes to remaining tool count" are relative to the value changes which are caused by internal processes in the NC, as well as to value changes caused by writing the respective system variables. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 17540 | TOOLTYPES_ALLOWED | | |
|---|---|---|---|
| MD number | Permitted tool types | | |
| Default setting: 0x3FF | Min. input limit: 0 | Max. input limit: 0x3FF | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Defines the tool types permitted in the NCK (see $TC_DP1) for the tool offset selection. This means that although tools of any tool types can be loaded to the NCK; however, only the tool types defined here may be defined in the tool which determines the offset. A bit value = 1 means that the specified tool type range is permitted for the offset selection. A bit value = 0 means that the specified tool type range is not permitted for the offset selection. When an attempt is made to select an offset for a cutting edge of this type, the selection is rejected and an offset-capable alarm is issued. Value = 0, 9999 for the tool type means "not defined". In general, it is not possible to select tool offsets with this value for the tool type.<br>Bit 0 = 0x1: Tool types 1 to 99 permitted<br>Bit 1 = 0x2: Tool types 100 to 199 permitted (milling tools)<br>Bit 2 = 0x4: Tool types 200 to 299 permitted (drilling tools)<br>Bit 3 = 0x8: Tool types 300 to 399 permitted<br>Bit 4 = 0x10: Tool types 400 to 499 permitted (grinding tools)<br>Bit 5 = 0x20: Tool types 500 to 599 permitted (turning tools)<br>Bit 6 = 0x40: Tool types 600 to 699 permitted<br>Bit 7 = 0x80: Tool types 700 to 799 permitted<br>Bit 8 = 0x100: Tool types 800 to 899 permitted<br>Bit 9 = 0x200: Tool types 900 to 999 permitted | | |
| Corresponding to... | MD18100 $MN_NUM_CUTTING_EDGES_IN_TOA | | |
| Additional references: | | | |

| 18074 | MM_TOOL_MANAGEMENT_TRACE_SZ | | |
|---|---|---|---|
| MD number | Maximum size of the tool management diagnostics ring buffer | | |
| Default setting: 25, 25 | Min. input limit: 4 | Max. input limit: 500 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Number of entries in the diagnostics ring buffer of the tool management.<br>Index 0 = buffer size of the IPO trace.<br>Index 1 = buffer size of the prep trace<br>There is a dedicated IPO trace buffer in each channel, and there is only a prep trace buffer in channel 1.<br>The memories are only allocated if bit 0 (0x0001) for a warm restart is at ON - and more precisely in both MD18080: MM_TOOL_MANAGEMENT_MASK and MD20310: TOOL_MANAGEMENT_MASK for each channel.<br>Trace data are written to the buffer if bit 13 (0x2000) is at ON in MD20310: TOOL_MANAGEMENT_MASK for each channel. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 18075 | MM_NUM_TOOLHOLDERS | | |
|---|---|---|---|
| MD number | Max. number of toolholders per TOA | | |
| Default setting: 16 | Min. input limit: 1 | Max. input limit: | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Maximum number of definable toolholders per TO area.<br>The maximum value is 20. The number 20 is derived from the maximum number of axes per channel in the 840D sl.<br>The address extension e of the commands Te=T, Me=6 (*) is the number of the toolholder.<br>t=T number / tool name - depending on the function, which is activated in the NCK.<br>(*) if the following applies: $MC_TOOL_CHANGE_MODE=1 and $MC_TOOL_CHANGE_M_CODE=6<br>For milling machines, generally, the toolholder is not a spindle.<br>See also $MC_SPIND_DEF_MASTER_SPIND.<br>For lathes, generally, the toolholder is not a spindle axis.<br>See also $MC_TOOL_MANAGEMENT_TOOLHOLDER.<br>Then the following should apply $MN_MM_NUM_TOOLHOLDERS greater or equal to $MC_SPIND_DEF_MASTER_SPIND/$MC_TOOL_MANAGEMENT_TOOLHOLDER.<br>If Bit0 = 1 in $MN_MM_TOOL_MANAGEMENT_MASK and $MC_TOOL_MANAGEMENT_MASK is set (= magazine management (TMMG)) is only applicable for sensible values $MN_MM_NUM_TOOLHOLDERS less than or equal to $MN_MM_NUM_LOCS_WITH_DISTANCE. Then, a maximum of $MN_MM_NUM_TOOLHOLDERS buffer locations, type spindle ($TC_MPP1[9998,x]=2) can be defined.<br>Example: TMMG not active<br>Assuming $MC_SPIND_DEF_MASTER_SPIND=3, $MN_MM_NUM_TOOLHOLDERS = 3.<br>Then T1=t, T2=t, T3=t, T=t can be programmed.<br>Example: TMMG active, milling machine with Me=6 as tool change command<br>$MN_MM_NUM_TOOLHOLDERS=14, $MN_MM_NUM_LOCS_WITH_DISTANCE=20, assuming 10 channels are active, all channels have TMMG active and have the same tool and machine data (=one TO area for all channels).<br>$MC_SPIND_DEF_MASTER_SPIND=1,....10 for the channels. Then, in the magazine buffer, up to 14 locations, type "toolholder"/"spindle" can be defined.<br>In addition, 6 other grippers or similar can be defined.<br>These locations (a maximum of 20) can be linked with magazines.<br>T1=t,....T14=t and Tt or M1=6,....M14=6 and M06 can be programmed in the channels<br>The PLC version used can limit the maximum number of toolholders. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 18076 | MM_NUM_LOCS_WITH_DISTANCE | | |
|---|---|---|---|
| MD number | Max. number of magazine locations per TOA with distance connection | | |
| Default setting: 32 | Min. input limit: 1 | Max. input limit: | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | The machine data makes sense if the magazine management function TMMG is active.<br>- see $MN_MM_TOOL_MANAGEMENT_MASK, $MC_TOOL_MANAGEMENT_MASK; in each case bit0 = 1.<br>Maximum number of magazine locations (spindles, loading locations,..) per TOA, that can have a distance connection to a magazine defined using $TC_MDPx[n,m].<br>Example: Assuming TMMG is active: $MN_MM_NUM_LOCS_WITH_DISTANCE = 5 and $MN_MM_NUM_DIST_REL_PER_MAGLOC = 2.<br>Two TOA units are defined each with three toolholders/spindles, two loading points.<br>Further, there are two grippers defined in each TO unit.<br>This means that in total there are 14 locations defined in the buffer magazine/loading magazine for which distances and assignments should be defined. 4 magazines are defined for TO unit 1, 6 magazines are defined for TO unit 2.<br>With the set value of $MN_MM_NUM_LOCS_WITH_DISTANCE = 5, every toolholder and every loading location can be connected; (see $TC_MDP1 and $TC_MDP2) and up to two grippers can be additionally allocated to each toolholder ($MN_MM_NUM_DIST_REL_PER_MAGLOC = 2); (see $TC_MLSR).<br>As a consequence, a toolholder/spindle location can have two tables - a distance table to the magazines and an allocation table to grippers and similar locations. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 18077 | MM_NUM_DIST_REL_PER_MAGLOC | | |
|---|---|---|---|
| MD number | Max. number of magazines in the distance table of a magazine location | | |
| Default setting: | Min. input limit: 0 | Max. input limit: | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | The machine data is only effective if the magazine management function, TMMG is active.<br>- see $MN_MM_TOOL_MANAGEMENT_MASK, $MC_TOOL_MANAGEMENT_MASK.<br>Two quantities are defined with the data:<br>1.) Max. number of magazines in the distance table of a magazine location (spindle, loading location,...)<br>2.) Maximum number of locations (gripper, ...) in the connection table of a spindle/toolholder.<br>Example: $MN_MM_NUM_DIST_REL_PER_MAGLOC = 3.<br>Assuming two TOA units are defined each with two toolholders/spindles and one loading point each.<br>Further, four grippers are defined in each TO unit.<br>TO unit 1 has 4 magazines defined, TO unit 2 has 6 magazines defined.<br>Then, each toolholder can define up to three distances to the magazines (see $TC_MDP2) and in addition, can define up to three relationships to grippers ($TC_MLSR). | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 18078 | MM_MAX_NUM_OF_HIERARCHIES | | |
|---|---|---|---|
| MD number | Maximum number of definable hierarchies for magazine location types | | |
| Default setting: 8 | Min. input limit: 0 | Max. input limit: | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | The machine data is only effective if the magazine management function,TMMG, is active - see $MN_MM_TOOL_MANAGEMENT_MASK, $MC_TOOL_MANAGEMENT_MASK.<br>Maximum number of definable hierarchies for magazine location types<br>The permissible value of index n of system parameter $TC_MPTH[n,m] is from 0 to "$MN_MM_MAX_NUM_OF_HIERARCHIES - 1".<br>(the maximum value for index m can be specified using machine data $MN_MM_MAX_HIERARCHY_ENTRIES)<br>Value= 0 means that the "magazine location type hierarchy" function is not available. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 18079 | MM_MAX_HIERARCHY_ENTRIES | | |
|---|---|---|---|
| MD number | Maximum permissible number of entries in a magazine-location-type hierarchy | | |
| Default setting: 8 | Min. input limit: 1 | Max. input limit: | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | The machine data is only effective if the magazine management function, TMMG, is active - see $MN_MM_TOOL_MANAGEMENT_MASK, $MC_TOOL_MANAGEMENT_MASK - and if $MN_MM_MAX_NUM_OF_HIERARCHIES is greater than zero.<br>Maximum number of entries in a magazine location type hierarchy.<br>The permissible value for index m of system parameter $TC_MPTH[n,m] is from 0 to "$MN_MM_MAX_NUM_OF_HIERARCHIES - 1".<br>(The maximum value for index n can be specified using machine data $MN_MM_MAX_NUM_OF_HIERARCHIES.)<br>Value= 0 means that the "magazine location type hierarchy" function is not available. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 18080 | MM_TOOL_MANAGEMENT_MASK | | |
|---|---|---|---|
| MD number | Memory for the tool management is reserved step-by-step | | |
| Default setting: 0x0 | Min. input limit: 0 | Max. input limit: 0xFFFF | |
| Change becomes effective after: POWER ON | Protection level: 1/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Activation of the tool management memory with "0" means:<br>The set tool management data do not occupy any memory, tool management is not available.<br>Bit 0=1: Memory for tool-management-specific data will be made available, the memory-reserving machine data must however be accordingly set (MM_NUM_MAGAZINE_LOCATION, MM_NUM_MAGAZINE)<br>Bit 1=1: Memory is available for monitoring data (TMMO)<br>Bit 2=1: Memory is available for user data (CC data)<br>Bit 3=1: Memory is available for considering the adjacent location<br>Bit 4=1: Memory and function release for PI service _N_TSEARC = "Complex search for tools in magazine" is available.<br>Bit 5=1: Wear monitoring active<br>Bit 6=1: Wear group available<br>Bit 7=1: Reserve memory for adapter of magazine locations<br>Bit 8=1: Memory for machining and/or setting up offsets<br>Bit 9=1: Tools of a turret are handled in OPI variable blocks so that they are not "shown" at toolholder locations, but always at a turret location. This means that especially tools of a turret no longer leave their turret location at tool change (as far as the display is concerned). SINUMERIK Operate does not require this setting.<br>Bit 9=0: Default behavior; tools of a turret are "shown" in OPI corresponding to their actual physical location (as far as the data is concerned).<br>Bit 10 = 1:Multitool function<br>The coded type of memory reservation enables economic use of memory management for the functionality provided.<br>Example:<br>Standard memory reservation for tool management:<br>MM_TOOL_MANAGEMENT_MASK = 3 (Bit 0 + 1=1) means tool management and tool monitoring data are made available<br>MM_TOOL_MANAGEMENT_MASK = 1 means tool management without tool monitoring function data<br>MM_TOOL_MANAGEMENT_MASK = 2 means tool management without tool monitoring function data | | |
| Special cases, errors,... | | | |

| 18082 | MM_NUM_TOOL | | |
|---|---|---|---|
| MD number | Number of tools the NCK can manage | | |
| Default setting: 30 | Min. input limit: 0 | Max. input limit: 1500 | |
| Changes effective after POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | The NC can manage as a maximum the number of tools entered in the MD. A tool has at least one cutting edge.<br>A buffered (backed-up) user memory is used.<br>The maximum number of tools possible correspond to the number of cutting edges. The MD should also be set even if no tool management is being used.<br>If this machine data is altered the buffered data is lost.<br>A maximum of 1500 tools are possible in the NCK, however, only a maximum of 600 per TO unit. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | MD18100 MM_NUM_CUTTING_EDGES_IN_TOA | | |
| Additional references: | Description of functions: Memory Configuration (S7), Tool Offset (W1) | | |

| 18083 | MM_NUM_MULTITOOL | | |
|---|---|---|---|
| MD number | Multitool function. Number of multitools that the NCK can manage | | |
| Default setting: 15 | Min. input limit: 0 | Max. input limit: 1500 | |
| Changes effective after POWER ON | Protection level: 1/1 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | "Several tools at a magazine location" function (multitool). Number of multitools (multiple tools) that the NCK can manage. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 18084 | MM_NUM_MAGAZINE | | |
|---|---|---|---|
| MD number | Number of magazines the NCK can manage | | |
| Default setting: 3 | Min. input limit: 0 | Max. input limit: 32 | |
| Changes effective after POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Tool management (TMG or TMMG) only if MD tool management and option tool management are set:<br>Number of magazines that the NCK can manage (active and background magazines).<br>The buffered memory for the magazines is reserved with this machine data.<br>Important: One load magazine and one buffer magazine are set up in the tool management for each TOA unit. These magazines must be taken into account.<br>Value = 0: Tool management cannot be activated because no data can be created. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD20310 TOOL_MANAGEMENT_MASK | | |
| Additional references: | Description of functions: Memory configuration (S7) | | |

| 18085 | MM_NUM_MULTITOOL_LOCATIONS | | |
|---|---|---|---|
| MD number | Multitool function. Number of multitool locations that the NCK can manage | | |
| Default setting: 30 | Min. input limit: 0 | Max. input limit: 1500 | |
| Changes effective after POWER ON | Protection level: 1/1 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | "Several tools at a magazine location" function (multitool). Number of multitool locations that the NCK can manage. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 18086 | MM_NUM_MAGAZINE_LOCATION | | |
|---|---|---|---|
| MD number | Number of magazine locations the NCK can manage | | |
| Default setting: 30 | Min. input limit: 0 | Max. input limit: 600 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | TMMG - only if MD for tool management and tool management option are set:<br>Number of magazine locations that the NCK can manage.<br>The buffered memory for the magazine locations is reserved with this MD.<br>Important: The number of all buffer locations and loading points must be taken into account here.<br>Value = 0: Tool management cannot be activated because no data can be created. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD20310 TOOL_MANAGEMENT_MASK | | |
| Additional references: | Description of functions: Memory configuration (S7) | | |

| 18088 | MM_NUM_TOOL_CARRIER | | |
|---|---|---|---|
| MD number | Maximum number of defined toolholders | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 99999999 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Maximum number of definable toolholders for tools that can be oriented in the TO area. The value is divided by the number of active TO units. The integer result indicates how many toolholders can be defined per TO unit.<br>The data to define a toolholder are set using the system variables $TC_CARR1, ...$TC_CARR14. The data are located in the buffered memory.<br>Example:<br>2 channels are active, with one channel per TO unit (=default).<br>3 holders must be defined in channel 1 and one holder in channel 2. The value to be set is 6 because 6/2 = 3. This means a max. of 3 holder definitions in each TO unit. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | | | |
| Additional references: | Description of functions: Tool Offsets (S7) | | |

| 18090 | MM_NUM_CC_MAGAZINE_PARAM | | |
|---|---|---|---|
| MD number | Number of OEM magazine data | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 10 | |
| Changes effective after POWER ON | Protection level: 2/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Number of magazine parameters (of the integer type) that are made available to the user or the Compile Cycle.<br>With this machine data, the amount of buffered memory required is increased by sizeof(int)* max. number of magazines. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD18084 MM_NUM_MAGAZINE | | |
| Additional references: | | | |

| 18091 | MM_TYPE_CC_MAGAZINE_PARAM[n] | | |
|---|---|---|---|
| MD number | OEM magazine data type | | |
| Default setting: 3 | Min. input limit: 1 | Max. input limit: 6 | |
| Change becomes effective after: POWER ON | Protection level: 2/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Only the standard default values may be applied.<br>Used to assign individual types to the parameters. The array index n can assume values between 0 and the setting in machine data MD18090: MM_NUM_CC_MAGAZINE_PARAM.<br>The possible values of the MD = 1, 2, 3, 4, 5 and 6 denote the NC command types BOOL, CHAR, INT, REAL, STRING and AXIS. The type FRAME cannot be defined here. Type STRING must not be longer than 31 characters. Example:<br>MD18090: MM_NUM_CC_MAGAZINE_PARAM=1<br>MD18091: MM_TYPE_CC_MAGAZINE_PARAM=5<br>= "UserMagazine" can be programmed for parameter $TC_MAPC1.<br>The buffered work memory is used. Changing the value can, but does not necessarily, result in reconfiguration of the buffered memory. | | |
| Corresponding to... | MD18090 MM_NUM_CC_MAGAZINE_PARAM<br>MD18084 MM_NUM_MAGAZINE | | |
| Additional references: | | | |

| 18092 | MM_NUM_CC_MAGLOC_PARAM | | |
|---|---|---|---|
| MD number | Number of OEM magazine location data | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 10 | |
| Changes effective after POWER ON | Protection level: 2/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Number of magazine-location data parameters (of the integer type) that are made available to the user or the Compile Cycle.<br>If this machine data is set, the amount of buffered memory required increases by sizeof(int) * max. number of magazine locations. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD18086 MM_NUM_MAGAZINE_LOCATION | | |
| Additional references: | | | |

| 18093 | MM_TYPE_CC_MAGLOG_PARAM[n] | | |
|---|---|---|---|
| MD number | OEM magazine location data type | | |
| Default setting: 3 | Min. input limit: 1 | Max. input limit: 6 | |
| Change becomes effective after: POWER ON | Protection level: 2/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Only the standard default values may be applied.<br>Used to assign individual types to the parameters. The array index n can assume values between 0 and the setting in machine data MD18090: MM_NUM_CC_MAGAZINE_PARAM.<br>The possible values of the MD = 1, 2, 3, 4 and 6 denote the NC command types<br>1 BOOL<br>2 CHAR<br>3 INT<br>4 REAL and<br>6 AXIS<br>Here, the STRING type is not explicitly possible. The value 5 is treated just like 2. The type FRAME cannot be defined here.<br>Example:<br>MD18090: MM_NUM_CC_MAGAZINE_PARAM=1<br>MD18091: MM_TYPE_CC_MAGAZINE_PARAM=2<br>= "UserMagazineLocation" can be programmed for parameter $TC_MPPC1.<br>The buffered work memory is used. Changing the value can, but does not necessarily, result in reconfiguration of the buffered memory. | | |
| Corresponding to... | MD18092 MM_NUM_CC_MAGLOG_PARAM | | |
| Additional references: | | | |

| 18094 | MM_NUM_CC_TDA_PARAM | | |
|---|---|---|---|
| MD number | Number of OEM tool data | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 10 | |
| Changes effective after POWER ON | Protection level: 2/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Number of tool-specific data that can be created for each tool (of type integer) and are available to the user or compile cycle.<br>If this machine data is set, the amount of buffered memory required increases by sizeof(double) * max. number of tools. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD18082 MM_NUM_TOOL | | |
| Additional references: | | | |

| 18095 | MM_TYPE_CC_TDA_PARAM[n] | | |
|---|---|---|---|
| MD number | OEM tool data type | | |
| Default setting: 4 | Min. input limit: 1 | Max. input limit: 6 | |
| Change becomes effective after: POWER ON | Protection level: 2/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Only the standard default values may be applied.<br>Used to assign individual types to the parameters. The array index n can assume values between 0 and the setting in machine data MD18094: MM_NUM_CC_TDA_PARAM.<br>The possible values of the MD = 1, 2, 3, 4, 5 and 6 denote the NC command types.<br>1 BOOL<br>2 CHAR<br>3 INT<br>4 REAL<br>5 STRING and<br>6 AXIS<br>The type FRAME cannot be defined here. Type STRING must not be longer than 31 characters.<br>Example:<br>MD18094: MM_NUM_CC_TDA_PARAM=1<br>MD18095: MM_TYPE_CC_TDA_PARAM=5<br>= "UserCuttingEdge" can be programmed for parameter $TC_TPC1.<br>The buffered work memory is used. Changing the value can, but does not necessarily, result in reconfiguration of the buffered memory. | | |
| Corresponding to... | MD18094 MM_NUM_CC_TDA_PARAM<br>MD18082 MM_NUM_TOOL | | |
| Additional references: | | | |

| 18096 | MM_NUM_CC_TOA_PARAM | | |
|---|---|---|---|
| MD number | Number of data per tool cutting edge for compile cycles | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 10 | |
| Change becomes effective after: POWER ON | Protection level: 2/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Number of TOA data that can be created for each tool (of type Double) and are available to the user or compile cycle.<br>If this machine data is set, the amount of buffered memory required increases by sizeof(double) * max. number of cutting edges. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD18100 MM_NUM_CUTTING_EDGES_IN_TOA | | |
| Additional references: | | | |

| 18097 | MM_TYPE_CC_TOA_PARAM[n] | | |
|---|---|---|---|
| MD number | OEM data type per cutting edge | | |
| Default setting: 4 | Min. input limit: 1 | Max. input limit: 6 | |
| Change becomes effective after: POWER ON | Protection level: 2/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Only the standard default values may be applied.<br>Used to assign individual types to the parameters. The array index n can assume values between 0 and the setting in machine data MD18096: MM_NUM_CC_TOA_PARAM.<br>The possible values of the MD = 1, 2, 3, 4 and 6 denote the NC command types<br>1 BOOL<br>2 CHAR<br>3 INT<br>4 REAL<br>6 AXIS<br>The type STRING cannot be used explicitly here, value 5 is treated like value 2.<br>The type FRAME cannot be defined here. Example:<br>MD18096: MM_NUM_CC_TOA_PARAM=1<br>MD18097: MM_TYPE_CC_TOA_PARAM=5<br>= "UserCuttingEdge" can be programmed for parameter $TC_DPC1.<br>The buffered work memory is used. Changing the value can, but does not necessarily, result in reconfiguration of the buffered memory. | | |
| Corresponding to... | MD18096 MM_NUM_CC_TOA_PARAM<br>MD18100 MM_NUM_CUTTING_EDGES_IN_TOA | | |
| Additional references: | | | |

| 18098 | MM_NUM_CC_MON_PARAM | | |
|---|---|---|---|
| MD number | Number of monitoring data per tool for compile cycles | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 10 | |
| Change becomes effective after: POWER ON | Protection level: 2/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Number of monitoring data that are created for each tool (of type integer) and are available to the user or compile cycle.<br>If this machine data is set, the amount of buffered memory required increases by sizeof(int) * max. number of cutting edges. | | |
| Special cases, errors,...: | | | |
| Corresponding to... | MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD18100 MM_NUM_CUTTING_EDGES_IN_TOA | | |
| Additional references: | | | |

| 18099 | MM_TYPE_CC_MON_PARAM[n] | | |
|---|---|---|---|
| MD number | OEM monitor data type | | |
| Default setting: 3 | Min. input limit: 1 | Max. input limit: 6 | |
| Change becomes effective after: POWER ON | Protection level: 2/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Only the standard default values may be applied.<br>Used to assign individual types to the parameters. The array index n can assume values between 0 and the setting in machine data MD18098: MM_NUM_CC_MON_PARAM.<br>The possible values of the MD = 1, 2, 3, 4 and 6 denote the NC command types<br>1 BOOL<br>2 CHAR<br>3 INT<br>4 REAL and<br>6 AXIS.<br>The type FRAME cannot be defined here.<br>(Type STRING is not explicitly possible here; the value 5 is treated just like 2).<br>Example:<br>MD18098: MM_NUM_CC_MON_PARAM=1<br>MD18099: MM_TYPE_CC_MON_PARAM=2<br>= "UserCuttingEdge" can be programmed for parameter $TC_MOPC1.<br>The buffered work memory is used. Changing the value can, but does not necessarily, result in reconfiguration of the buffered memory. | | |
| Corresponding to... | MD18100 MM_NUM_CUTTING_EDGES_IN_TOA<br>MD18098 MM_NUM_CC_MON_PARAM | | |
| Additional references: | | | |

| 18100 | MM_NUM_CUTTING_EDGES_IN_TOA | | |
|---|---|---|---|
| MD number | Tool cutting edges per TO area | | |
| Default setting: 30 | Min. input limit: 0 | Max. input limit: 1500 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Defines the number of tool cutting edges in a TO area.<br>For each tool edge approx. 250 bytes per TOA block of the battery-backed memory are reserved with this machine data irrespective of the tool type.<br>Tools with type 400-499 cutting edges (=grinding tools) also occupy the location of a cutting edge.<br>Example:<br>Define 10 grinding tools with one cutting edge each.<br>Then, as a minimum, the following must apply:<br>MM_NUM_TOOL = 10<br>MM_NUM_CUTTING_EDGES_IN_TOA = 20<br>See also MM_NUM_TOOL<br>A buffered (backed-up) user memory is used. | | |
| Special cases, errors,...: | If this machine data is altered the buffered data is lost! | | |
| Corresponding to... | | | |
| Additional references: | Description of functions: Memory configuration (S7) | | |

| 18102 | MM_TYPE_OF_CUTTING_EDGE | | |
|---|---|---|---|
| MD number | Type of D number programming | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 1 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | The "flat D number management" is activated with the MD.<br>The individual values can determine the type of D programming<br>- direct or<br>- indirect programming.<br>The default value is 0. This setting means that the NCK manages the T and D numbers.<br>A value > 0 is only accepted by the NCK if bit 0 is not set in MD $MN_MM_TOOL_MANAGEMENT_MASK, i.e. the tool management function must not simultaneously active.<br>0: No "flat D number management" active<br>1: D numbers are directly and absolutely programmed<br>Notice: SINUMERIK Operate does not support the function "Flat D numbers". | | |
| Special cases, errors,...: | | | |
| Corresponding to... | | | |
| Additional references: | Description of functions: Tool Offset (W1) | | |

| 18104 | MM_NUM_TOOL_ADAPTER | | |
|---|---|---|---|
| MD number | Tool adapter in TO area | | |
| Default setting: -1 | Min. input limit: -1 | Max. input limit: 600 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Number of tool adapters in the TO area.<br>This function can only be used if magazine locations are available in the NCK. The tool management function must be active. In order to activate the setting, bit 7 (=0x80) must be set in MD $MN_MM_TOOL_MANAGEMENT _MASK.<br>Adapter data records and the cutting-edge-specific basis / adapter data records mutually exclude one another, i.e. when adapter data are defined, then parameters $TC_DP21, $TC_DP22, $TC_DP23 or their values in NCK are available.<br>-1:<br>Every magazine location is automatically assigned an adapter,<br>i.e. internally there are just as many adapters foreseen as are foreseen by the magazine locations set in machine data $MN_MM_NUM_MAGAZINE_LOCATION.<br>-2<br>Every magazine location and every multitool location is automatically allocated an adapter. This means that internally just as many adapters are available as magazine locations specified using machine data $MN_MM_NUM_MAGAZINE_LOCATION and multitool locations specified using $MN_MM_NUM_MULTITOOL_LOCATIONS.<br>0:<br>No adapter-data definition possible. Cutting-edge-specific parameters $TC_DP21, $TC_DP22 and $TC_DP23 are available in cases where adapters are utilized outside the active TM.<br>> 0:<br>Number of adapter data records. By this, adapters can be defined independently of magazine locations. An additional step following definition of the data assigns the adapters to magazine locations. | | |
| Corresponding to... | MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD20310 TOOL_MANAGEMENT_MASK<br>MD18084 MM_NUM_MAGAZINE<br>MD18086 MM_NUM_MAGAZINE_LOCATION | | |
| Additional references: | | | |

| 18105 | MM_MAX_CUTTING_EDGE_NO | | |
|---|---|---|---|
| MD number | Maximum value of D number | | |
| Default setting: 9 | Min. input limit: 1 | Max. input limit: 32000 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |

| 18105 | MM_MAX_CUTTING_EDGE_NO |
|---|---|
| Meaning: | Maximum value of D number.<br>The maximum number of D numbers per cutting edge is not affected by this.<br>The monitoring of the D number assignment associated with this value is only effective for new definitions of D numbers. This means the existing data records are not checked later - if the MD is changed.<br>Advisable setting:<br>$MN_MM_MAX_CUTTING_EDGE_NO equal to $MN_MM_MAX_CUTTING_EDGE_PER_TOOL. If $MN_MM_MAX_CUTTING_EDGE_NO > $MN_MM_MAX_CUTTING_EDGE_PER_TOOL is set, you should familiarize yourself with the difference between offset number D and the tool edge number CE.<br>See also language commands CHKDNO, CHKDM, GETDNO, SETDNO, DZERO.<br>The MD is not evaluated with the function "flat D number" and accordingly is not meaningful there.<br>The MD can change the memory requirements:<br>A change from "less than equal to" to "greater than" - or vice versa - in the values of both the above mentioned MDs can influence the demand for non-buffered memory. |
| Corresponding to... | MD18106 MM_MAX_CUTTING_EDGE_PER_TOOL |
| Additional references: | Description of functions: Tool Offset (W1) |

| 18106 | MM_MAX_CUTTING_EDGE_PER_TOOL | | |
|---|---|---|---|
| MD number | Maximum number of D numbers per tool | | |
| Default setting: 9 | Min. input limit: 1 | Max. input limit: 12 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Maximum number of cutting edges (D offset) per tool (per T number)<br>This allows greater security with the data definition. A value of 1 can be set if only tools with one cutting edge are to be used. This will avoid the problem of assigning more than one cutting edge to the tool when data is defined.<br>Logically the same value is set for MM_MAX_CUTTING_EDGE_NO as for MM_MAX_CUTTING_EDGE_PER_TOOL. If MM_MAX_CUTTING_EDGE_NO is set greater than MM_MAX_CUTTING_EDGE_PER_TOOL, you should familiarize yourself with the difference between offset number D and the tool edge number CE.<br>See also language commands CHKDNO, CHKDM, GETDNO, SETDNO, DZERO.<br>The MD is not evaluated with the function "flat D number" and accordingly is not meaningful there.<br>The MD can change the memory requirements:<br>A change from "less than equal to" to "greater than" - or vice versa - in the values of both the above mentioned MDs can influence the demand for non-buffered memory. | | |
| Corresponding to... | MD18105 MM_MAX_CUTTING_EDGE_NO | | |
| Additional references: | Description of functions: Tool Offset (W1) | | |

| 18108 | MM_NUM_SUMCORR | | |
|---|---|---|---|
| MD number | Additive offsets in the TO area | | |
| Default setting: -1 | Min. input limit: -1 | Max. input limit: 9000 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Total number of additive offsets in NCK.<br>A value of -1 means that the number of additive offsets equals the number of cutting edges * number of additive offsets per cutting edge.<br>A value > 0 and < "Number of cutting edges * number of additive offsets per cutting edge" means that per cutting edge, a maximum "Number of additive offsets per cutting edge" additive offsets can - but does not need to - be defined, i.e. this provides an option of using the buffered memory sparingly. Only the cutting edges defined for the explicit data have a additive offset data record.<br>Buffered memory is reserved. The memory requirements for additive offset are doubled if "Setup offset" is also configured and active; see MD $MN_MM__KIND_OF_SUMCORR. | | |
| Corresponding to... | MD18100 MM_NUM_CUTTING_EDGE_IN_TOA<br>MD18110 MM_MAX_SUMCORR_PER_CUTTEDGE | | |
| Additional references: | Description of functions: Tool Offset (W1) | | |

| 18110 | MM_MAX_SUMCORR_PER_CUTTEDGE | | |
|---|---|---|---|
| MD number | Maximum number of additive offsets per cutting edge | | |
| Default setting: 1 | Min. input limit: 1 | Max. input limit: 6 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Maximum number of additive offsets per cutting edge<br>The following applies for MM_NUM_SUMCORR > 0:<br>This data does not define the memory, but is used for monitoring purposes only.<br>The following applies to MM_NUM_SUMCORR = -1:<br>This data defines the memory. | | |
| Corresponding to... | MD18100 MM_NUM_CUTTING_EDGES_IN_TOA<br>MD18108 MM_NUM_SUMCORR | | |
| Additional references: | Description of functions: Memory configuration (S7) | | |

| 18112 | MM_KIND_OF_SUMCORR | | |
|---|---|---|---|
| MD number | Properties of additive offsets in the TO area | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 0x1F | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Properties of additive offsets in NCK.<br>Bit 0=0: "Additive offsets fine" are saved when the tool data is backed up.<br>Bit 0=1: "Additive offsets fine" are saved when the tool data is not backed up.<br><br>Bit 1=0: Set-up offsets are saved when the tool data is backed up.<br>Bit 1=1: Set-up offsets are not saved when the tool data is backed up.<br><br>Bit 2=0: If the function tool management (TMMG) or tool monitoring (TMMO) are used, then setting the tool status to "active" has no effect on the "additive offsets fine"/setup offsets already in use.<br>Bit 2=1 When the tool status is set to "active", the existing additive offsets are set to the value 0. This does not influence the setup offsets.<br><br>Bit 3=0: If the functions "TMG" = "Adapter" are in use: "Additive offsets fine"/setup offsets are transformed.<br>Bit 3=1: "Additive offsets fine"/setup offsets are not transformed.<br><br>Bit 4=0: No setting up offset data records.<br>Bit 4=1: Setting up offset data records are additionally created. The additive offset is thus the sum of the setting up offset + additive offset fine.<br><br>Changing the states of bits 0, 1, 2 and 3 does not alter the memory configuration. Changing the status of bit 4 causes the buffered memory to be re-configured with the next Power On. | | |
| Corresponding to... | MD18100 MM_NUM_CUTTING_EDGES_IN_TOA<br>MD18108 MM_NUM_SUMCORR<br>MD18110 MM_MAX_SUMCORR_PER_CUTTEDGE<br>MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD20310 MC_TOOL_MANAGEMENT_MASK<br>MD18086 MM_NUM_MAGAZINE_LOCATION<br>MD18104 MM_NUM_TOOL_ADAPTER | | |
| Additional references: | Description of functions: Tool Offset (W1) | | |

| 18192 | MM_NUM_CC_MULTITOOL_PARAM | | |
|---|---|---|---|
| MD number | Number of multitool-specific parameters $TC_MTPCn per multitool | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 10 | |
| Change becomes effective after: POWER ON | Protection level: 1/1 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Number of multitool-specific parameters $TC_MTPCn, that can be created for each multitool and that are available to users or the compile cycle. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 18193 | MM_TYPE_CC_MULTITOOL_PARAM | | |
|---|---|---|---|
| MD number | OEM multitool data type | | |
| Default setting: 3, 3, 3, 3 | Min. input limit: 1 | Max. input limit: 10 | |
| Change becomes effective after: POWER ON | Protection level: 1/1 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | User or OEM data in the tool management.<br>Type of the multitool-specific Siemens user data $TC_MTPCn configured using MD18192 $MN_MM_NUM_CC_MULTITOOL_PARAM.<br>Every parameter can be allocated its own type. The following types are permissible: Type value of the machine data<br>(see types of the NC language)<br>BOOL 1<br>CHAR 2<br>INT 3<br>REAL 4<br>STRING 5 (identifiers are permitted up to a maximum of 31 characters)<br>AXIS 6<br>FRAME not defined | | |
| Corresponding to... | MD18192, MD18083, MD18085 | | |
| Additional references: | | | |

| 18194 | MM_NUM_CC_MTLOC_PARAM | | |
|---|---|---|---|
| MD number | Number of OEM multitool location data parameters $TC_MTPPCn per multitool location | | |
| Default setting: 3, 3, 3, 3 | Min. input limit: 1 | Max. input limit: 10 | |
| Change becomes effective after: POWER ON | Protection level: 1/1 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Number of multitool location-specific parameters $TC_MTPPCn that can be created for each multitool location and that are available to users or the compile cycle. | | |
| Corresponding to... | | | |
| Additional references: | | | |

| 18195 | MM_NUM_CC_MTLOC_PARAM | | |
|---|---|---|---|
| MD number | OEM multitool location data type | | |
| Default setting: 3, 3, 3, 3 | Min. input limit: 1 | Max. input limit: 10 | |
| Change becomes effective after: POWER ON | Protection level: 1/1 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | User or OEM data in the tool management.<br>Type of the multitool location-specific Siemens user data $TC_MTPPCn configured using MD18194 $MN_MM_NUM_CC_MTLOC_PARAM.<br>Every parameter can be allocated its own type. The following types are permissible: Type value of the machine data<br>(see types of the NC language)<br>BOOL 1<br>CHAR 2<br>INT 3<br>REAL 4<br>STRING 5 (identifiers are permitted up to a maximum of 31 characters)<br>AXIS 6<br>FRAME not defined | | |
| Corresponding to... | MD18192, MD18083, MD18085 | | |
| Additional references: | | | |

# 6.2 Channel-specific machine data

| 20090 | SPIND_DEF_MASTER_SPIND | | |
|---|---|---|---|
| MD number | Initial setting of master spindle in channel | | |
| Default setting: 1, 1, … | Min. input limit: 1 | Max. input limit: 20 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: BYTE | | | |
| Meaning: | Definition of master spindle in channel. The number of the spindle is set.<br>Example:<br>1 corresponds to spindle S1. When S is programmed, the current master spindle is automatically addressed.<br>The SETMS(n) command can be programmed to declare the spindle number as the master spindle. SETMS declares the spindle defined in the MD to be the master spindle again. | | |
| Corresponding to... | | | |
| Additional references: | Description of functions: Spindles (S1) | | |

| 20096 | T_M_ADDRESS_EXT_IS_SPINO | | |
|---|---|---|---|
| MD number | Meaning of the address extension with T, M tool change | | |
| Default setting: FALSE | Min. input limit: - | Max. input limit: - | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: | |
| Data type: Boolean | | | |
| Meaning: | The MD is only of significance when the "Tool management" / "Flat D numbers" are inactive.<br>FALSE<br>The contents of the address extension of the NC addresses T and M "change-command number" are not evaluated by the NCK. The PLC determines the meaning of the programmed extension<br>TRUE<br>The address extension of NC addresses T and M "tool change command number" - tool change command number" = TOOL_CHANGE_M_CODE with 6 as default value - are interpreted as spindle number. NCK handles the extension essentially the same as the active functions "tool management" or "flat D number management".<br>This means that the programmed D number always refers to the T number of programmed main-spindle numbers. | | |
| Corresponding to... | MD20090 SPIND_DEF_MASTER_SPIND<br>MD22550 TOOL_CHANGE_MODE<br>M 22560 TOOL_CHANGE_M_CODE | | |
| Additional references: | | | |

| 20110 | RESET_MODE_MASK | | |
|---|---|---|---|
| MD number | Determination of basic control settings after Reset/TP End | | |
| Default setting: 0x0 | Min. input limit: 0 | Max. input limit: 0x7FFFF | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: HEX | |
| Data type: DWORD | | | |
| Meaning: | Definition of the basic PLC setting after booting and reset/end of part program with respect to the G codes (especially current level and adjustable zero offset), tool-length offset and transformation by setting the following bits.<br>Bit 0: Reset mode<br>Bit 1: Suppress auxiliary function output for tool selection<br>Bit 2: Selection of the reset response after Power On; e.g. of tool offset<br>Bit 3: Only of significance without active tool management: Selection of the reset response at the end of the test mode for active tool offsets. The bit is only significant if bits 0 and 6 are set.<br>It defines to what "actual setting for the active tool length correction" refers;<br>- the program that was active at the end of test operation<br>- the program that was active before switching-on test operation<br>Bit 4: Reserved! Setting is now made via $MC_GCODE_RESET_MODE[.]<br>Bit 5: Reserved! Setting is now made via $MC_GCODE_RESET_MODE[.]<br>Bit 6: Reset behavior, "active tool length compensation"<br>Bit 7: Reset behavior of "active kinematic transformation"<br>Bit 8: Reset behavior, "coupled-motion axes"<br>Bit 9: Reset behavior "tangential tracking"<br>Bit 10: Reset behavior, "synchronous spindle"<br>Bit 11: Reset behavior, "revolutional feed rate"<br>Bit 12: Reset behavior, "geo axis exchange"<br>Bit 13: Reset behavior "master value coupling"<br>Bit 14: Reset behavior, "basic frame"<br>Bits 4 to 11 are evaluated only if bit 0=1.<br>Bit 15: Function for electronic gears, not relevant for tool management.<br>Bit 16=0: After end of program/reset, the number given by the MD SPIND_DEF_MASTER_SPIND is the number of the master spindle<br>Bit 16=1: The programmed value of SETMS is retained after end of program/reset<br>Bit 17=0: After end of program/reset, the toolholder number provided in MD TOOL_MANAGEMENT_TOOLHOLDER is the number of the master toolholder<br>Bit 17=1: The programmed value of SETMTH is retained after end of program/reset<br>Bit 18: Reset behavior "reference axis for G96/G961/G962"<br>The bits 4 to 11, 16 and 17 are only evaluated for bit 0=1. Bit value=0 is set so that the behavior applicable up to now is retained with bit 0=1. (The effect of bit 0=0 was and is that the values programmed for SETMTH/SETMS are retained at end of program.) | | |
| Corresponding to... | MD20120 TOOL_RESET_VALUE<br>MD20130 CUTTING_EDGE_RESET_VALUE<br>MD20150 GCODE_RESET_VALUES<br>MD20152 GCODE_RESET_MODE<br>MD20140 TRAFO_RESET_VALUE<br>MD20112 START_MODE_MASK<br>MD20121 TOOL_PRESEL_RESET_VALUE<br>MD20118 GEOAX_CHANGE_RESET | | |
| Additional references: | Description of functions: Coordinate Systems (K2) | | |

| 20112 | START_MODE_MASK | | |
|---|---|---|---|
| MD number | Definition of the initial state of the control after part program start | | |
| Default setting: 0x400 | Min. input limit: 0 | Max. input limit: 0x7FFFF | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Definition of the initial state of the control for part program start with respect to the G codes (especially current level and adjustable zero offset), tool-length offset, transformation and axis coupling setting the following bits (only the bits in bold are relevant for tool management):<br>Bit 0: not assigned: $MC_START_MODE_MASK is evaluated every time the part program is started<br>Bit 1: Suppress auxiliary function output for tool selection<br>Bit 4: Start response G code "current plane"<br>Bit 5: Start response G code "settable work offset"<br>Bit 6: Starting behavior, "active tool length compensation"<br>Bit 7: Starting behavior, "active kinematic transformation"<br>Bit 8: Starting behavior, "coupled-motion axes"<br>Bit 9: Starting behavior, "tangential tracking"<br>Bit 10: Starting behavior, "synchronous spindle"<br>Bit 11: Reserved<br>Bit 12: Starting behavior, "geo axis exchange"<br>Bit 13: Starting behavior, "master value coupling"<br>Bit 14: Starting behavior, "basic frame"<br>Bit 15: Function for electronic gears, not relevant for tool management.<br>Bit 16=0: The current value SETMS is retained (depends on the settings in RESET_MODE_MASK)<br>Bit 16=1: At program start, the spindle defined in MD: $MC_SPIND_DEF_MASTER_SPIND is the master spindle.<br>Bit 17=0: The current value SETMTH is retained (depends on the settings in RESET_MODE_MASK)<br>Bit 17=1: At program start, the number specified by MD: $MC_Tool_Management_Toolholder is the number of the master toolholder<br>Bit 18=1: Reference axis for G96/G961/G962<br>Bit value=0 is set so that the behavior applicable up to now is retained. | | |
| Corresponding to... | MD20120 TOOL_RESET_VALUE<br>MD20130 CUTTING_EDGE_RESET_VALUE<br>MD20150 GCODE_RESET_VALUES<br>MD20152 GCODE_RESET_MODE<br>MD20140 TRAFO_RESET_VALUE<br>MD20110:RESET_MODE_MASK<br>MD20121 TOOL_PRESEL_RESET_VALUE<br>MD20118 GEOAX_CHANGE_RESET | | |
| Additional references: | Description of functions: Coordinate Systems (K2) | | |

| 20120 | TOOL_RESET_VALUE (only without tool management) | | |
|---|---|---|---|
| MD number | Tool length compensation at power-up (Reset/TP end) | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 32000 | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Definition of the tool where the tool length compensation is selected at power up and for reset or TP end depending on MD20110 RESET_MODE_MASK and for TP depending on MD 20112: START_MODE_MASK. | | |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK | | |
| Additional references: | Description of functions: Coordinate Systems (K2) | | |

| 20121 | TOOL_PRESEL_RESET_VALUE (only without tool management) | | |
|---|---|---|---|
| MD number | Preselect tool on Reset | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 32000 | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Definition of the preselected tool with MD 20310=1. A tool is preselected after power-up and at reset or end of part program depending on MD20110 and on start of part program depending on MD20112.<br>This data is only valid without tool management. | | |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK | | |
| Additional references: | Description of functions: Coordinate Systems (K2) | | |

| 20122 | TOOL_RESET_NAME | | |
|---|---|---|---|
| MD number | Active tool at reset/start with tool management | | |
| Default setting: - | Min. input limit: - | Max. input limit: - | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: - | |
| Data type: STRING | | | |
| Meaning: | This data is valid only if the TM function is active.<br>Definition of the toolholder with which the tool length compensation is selected during power up and for a reset or an end of the part program depending on MD20110 RESET_MODE_MASK and for a part program start depending on MD20112 START_MODE_MASK. | | |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK<br>MD20124 TOOL_MANAGEMENT_TOOLHOLDER<br>M 20130 CUTTING_EDGE_RESET_VALUE | | |
| Additional references: | | | |

| 20123 | USEKT_RESET_VALUE | | |
|---|---|---|---|
| MD number | Preselected value of $P_USEKT at RESET | | |
| Default setting: 0x0,... | Min. input limit: 0 | Max. input limit: 0xF | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: | |
| Data type: DWORD | | | |
| Meaning: | This data is valid only if the TM function is active.<br>The system variable $P_USEKT is preassigned with the value of this MD:<br>- after power up: Depending on $MC_START_MODE_MASK<br>- after reset or part program end: depending on $MC_RESET_MODE_MASK | | |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK | | |
| Additional references: | | | |

| 20124 | TOOL_MANAGEMENT_TOOLHOLDER | | |
|---|---|---|---|
| MD number | Toolholder number | | |
| Default setting: 0,0,0,... | Min. input limit: 0 | Max. input limit: 16 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | This MD is only of significance when tool management is active.<br>Tool management must know on which toolholder the tool is to be loaded. The data is only evaluated if the value is greater than zero.<br>Then, $TC_MPP5 numbers are no longer seen as "spindle numbers", but as toolholder number.<br>The automatic address extension of T and of M06 is then the value for this MD and no longer the value of $MC_SPIND_DEF_MASTER_SPIND. The MD is used to define the master toolholder number to which a tool preparation or a tool change refers.<br>When determining the tool on the toolholder for the setting "keep old offset" of MD $MC_RESET_MODE_MASK, then reference is also made to this value.<br>If a machine has several toolholders, but no specific master spindle, then the MD serves as a default value to determine the toolholder to which the tool should be loaded at a tool change (reset, start, T="identifier", M06). When defining the magazine locations of internal magazines, locations, type "spindle" - $TC_MPP1=2=spindle-location - are assigned a "location type index" ($TC_MPP5). This allocates a specific toolholder to the location.<br>The toolholder with number n can be declared the master toolholder using the language command SETMTH(n). This means that the offsets of a tool, that is loaded to a buffer location, type "SPINDLE" and with the value $TC_MPP5=n correct the tool path.<br>Tool management change to "SPINDLE" locations with $TC_MPP5 not equal to the number of the master toolholder have no effect on the path.<br>The command SETMTH is used to declare the toolholder defined in the MD as the master toolholder again. | | |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK<br>MD20122 TOOL_RESET_NAME<br>MD20130 CUTTING_EDGE_RESET_VALUE | | |
| Additional references: | Description of functions: Coordinate Systems (K2) | | |

| 20126 | TOOL_CARRIER_RESET_VALUE | | |
|---|---|---|---|
| MD number | Operative toolholder on Reset | | |
| Default setting: 0 | Min. input limit: 0.0 | Max. input limit: - | |
| Change becomes effective after: Reset | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Definition of the toolholder with which the tool length compensation is selected during power up and for a reset or an end of the part program as a dependency on the machine data $MC_RESET_MODE_MASK and for a main program start as a dependency on the machine data $MC_START_MODE_MASK.<br>This data is valid without tool management. | | |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK | | |
| Additional references: | Description of functions: Tool Offset (W1) | | |

| 20128 | COLLECT_TOOL_CHANGE | | |
|---|---|---|---|
| MD number | Tool change commands to the PLC after block search | | |
| Default setting: 1 | Min. input limit: - | Max. input limit: - | |
| Change becomes effective after: immediately | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | This MD is only of significance when magazine management is active.<br>($MN_MM_TOOL_MANAGEMENT_MASK, $MC_TOOL_MANAGEMENT_MASK)<br>It determines whether, after a block search with calculation of the tool change command, tool preparation commands (general tool change commands) are output to the PLC or not.<br>1: Tool change commands and tool preparation commands are collected and output to the PLC when the program starts after the search target has been reached<br>0: All tool/magazine-specific commands, which were collected in the block search, are not output to the PLC with the subsequent program start! This means that also programmed POSM, TCI, TCA commands are also not output.<br>Comment 1:<br>Without active magazine management the tool change M code is not collected if it is not assigned to any auxiliary function group. With active magazine management, the machine data value corresponds to =0<br>Comment 2:<br>The value =0 is e.g. practical, if, after reaching the search target, the collected tool change commands are output to the PLC in an ASUB program using the commands GETSELT, GETEXTET. | | |
| Corresponding to... | MD22560 TOOL_CHANGE_M_CODE | | |
| Additional references: | | | |

| 20130 | CUTTING_EDGE_RESET_VALUE | | |
|---|---|---|---|
| MD number | Tool cutting edge length compensation at power-up (Reset/TP end) | | |
| Default setting: 0, 0, 0, ... | Min. input limit: 0 | Max. input limit: 32000 | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Definition of the tool cutting edge with which the tool length compensation is selected during power up and for a reset or an end of the part program depending on MD20110 $MC_RESET_MODE_MASK and for a part program start depending on MD20112 $MC_START_MODE_MASK.<br>When tool management is active and bits 0 and 6 set in $MC_RESET_MODE_MASK, the last offset of the tool which was active on power-off - generally the tool in the spindle - is operative after power up. | | |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK | | |
| Additional references: | Description of functions: Coordinate Systems (K2) | | |

| 20132 | SUMCORR_RESET_VALUE | | |
|---|---|---|---|
| MD number | Additive offset effective at reset | | |
| Default setting: 0, 0, ... | Min. input limit: 0 | Max. input limit: 6 | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Definition of the additive offset with which the additive offset is selected during power up and for a reset or an end of the part program as a dependency on the machine data $MC_RESET_MODE_MASK and for a part program start as a dependency on the machine data $MC_START_MODE_MASK.<br>Machine data 18110 $MN_MAX_SUMCORR_PER_CUTTEDGE determines the maximum meaningful value which can be entered. | | |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK | | |
| Additional references: | | | |

| 20140 | TRAFO_RESET_VALUE | | |
|---|---|---|---|
| MD number | Transformation data record at power up (Reset/TP end) | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 20 | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: - | |
| Data type: BYTE | | | |
| Meaning: | Definition of the transformation data record selected during power up and for a reset or an end of the part program depending on MD20110 $MC_RESET_MODE_MASK and for a part program start depending on MD20112 $MC_START_MODE_MASK. | | |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK | | |
| Additional references: | Description of functions: Axes, coordinate systems,... (K2) | | |

| 20150 | GCODE_RESET_VALUES[n] | | |
|---|---|---|---|
| MD number | Initial setting of G group | | |
| Default setting:{2, 0, 0, 1, 0...} | Min. input limit:- | Max. input limit: - | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: - | |
| Data type: BYTE | | | |

Meaning:

Definition of the G code which is to become effective at power up or reset or end of part program depending on MD20110 $MC_RESET_MODE_MASK and at part program start depending on MD20112 $MC_START_MODE_MASK.

The G code index must be specified in the respective groups as preset value. For a list of the G groups with the G functions contained therein, please refer to References: Programming Manual, Fundamentals

| Name | Group | Default value for 840D sl |
|---|---|---|
| GCODE_RESET_VALUES[0] | 1 | 2 (G01) |
| GCODE_RESET_VALUES[1] | 2 | 0 (inactive) |
| GCODE_RESET_VALUES[2] | 3 | 2 (inactive) |
| GCODE_RESET_VALUES[3] | 4 | 2 (STARTFIFO) |
| GCODE_RESET_VALUES[4] | 5 | 0 (inactive) |
| GCODE_RESET_VALUES[5] | 6 | 1 (G17) |
| GCODE_RESET_VALUES[6] | 7 | 1 (G40) |
| GCODE_RESET_VALUES[7] | 8 | 1 (G500) |
| GCODE_RESET_VALUES[8] | 9 | 0 (inactive) |
| GCODE_RESET_VALUES[9] | 10 | 1 (G60) |
| GCODE_RESET_VALUES[10] | 11 | 0 (inactive) |
| GCODE_RESET_VALUES[11] | 12 | 1 (G601) |
| GCODE_RESET_VALUES[12] | 13 | 2 (G71) |
| GCODE_RESET_VALUES[13] | 14 | 1 (G90) |
| GCODE_RESET_VALUES[14] | 15 | 2 (G94) |
| GCODE_RESET_VALUES[15] | 16 | 1 (CFC) |
| GCODE_RESET_VALUES[16] | 17 | 1 (NORM) |
| GCODE_RESET_VALUES[17] | 18 | 1 (G450) |
| GCODE_RESET_VALUES[18] | 19 | 1 (BNAT) |
| GCODE_RESET_VALUES[19] | 20 | 1 (ENAT) |
| GCODE_RESET_VALUES[20] | 21 | 1 (BRISK) |
| GCODE_RESET_VALUES[21] | 22 | 1 (CUT2D) |
| GCODE_RESET_VALUES[22] | 23 | 1 (CDOF) |
| GCODE_RESET_VALUES[23] | 24 | 1 (FFWOF) |
| GCODE_RESET_VALUES[24] | 25 | 1 (ORIWKS) |
| GCODE_RESET_VALUES[25] | 26 | 2 (RMI) |
| GCODE_RESET_VALUES[26] | 27 | 1 (ORIC) |
| GCODE_RESET_VALUES[27] | 28 | 1 (WALIMON) |
| GCODE_RESET_VALUES[28] | 29 | 1 (DIAMOF) |
| GCODE_RESET_VALUES[29] | 30 | 1 (COMPOF) |
| GCODE_RESET_VALUES[30] | 31 | 1 (inactive) |
| GCODE_RESET_VALUES[31] | 32 | 1 (inactive) |
| GCODE_RESET_VALUES[32] | 33 | 1 (FTCOF) |
| GCODE_RESET_VALUES[33] | 34 | 1 (OSOF) |
| GCODE_RESET_VALUES[34] | 35 | 1 (SPOF) |
| GCODE_RESET_VALUES[35] | 36 | 1 (PDELAYON) |
| GCODE_RESET_VALUES[36] | 37 | 1 (FNORM) |
| GCODE_RESET_VALUES[37] | 38 | 1 (SPIF1) |
| GCODE_RESET_VALUES[38] | 39 | 1 (CCPRECOF) |
| GCODE_RESET_VALUES[39] | 40 | 1 (CUTCONOF) |
| GCODE_RESET_VALUES[40] | 41 | 1 (LFOF) |
| GCODE_RESET_VALUES[41] | 42 | 1 (TCOABS) |
| GCODE_RESET_VALUES[42] | 43 | 1 (G140) |
| GCODE_RESET_VALUES[43] | 44 | 1 (G340) |

| 20150 | GCODE_RESET_VALUES[n] | | |
|---|---|---|---|
| Meaning: | GCODE_RESET_VALUES[44] | 45 | 1 (SPATH) |
| | GCODE_RESET_VALUES[45] | 46 | 1 (LFTXT) |
| | GCODE_RESET_VALUES[46] | 47 | 1 (G290 Sinumerik mode) |
| | GCODE_RESET_VALUES[47] | 48 | 3 (G460) |
| | GCODE_RESET_VALUES[48] | 49 | 1 (CP) |
| | GCODE_RESET_VALUES[49] | 50 | 1 (ORIEULER) |
| | GCODE_RESET_VALUES[50] | 51 | 1 (ORIVECT) |
| | GCODE_RESET_VALUES[51] | 52 | 1 (PAROTOF) |
| | GCODE_RESET_VALUES[52] | 53 | 1 (TOROTOF) |
| | GCODE_RESET_VALUES[53] | 54 | 1 (ORIROTA) |
| | GCODE_RESET_VALUES[54] | 55 | 1 (RTLION) |
| | GCODE_RESET_VALUES[55] | 56 | 1 (TOWSTD) |
| | GCODE_RESET_VALUES[56] | 57 | 1 (FENDNORM) |
| | GCODE_RESET_VALUES[57] | 58 | 1 (RELIEVEON) |
| | GCODE_RESET_VALUES[58] | 59 | 1 (DYNNORM) |
| | GCODE_RESET_VALUES[59] | 60 | 1 (WALCS0) |
| | GCODE_RESET_VALUES[60] | 61 | 1 (ORISOF) |
| | :: | | |
| | GCODE_RESET_VALUES[69] | 70 | 1 (not defined) |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK | | |
| Additional references: | (K1, G2) | | |

| 20152 | GCODE_RESET_MODE[n] | | |
|---|---|---|---|
| MD number | Reset behavior of G groups | | |
| Default setting: 0 | Min. input limit: - | Max. input limit: - | |
| Change becomes effective after: RESET | Protection level: 2/7 | Unit: - | |
| Data type: BYTE | | | |
| Meaning: | This MD is only evaluated if bit 0 is set in $MC_RESET_MODE_MASK.<br>This MD is used to define for each entry in MD $MN_GCODE_RESET_VALUES (i.e. for each G group), whether a setting according to the $MC_GCODE_RESET_VALUES is undertaken again for a reset/part program end (MD=0) or whether the current setting is retained (MD=1).<br>Example:<br>The initial state of the 6th G group (current level) is read from the machine data $MC_GCODE_RESET_VALUES for each reset/part program end here:<br>$MC_GCODE_RESET_VALUES[5]=1; reset value of 6th G group is M17<br>$MC_GCODE_RESET_MODE[5]=0; initial state for the 6th G group after<br>;reset/part program end according to<br>;$MC_GCODE_RESET_VALUES[5]<br>However, if the current setting of the 6th G group (current level) is to be retained beyond reset/part program end, then the following setting is obtained:<br>$MC_GCODE_RESET_VALUES[5]=1; reset value of 6th G group is M17<br>$MC_GCODE_RESET_MODE[5]=1; current setting for the 6th G group<br>; is also kept after reset/part program end | | |
| Corresponding to... | MD20110 RESET_MODE_MASK<br>MD20112 START_MODE_MASK | | |
| Additional references: | Description of functions: Axes, coordinate systems,... (K2) | | |

| 20270 | CUTTING_EDGE_DEFAULT | | |
|---|---|---|---|
| MD number | Initial state of tool cutting edge without programming | | |
| Default setting: 1 | Min. input limit: -2 | Max. input limit: 32000 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Default tool cutting edge after tool change<br>If no cutting edge is programmed after a tool change, then the edge number preset in CUTTING_EDGE_DEFAULT is applied.<br>Value = 0: No cutting edge is initially active after a tool change. Cutting-edge selection only takes at D programming.<br>Value = 1: No. of the cutting edge<br>Value = -1: Cutting edge number of old tool also applies to new tool.<br>Value = -2: Cutting edge (offset) of the old tool remains active until D is programmed.<br>Example:<br>MD: CUTTING_EDGE_DEFAULT = 1;<br>after a tool change, without programming a cutting edge, the first cutting edge is active | | |
| Corresponding to... | | | |
| Additional references: | Description of functions: Tool Offset (W1) | | |

| 20272 | SUMCORR_DEFAULT | | |
|---|---|---|---|
| MD number | Initial state of additive offset without programming | | |
| Default setting: 0 | Min. input limit: -1 | Max. input limit: 6 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | The number of the additive offset for the cutting edge that is active when a new cutting-edge offset is activated without a programmed DL value.<br>The MD18110 $MN_MM_MAX_SUMCORR_PERCUTTEDGE determines the maximum meaningful value which can be entered.<br>Value: Meaning<br>> 0: Number of additive offset<br>= 0: No additive offset active with D programming<br>= -1: The additive offset number for the previously programmed D is used. | | |
| Corresponding to... | MD20270 CUTTING_EDGE_DEFAULT | | |
| Additional references: | Description of functions: Tool Offset (W1) | | |

**Note**

The output of the DL number is controlled by the MD AUXFU_DL_SYNC_TYPE.

| 20310 | TOOL_MANAGEMENT_MASK | | |
|---|---|---|---|
| MD number | Channel-specific activation of tool management functions | | |
| Default setting: 0x0,... | Min. input limit: 0 | Max. input limit: 0xFFFFFF | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: HEX | |
| Data type: DWORD | | | |
| Meaning: | MD = 0: Tool management inactive<br>Bit 0=1: Tool management active<br>The tool management functions are enabled for the current channel.<br>Bit 1=1: TM monitoring function active<br>Functions for monitoring tools (tool life and workpiece count) are enabled.<br>Bit 2=1: OEM functions active<br>The memory can be used for the user data (see also M 18090 to18098)<br>Bit 3=1: Adjacent location consideration active<br>Bit 0 to bit 3 must be set just like MD18080 MM_TOOL_MANAGEMENT_MASK. | | |
| Meaning: | Bit 4=1: The PLC has the option to request another T preparation with modified parameters. Acknowledgement status "2", "7" and "103" is enabled with this bit. This causes the tool selection to be repeated in the NCK | | |
| | Bits 5 to 8<br>Bit 5 and bit 7 refer to the main spindle<br>Bit 6 and bit 8 refer to the secondary spindles<br>Bit 5 = 1: The command output is considered completed if the internal transport acknowledgement + the transport acknowledgement are present, i.e. if the command was received by the basic PLC program.<br>Bit 19=1 additionally allows the block change to be prevented (main run) until the required acknowledgements are received.<br>Bit 7 = 1: The command output is not considered completed until the end acknowledgement from the PLC is received, i.e. the command was acknowledged by the PLC user program with status "1".<br>Bit 19=1 additionally allows the block change to be prevented (main run) until the required acknowledgements are received.<br>Bit 5 and bit 7 (alternatively bit 6 and bit 8) are mutually exclusive!<br>Only the following combinations are permitted:<br>Bit 5: …0…1…0<br>Bit 7: …0…0…1<br>With the default setting, i.e. bit 5 to 8 = 0, synchronization is performed in the block in which a cutting edge was first selected.<br>Setting these bits delays block processing. | | |
| Meaning: | Bit 9: Reserved for test purposes<br>(no command output to the PLC)<br>can also be used by the machine manufacturer in the test phase, as long as the PLC program does not yet change tools | | |
| Meaning: | Bit 10=1: M06 is delayed until the preparation is taken over by the PLC user program.<br>The change command is only output when the preparation acknowledgement is received. This can be, for example status "1" or "105".<br>Bit 10=0: The change command is output without delay, immediately after the preparation command. | | |

| 20310 | TOOL_MANAGEMENT_MASK |
|---|---|
| Meaning: | Bit 11=1: The tool preparation command (PLC command numbers = 2, 4, 5) is carried out even if the same tool preparation command has taken place! (Commands 4, 5 contain the tool preparation)<br>Example: (tool change takes place with M06 (PLC command number=3):<br>T="TL1"; Tool preparation<br>M06; tool change<br>T="TL2"; 1st tool preparation after M6 (for the same toolholder)<br>; is always output to PLC<br>T="TL2"; 2nd tool preparation, is only output as command to PLC if bit 11 = 1<br>; This tool preparation counts as the first one if the status of the tool has changed since the previous tool preparation such that it can no longer be used.<br>A possible reason for this would be e.g. asynchronous unloading of a tool. This tool preparation them attempts to select a replacement tool.<br>Bit 11=0: The preparation command can be output only once for each tool. |
| Meaning: | Bit 12=1: The tool preparation command (PLC command numbers = 2, 4, 5) is carried out even if the tool is already positioned in the spindle/toolholder.<br>T="TL1"; Tool preparation<br>M06; tool change<br>T="TL1"; Tool is already placed on the toolholder<br>; 1. Tool preparation after M06 (for the same toolholder)<br>; is only output to PLC if bit 12 = 1<br>; A tool that cannot be used (e.g. disabled due to tool monitoring) on the toolholder does not count as if placed on the toolholder. This tool preparation them attempts to select a replacement tool.<br>T="TL2"; 2nd tool preparation - the following rules applies for bit 11 for output<br>Bit 12=0: The preparation command is not executed if the tool is already positioned in the spindle. |
| | Bit 13=1: Trace<br>For reset, the command output of the NCK and the acknowledgements of the PLC are saved in a trace file (TCTRAxx.mpf, xx=channel No.).<br>Corresponds with $MN_MM_TOOL_MANAGEMENT_TRACE_SZ.. |
| | Bit 14=1: Reset mode<br>Tool and offset selection according to the settings in MD: $MC_RESET_MODE_MASK and $MC_START_MODE_MASK.<br>Bit 14=0: No reset mode |

| 20310 | TOOL_MANAGEMENT_MASK |
|---|---|
| Meaning: | Bit 15=1: The tool is not returned if several preparation commands have been issued (Tx->Tx).<br>Bit 15=0: Tool is returned from possibly defined buffers.<br>Bit 16=1: T=location number is active<br>Bit 16=0: T="Tool name"<br>Bit 17=1: Tool life monitoring is controlled by the PLC (DB21.DBX1.3).<br>Bit 18=1: Activation of monitoring "last tool of tool group"<br>Bit 18 extends the search for a suitable tool, especially if there are many disabled replacement tools.<br>Bit 18=0: No monitoring for "Last tool in tool group"<br>Bit 19=1: The synchronizations defined by bits 5...8 are relative to the main run block, i.e. there is no block change until the required acknowledgements are received<br>Bit 19 in conjunction with bits 5, 6, 7, 8 set delays the block processing.<br>Bit 19=0: The synchronizations defined by bits 5...8 are relative to the tool management command output, i.e. there is no block change delay |
| Meaning: | Bit 20=0: The commands generated on PLC signal "program testing active" are not output to the PLC. NCK acknowledges the commands itself. Magazine and tool data are not changed.<br>Bit 20=1: The commands generated for PLC signal "program testing active" are output to the PLC. Depending on the type of acknowledgement, tool/magazine data can be changed in the NCK. If the acknowledgement parameters for the "target magazine" are set to the same values as the "source magazine", the tool is not transported and thus no data modified in the NCK. |
| | Bit 21=0: Default setting: Ignore the tool status "W" at tool selection<br>Bit 21=1: Tools in status "W" cannot be selected by another tool change, tool preparation command. |
| | Bit 22=1: "Tool subgroups" function<br>$TC_TP11[x] is the grouping or selection parameter |
| | Bit 23=0: Default setting<br>The tool management optimally and reliably selects the tool in the main run, i.e. the interpreter may have to wait for the end of the tool selection for offset selection.<br>Bit 23=1: For basic applications<br>The interpreter selects the tool itself, i.e. no synchronization is required with the main run for offset selection. (If the tool becomes no longer useable after selection but before loading, an uncorrectable alarm may result.) |
| | Bit 24=0: Default setting<br>If the PLC commands 8 and 9 (asynchronous transfer) want to move a tool to a location that is reserved for another tool, this is rejected and an alarm is issued.<br>Bit 24=1: If the PLC commands 8 and 9 are to move a tool to a location that is reserved for another tool with "Reserved for tool from buffer" (bit values="H4"), this is possible. This location reservation is then removed before the movement is executed ("Reserved for new tool to be loaded" (bit value="H8") remains effective). |
| Corresponding to... | MD18080 MM_TOOL_MANAGEMENT_MASK<br>MD20320 TOOL_TIME_MONITOR_MASK<br>MD20122 MC_TOOL_RESET_NAME<br>MD20110 MC_RESET_MODE_MASK<br>MD20124 MC_TOOL_MANAGEMENT_TOOLHOLDER<br>MD22560 TOOL_CHANGE_M_CODE |
| Additional references: | |

| 20320 | TOOL_TIME_MONITOR_MASK | | |
|---|---|---|---|
| MD number | Time monitoring for tool in the toolholder | | |
| Default setting: 0x0 | Min. input limit: - | Max. input limit: - | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: HEX | |
| Data type: DWORD | | | |
| Meaning: | Activation of tool time monitoring for toolholder or spindle 1....x.<br>As soon as the path axes are moved (not for G00, always for G63), the tool time monitoring data for the tool which is located in the selected toolholder – which is at the same time the master toolholder – are updated.<br>Bit 0...x-1: Monitoring of active tool in spindle 1...x | | |
| Corresponding to... | | | |
| Additional references: | Description of functions: Memory configuration (S7) | | |

| 22550 | TOOL_CHANGE_MODE | | |
|---|---|---|---|
| MD number | New tool offset for M function | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 1 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: BYTE | | | |
| Meaning: | A tool is selected in the program with the T function. The setting in this machine data determines whether the new tool is loaded immediately on execution of the T function:<br>MD: TOOL_CHANGE_MODE = 0<br>The new tool data becomes effective directly when T or D is programmed.<br>This setting is used mainly for turning machines with tool turret.<br>If there is no D programmed in the block with T, the tool offset which is defined in $MC_CUTTING_EDGE_DEFAULT becomes effective.<br>MD: TOOL_CHANGE_MODE = 1<br>The new tool is prepared for changing with the T function. This setting is used mainly on milling machines with a tool magazine, in order to bring the new tool into the tool change position without interrupting the machining process. With the M function set in MD 22560: TOOL_CHANGE_MODE, the old tool is removed from the spindle and the new tool is loaded into the spindle. According to DIN 66025, this tool change must be programmed with the M function M06. | | |
| Corresponding to... | MD22560 TOOL_CHANGE_M_CODE | | |
| Additional references: | Description of functions: Tool Offset (W1) | | |

| 22560 | TOOL_CHANGE_M_CODE | | |
|---|---|---|---|
| MD number | M function for tool change | | |
| Default setting: 6 | Min. input limit: 0 | Max. input limit: 99999999 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | If the T function is used only to prepare a new tool for a tool change (this setting is used mainly on milling machines with a tool magazine, in order to bring the new tool into the tool change position without interrupting the machining process), the tool change must be initiated with an additional M function. The M function entered in TOOL_CHANGE_M_CODE initiates the tool change (remove old tool from the spindle and load the new tool in the spindle).<br>This tool change is required to be programmed with M function M06, in accordance with DIN66025. | | |
| Corresponding to... | MD22550 TOOL_CHANGE_MODE | | |
| Additional references: | Functional description for tool offset (W1) | | |

| 22562 | TOOL_CHANGE_ERROR_MODE | | |
|---|---|---|---|
| MD number | Response when errors occur at tool change | | |
| Default setting: 0x0 | Min. input limit: 0 | Max. input limit: 0xFF | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Response in the case that faults/problems occur for a programmed tool change.<br>Bit 0=0: Standard behavior: Stop on faulty NC block<br>Bit 0=1: If the error occurs in the block containing the tool change preparation command, the alarm activated by the preparation command (T) is delayed until the program run reaches the point at which the associated tool change command (M06) is interpreted. Only then is the alarm output that is triggered by the preparation command. The operator can make corrections in this block. When execution of the program is continued, the faulty NC block is interpreted again and the preparatory command is internally executed again automatically.<br>The value = 1 is only of significance if the setting MD22550 TOOL_CHANGE_MODE = 1 is used.<br>Bit 1 is only meaningful if tool management is active.<br>Bit 1=0: Standard behavior: During the tool-change preparation only those tools are recognized whose data are assigned to a magazine.<br>Bit 1=1: Manual tools can be loaded at change.<br>A tool will also be loaded at change if its data is registered in the NCK, but not assigned to a magazine. In this case, the tool data are automatically assigned to the programmed programmed toolholder.<br>The user is prompted to place tools into the toolholder or remove tools from it.<br>Bit 2 Qualifying the offset programming<br>Bit 2=0: Active D No. > 0 and active D No.=0 results in offset 0<br>Active D no. > 0 and active D No.=0 result in additive offset 0<br>Bit 2=1: Active D No. > 0 and active D No.=0 generates an alarm message<br>Active D No. > 0 and active D No.=0 generates an alarm message<br>Bits 3 and 4 are only meaningful if tool management is active.<br>Function:<br>Control of behavior of Init block generation at program start if disabled tool is positioned in the spindle and needs to be activated.<br>Also refer to: MD 20112: START_MODE_MASK, MD 20110: RESET_MODE_MASK<br>At RESET the response of "keep disabled tool on spindle active" is not affected by this.<br>Bit 3=0: Default: If the tool on the spindle is disabled: Generate a tool-change command that requests a replacement tool. If there is no replacement, then an alarm is produced.<br>Bit 3=1: The disabled status of the spindle tool is ignored. The tool is active. The following part program should be formulated such that no parts are machined with the disabled tool.<br>Bit 4=0: Default: An attempt is made to activate the spindle tool or the replacement tool<br>Bit 4=1: If the tool on the spindle is disabled, T0 is programmed in the start init. block.<br>The following statements are given for the combination of bit 3 and bit 4:<br>0 / 0: Response as before, automatic change at NC Start is the disabled tool is in the spindle<br>1 / 0: Is not automatically changed<br>0 / 1: A T0 is generated automatically for a disabled tool in the spindle at NC Start<br>1 / 1: no statement | | |

| 22562 | TOOL_CHANGE_ERROR_MODE |
|---|---|
| | Bit 5: Reserved<br>Bit 6=0: Default: with T0 or D0 then precisely only T0 or D0 are programmed. In other words, the MD $MC_CUTTING_EDGE_DEFAULT, $MC_SUMCORR_DEFAULT define the value of D, DL when T0 is programmed.<br>Example: $MC_CUTTING_EDGE_DEFAULT=1, $MC_SUMCORR_DEFAULT=2, $MC_TOOL_CHANGE_MODE=0 (tool change with T programming)<br>N10 T0; T No. 0 has active number D1 and DL=2 which results in an offset of zero. If, in addition, bit 2 is also set:<br>Programming of<br>a) T0; to deselect tool<br>b) D0; for offset deselection<br>generates an alarm, if<br>a) At least one of MD $MC_CUTTING_EDGE_DEFAULT, $MC_SUMCORR_DEFAULT is not equal to zero (T0 D0 DL=0 is the correct programming).<br>b) The MD $MC_SUMCORR_DEFAULT is not equal to zero (D0 DL=0 is the correct programming).<br>Bit 6=1: Controls the NCK behavior with programming of (x, y, z all greater than zero), if at least one of MD $MC_CUTTING_EDGE_DEFAULT, $MC_SUMCORR_DEFAULT is not equal to zero.<br>a) Tx Dy -> T0<br>with T0 - D0 or D0 DL=0 is automatically programmed in the NCK; i.e. values not equal to zero for MD $MC_CUTTING_EDGE_DEFAULT, $MC_SUMCORR_DEFAULT are processed as if the value were equal to zero.<br>b) Tx Dy >T0 Dy, or T0 DL =z, or T0 Dy DL=z, or T0 D0 DL=z explicitly programmed values of D, DL are not influenced.<br>c) Dy DL=z -> D0<br>with D0 - DL=0 is automatically programmed in the NCK; i.e. values not equal to zero for MD $MC_SUMCORR_DEFAULT are processed as if the value were equal to zero.<br>d) Dy DL=z -> D0 DL=z<br>explicitly programmed values of DL are not influenced.<br>If in addition bit 2 is also set:<br>only T0/D0 have to be programmed for tool/offset deselection and therefore no alarm is output.<br>The statements regarding $MC_SUMCORR_DEFAULT or DL are only valid if the additive offset function is active (see $MN_MM_TOOL_MANAGEMENT_MASK, bit 8). |

| 22562 | TOOL_CHANGE_ERROR_MODE |
|---|---|
| | Bit 7=0: Programming Tx checks whether a tool with the T number x is known in the TO unit of the channel. If it is not, processing stops in this block and alarm 17190 is issued.<br>Bit 7=1: Only if tool basic functionality is active ($MC_TOOL_MANAGEMENT_MASK, bit 0.1=0) and ($MN_MM_TYPE_OF_CUTTING_EDGE=0):<br>If Tx is programmed, any unknown Tx is first ignored and the alarm for the preparation command (Tx) is ignored until D selection is interpreted in the program execution. Only then is alarm 17191 output that was triggered by the preparation command. This means that in this block, the operator could use the D selection to make corrections. When execution of the program is continued, the faulty NC block is interpreted again and the preparatory command is internally executed again automatically.<br>(It is interesting for cutting edge default=0 or =-2 or D0 programming, otherwise when changing the tool, the D from cutting edge default is deselected.)<br>This variant can be required if you want to program "Tool number=Location" (turret as toolholder) without tool management. The turret can only be positioned at a location for which there is no tool defined (yet).<br>If bit 0=1 is set, this bit is irrelevant. |
| Additional references: | Description of functions: Tool Offset (W1) |

| 28085 | MM_LINK_TOA_UNIT | | |
|---|---|---|---|
| MD number | Allocation of a TO unit to a channel | | |
| Default setting: 1, 2, 3, 4, 5, ... | Min. input limit: 1 | Max. input limit: 10 | |
| Change becomes effective after: POWER ON | Protection level: 2/7 | Unit: | |
| Data type: DWORD | | | |
| Meaning: | The area T0 includes all tool, magazine, ... data blocks, which the NCK knows. The maximum number of units in the TO area match the maximum number of channels.<br>If MM_LINK_TOA_UNIT = default, then each channel is individually assigned a TO unit.<br>The channel is assigned to the TO unit i with MM_LINK_TOA_UNIT = i. It is thus possible to assign one TO unit to several channels.<br>Notice<br>The upper limit value does not imply that the value is always meaningful or without conflict. If one channel (the first) is active and the other not on a system with a total of 2 channels, the MD on channel 1 can be formally set to a value of 2. However, the NCK cannot work with this setting. This setting would mean that channel 1 possesses no data blocks for tool offsets since a channel with Id=2 does not exist.<br>The NCK detects this conflict during power-on or a warm restart and reacts by independently changing the (incorrect) setting to the default setting for the MD. | | |
| Corresponding to... | | | |
| Additional references: | Description of functions: Memory configuration (S7) | | |

# 6.3 Machine data for function replacement

| 10715 | M_NO_FCT_CYCLE | | |
|---|---|---|---|
| MD number | M function to be replaced by a subprogram | | |
| Default setting: -1 | Min. input limit: - | Max. input limit: - | |
| Changes effective after Power On | Protection level: 2/4 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | M number with which the subprogram is called.<br>The name of the subprogram is stored in $MN_M_NO_FCT_CYCLE_NAME[n]. If the M function defined using $MN_M_NO_FCT_CYCLE[n] is programmed in a part program block, then the subprogram defined in M_NO_FCT_CYCLE_NAME[n] is started at the end of block.<br>If the M function is re-programmed in the subroutine, then there is no longer any replacement by a subroutine call.<br>$MN_M_NO_FCT_CYCLE[n] acts both in the Siemens mode G290 as well as in the external language mode G291.<br>The subroutines configured with $MN_M_NO_FCT_CYCLE_NAME[n] and $MN_T_NO_FCT_CYCLE_NAME may not be effective in one block (part-program line) at the same time, i.e. max. one M/T function replacement can be effective per block. Neither an M98 nor a modal subprogram call may be programmed in the block with the M function replacement.<br>A subprogram return jump or end of part program is also not permitted. Alarm 14016 is generated in the case of a conflict.<br>Constraints:<br>M functions with a fixed meaning and configurable M functions are checked for competing settings. A conflict is signaled with an alarm. The following M functions are checked:<br>- M0 to M5,<br>- M17, M30,<br>- M40 to M45,<br>- M function for selecting spindle/axis mode according to $MC_SPIND_RIGID_TAPPING_M_NR (default M70)<br>- M functions for nibbling/punching as configured in $MC_NIBBLE_PUNCH_CODE if activated by $MC_PUNCHNIB_ACTIVATION.<br>- for applied external language ($MN_MM_EXTERN_LANGUAGE) M19, M96-M99.<br>Exception: The M functions defined by $MC_TOOL_CHANGE_M_CODE for the tool change. | | |
| Corresponding to... | | | |
| Additional references: | ISO dialects for SINUMERIK (FBFA) | | |

| 10716 | M_NO_FCT_CYCLE_NAME | | |
|---|---|---|---|
| MD number | Subroutines for M function replacement | | |
| Default setting: - | Min. input limit: - | Max. input limit: - | |
| Changes effective after Power On | Protection level: 2/4 | Unit: - | |
| Data type: STRING | | | |
| Meaning: | The cycle name is stored in the machine data. This cycle is called if the M function was programmed from machine datum $MN_M_NO_FCT_CYCLE.<br>If the M function is programmed in a motion block, then the cycle is executed after the motion.<br>$MN_M_NO_FCT_CYCLE acts both in the Siemens mode G290 as well as in the external language mode G291.<br>If a T number is programmed in the calling block, the programmed T number<br>can be queried in the cycle under the variable $P_TOOL.<br>M and T function replacement may not be effective in one block at the same time, i.e. max. one M/T function replacement can be effective per block. Neither an M98 nor a modal subprogram call may be programmed in the block with the M function replacement. A subprogram return jump or end of part program is also not permitted.<br>Alarm 14016 is generated in the case of a conflict. | | |
| Corresponding to... | MD10715 M_NO_FCT_CYCLE<br>MD10717 T_NO_FCT_CYCLE_NAME | | |
| Additional references: | ISO dialects for SINUMERIK (FBFA) | | |

| 10717 | T_NO_FCT_CYCLE_NAME | | |
|---|---|---|---|
| MD number | Name of tool change cycle for T function replacement | | |
| Default setting: - | Min. input limit: - | Max. input limit: - | |
| Changes effective after Power On | Protection level: 2/4 | Unit: - | |
| Data type: STRING | | | |
| Meaning: | Cycle name for tool change routine during call via T function.<br>If a T function is programmed in a part program block, then the subprogram defined in t_NO_FCT_CYCLE_NAME is called at the end of block.<br>The programmed T number can be queried in the cycle via the system variables $C_T/$C_T_PROG as decimal value and via $C_TS / $C_TS / $C_TS_PROG as string (only in tool management).<br>$MN_T_NO_FCT_CYCLE_NAME acts both in the Siemens mode G290 as well as in the external language mode G291.<br>The subroutines configured with $MN_M_NO_FCT_CYCLE_NAME and $MN_T_NO_FCT_CYCLE_NAME may not be effective in one block at the same time, i.e. max. one M/T function replacement can be effective per block.<br>Neither an M98 nor a modal subroutine call may be programmed in the block with the T function replacement. A subprogram return jump or end of part program is also not permitted.<br>Alarm 14016 is generated in the case of a conflict. | | |
| Corresponding to... | MD10715 M_NO_FCT_CYCLE<br>MD10716 M_NO_FCT_CYCLE_NAME | | |
| Additional references: | ISO dialects for SINUMERIK (FBFA) | | |

| 10718 | M_NO_FCT_CYCLE_PAR | | |
|---|---|---|---|
| MD number | M function replacement with parameters | | |
| Default setting: -1 | Min. input limit: - | Max. input limit: - | |
| Changes effective after Power On | Protection level: 7/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | If a M function replacement was configured with $MN_M_NO_FCT_CYCLE[n] / $MN_M_NO_FCT_CYCLE_NAME[n], then $MN_M_NO_FCT_CYCLE_PAR can be used for specifying parameter transfer for one of these M functions per system variable as is the case for the T function replacement. The parameters stored in the system variables always refer to the part program line in which the M function to be replaced is programmed.<br>The following system variables are available:<br>$C_ME: Address extension of the substituted M function<br>$C_T_PROG: TRUE if address T has been programmed<br>$C_T: Value of address T (integer)<br>$C_TE: Address extension of address T<br>$C_TS_PROG: TRUE if address TS has been programmed<br>$C_D_PROG: TRUE if address D has been programmed<br>$C_D: Value of address D<br>$C_DL_PROG: TRUE if address DL has been programmed<br>$C_DL: Value of address DL | | |
| Corresponding to... | | | |
| Additional references: | ISO dialects for SINUMERIK (FBFA) | | |

| 10719 | T_NO_FCT_CYCLE_MODE | | |
|---|---|---|---|
| MD number | Parameter assignment for T function replacement | | |
| Default setting: 0 | Min. input limit: 0 | Max. input limit: 7 | |
| Changes effective after Power On | Protection level: 7/2 | Unit: - | |
| Data type: DWORD | | | |
| Meaning: | Processing of the substitution program is parameterized in this MD for the tool selection/tool offset selection.<br>Bit 0 = 0:<br>The D or DL number is transferred to the substitution program (default value)<br>Bit 0 = 1:<br>The D or DL number is not transferred to the substitution program if the following conditions are fulfilled: $MC_TOOL_CHANGE_MODE = 1 programming of D/DL with T or M function with which the tool-changing cycle is called, in one part program line<br>Bit 1 = 0:<br>Execution of substitution subroutine at end of block (default value)<br>Bit 1 = 1:<br>Processing of substitution subroutine at start of block<br>Bit 2 = 0:<br>Processing of substitution subprogram according to setting for bit 1<br>Bit 2 = 1:<br>Execution of substitution subroutine at start of block and end of block | | |
| Corresponding to... | | | |
| Additional references: | ISO dialects for SINUMERIK (FBFA) | | |

| 11717 | D_NO_FCT_CYCLE_NAME | | |
|---|---|---|---|
| MD number | Subroutine name for D function replacement | | |
| Default setting: - | Min. input limit: - | Max. input limit: - | |
| Changes effective after Power On | Protection level: 7/2 | Unit: - | |
| Data type: STRING | | | |
| Meaning: | Cycle name for D function replacement routine.<br>If a D function is programmed in a part program block, the subroutine defined with $MN_D_NO_FCT_CYCLE_NAME is called in accordance with the machine data $MN_T_NO_FCT_CYCLE_NAME, $MN_T_NO_FCT_CYCLE_MODE and $MN_M_NO_FCT_CYCLE_PAR.<br>The programmed D number can be queried in the cycle via the system variables $C_D / $C_D_PROG.<br>$MN_D_NO_FCT_CYCLE_NAME can only run in Siemens mode (G290).<br>A maximum of one M/T/D function replacement can be effective for each part program line. A modal subroutine call may not be programmed in the block with the D function replacement. It is also not permissible to program a subroutine return jump or end of part program.<br>Alarm 14016 is generated in the case of a conflict. | | |
| Corresponding to... | | | |
| Additional references: | ISO dialects for SINUMERIK (FBFA) | | |

## 6.4 Machine data for the Siemens user data

The numbers of the Siemens machine data are listed in the following. This data is defined by Siemens and must not be used by users. No detailed description of them is given for this reason.

18200

18201

18202

18203

18204

18205

18206

18207

18208

18209

**Note**

A detailed description of machine data 18091, 18093, 18095, 18097 and 18099 has been provided, but these MD may be used only if they are set to their respective defaults.

**Multitool machine data**

18196

18197

18198

18199

# Signal description of the PLC interface 7

## 7.1 Overview of data blocks

### General

The table below shows an overview of the data blocks used for data management.

| | |
|---|---|
| DB 71 | For loading/unloading points |
| DB 1071 | Extended data for multitools |
| DB 72 | For spindle as change position |
| DB 1072 | Extended data for multitools |
| DB 73 | For turret as change position |
| DB 1073 | Extended data for multitools |
| DB 74 | Internal data block of basic program for tool management |

1. There is an independent interface area in DB 71 for each loading point configured in the magazine configuration. The interface area for loading point 1 generally has the task of loading into the spindle.

   Relocation- and positioning tasks are always handled via loading point_1 (spindle loading point).

2. DB 72 includes an independent interface area for every spindle defined in the tool management system.
3. An independent interface area is provided in DB 73 for each turret of the magazine configuration. The turret numbers are numbered without any gaps from the smallest up to the highest magazine number.
4. Data for multitools is available in data blocks DB1071, DB1072 and DB1073 (analog to DB71, DB72 and DB73 loading and unloading, spindle change positions, revolver).

All interfaces are designed for receiving tool-management commands (load, tool change, ...). Basic program blocks FC 6 (multitool), FC 7 and FC 8 are used to communicate the current positions of tools.

One of the interfaces is updated by NCK via the basic program in accordance with a command (e.g. by operating the function "Load" or by a part-program function like "Tool change").

**Note**

The PLC must also be adapted if data of magazines, buffers or loading/unloading positions are changed in the commissioning branch.

Either directly by changing DB 4 or using HMI Advanced under generate "PLC data".

With the next restart, the basic PLC program automatically clears DB 71 ... DB 74 and creates the blocks from new again.

# 7.2 Interface for loading/unloading magazine

| **DB 71 Data block** | **Signals of loading/unloading points NCK -> PLC interface** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
| | Interfaces | | | | | | | |
| DBB 0 | INT 8 | INT 7 | INT 6 | INT 5 | INT 4 | INT 3 | INT 2 | INT 1 |
| DBB 1 | INT 16 | INT 15 | INT 14 | INT 13 | INT 12 | INT 11 | INT 10 | INT 9 |
| DBB 2 | Ackn INT 8 | Ackn INT 7 | Ackn INT 6 | Ackn INT 5 | Ackn INT 4 | Ackn INT 3 | Ackn INT 2 | Ackn INT 1 |
| DBB 3 | Ackn INT 16 | Ackn INT 15 | Ackn INT 14 | Ackn INT 13 | Ackn INT 12 | Ackn INT 11 | Ackn INT 10 | Ackn INT 9 |
| DBB n+0 | Res. | | Positioning a multitool | Positioning from the NC program | Positioning a multitool | Relocating | Unloading | Loading |
| DBB n+1 | Data in the extended range (DB 1071) | Res. | Res. | Res. | Res. | Res. | Res. | Acknowl-edgment status = 3 |
| DBB n+2 | Assigned channel (8bit-Int) | | | | | | | |
| DBB n+3 | Tool management number (8bit-Int) | | | | | | | |
| DBD n+4 | Reserved | | | | | | | |
| DBD n+8 | Reserved | | | | | | | |
| DBD n+12 | Reserved | | | | | | | |
| DBW n+16 | Identifier for loading/unloading point (Int), (fixed value 9999) | | | | | | | |
| DBW n+18 | Location No. of loading/unloading point (Int) | | | | | | | |
| DBW n+20 | Magazine No. (source) for unloading/relocating/positioning (Int) | | | | | | | |
| DBW n+22 | Location No. (source) for unloading/relocating/positioning (Int) | | | | | | | |
| DBW n+24 | Magazine No. (target) for unloading/relocating/positioning (Int) | | | | | | | |
| DBW n+26 | Location no. (target) for unloading/relocating/positioning (Int) | | | | | | | |
| DBW n+28 HMI to PLC | | | | | | | | Loading/un-loading with-out moving magazine |
| DBW n+29 | Spare | | | | | | | |

Starting addresses of loading/unloading points:

Loading/unloading point 1: n = 4
Loading/unloading point 2: n = 34
Loading/unloading point 3: n = 64
Loading/unloading point 4: n = 94

Example for calculating the address DBW n+24 (magazine No. target)

n=(m-1)*len+4 m = location no. of loading station/point

len = 30 (length of loading point)
m = 2; len = 30 n= (2-1)*30+4 --> n = 34
DBW (34+24) = DBW 58

Address for magazine No. target of 2nd loading point is DBW 58.

Loading point 1 is intended for loading/unloading in all spindles. Loading point is also used to relocate/position tools in any location (e.g. buffer location).

| DB71.DBX0.0 - 1.7 | Active status of interface 1- 16 |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The active interface has a valid data record. A task bit has been set in DBB (n+0). There are 16 interfaces. Address "n" must always be calculated for the active interface. |
| Signal state 0 | Operation for this interface has ended. Is reset by FC 8 or FC 6. |

| DB71.DBX2.0 - 3.7 | "auto" acknowledgement of interface 1 - 16 |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | When setting (edge) of the bit, the pending command is acknowledged with_1.<br>e.g.<br>U DB71.DBX0.0<br>U DB71.DBX4.1 (unload)<br>S DB71.DBX2.0 |
| Signal state 0 | Operation for this interface has ended. Is reset by the basic program. |

| DB71.DBX(n+0).0 | Command: Loading |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | Loading operation for a tool is initiated. The magazine location into which the tool is to be loaded is defined in DBW(n+26). The loading point in question is the location number of the loading point. It is also located in DBW(n+18) |
| Corresponding to... | DB71DBX(n+16) and (n+18) and (n+26) |

| DB71.DBX(n+0).1 | Command: Unloading |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | Unloading operation is initiated for a tool; the magazine location from which it is to be unloaded is in DBW (n+20) and DBW (n+22). The number of the unloading point is in DBW(n+18). |
| Corresponding to... | DB71DBX(n+16) and (n+18) or (n+20) and (n+22) |

| DB71.DBX(n+0).2 | Command: Relocating |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | Relocate operation for a tool is initiated. From magazine/location (n+20, n+22=source) to magazine/location (n+24, n+26=target) |

**Note**

The bits in DBB(n+0) (loading, unloading,....) are not updated by the basic program until a new task exists for this interface. They are current only if the corresponding interface bit in DBB0 is set to "1". If required, the user can reset bits DBB(n+0).

| DB71.DBX(n+0).3 | Command: Positioning to the loading point |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | A magazine location is to be positioned at the loading point (magazine no. 9999). The magazine location that is to be moved to the loading point is in DB71.DBW(n+20) and (n+22). The loading point is in DB71.DBWn+18. |

| DB71.DBX(n+0).4 | Command: Job comes from the NC program |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The signal is set if the job is received from the part program or via a cycle.<br>1. Positioning job with the language command POSM<br>2. A relocation job or tool transport using the language command MVTOOL<br>3. Positioning a multitool using the language command POSMT |

| DB71.DBX(n+0).5 | Command: Positioning a multitool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | Positioning a multitool has been initiated.<br>This can be realized using a language command, PI service or the HMI user interface. |

| DB71.DBX(n+1).0 | "auto" ackn negative |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The bit is only evaluated in conjunction with "auto" ackn. If it is set, then the auto acknowledge is negative, i.e. with status_3. |

| DB71.DBX(n+1).7 | Command: Data in the extended range |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The signal is set if a multitool is loaded, unloaded or positioned. The multitool data are then available in DB 1071. |

| DB71.DBB(n+2) | Assigned channel |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Number of the channel for which the active interface is valid. |

| DB71.DBB(n+3) | Tool management No. |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Associated tool management number; corresponds to the number of the TO unit within a TO area. |

| DB71.DBW(n+16) | Identifier for loading/unloading point (fixed value 9999) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | The identifier for the loading/unloading point is fixed to the value 9999. |

| DB71.DBW(n+18) | Location No. of the loading/unloading point |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | The location No. of the loading/unloading point is displayed. |

| DB71.DBW(n+20) | Magazine No. (source) for unloading/relocating/positioning |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Unloading: Magazine from which the tool is to be unloaded<br>Relocating: Magazine from which the tool comes<br>Positioning: Magazine that is to be positioned |
| Corresponding to... | DBW(n+22) |

| DB71.DBW(n+22) | Location No. (source) for unloading/relocating/positioning |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Unloading: Location from which the tool is to be unloaded<br>Relocating: Location from where the tool comes<br>Positioning: Location that should be positioned |
| Corresponding to... | DBW(n+20) |

| DB71.DBW(n+24) | Magazine No. (target) for unloading/relocating/positioning |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Loading: Magazine into which the tool is to be loaded<br>Relocating: Magazine into which the tool comes<br>Positioning: Magazine to be positioned to<br>Tool remains in the original magazine<br>Only meaningful for interface 1. If values other than 0 are entered here, the data define the magazine or location for positioning (language command POSM). |
| Corresponding to... | DBW(n+26) |

| DB71.DBW(n+26) | Location No. (target) for unloading/relocating/positioning |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Loading: Location into which the tool is to be loaded<br>Relocating: Location into which the tool comes<br>Positioning: Location to be positioned to<br>Tool remains at the original location<br>Only meaningful for interface 1. If values other than 0 are entered here, the data define the magazine or location for positioning (language command POSM). |
| Corresponding to... | DBW(n+24) |

| DB71.DBX(n+28) Bit0 | Loading/unloading without moving magazine |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | HMI / Jobshop sets/deletes this signal when requested by the operator. If the bit is active, there must be no traversing motion of the magazine, only a mechanical unlocking/locking of the location. The loading/unloading command must be acknowledged after the action. For a positioning and relocating request, this signal is not valid for a traversing motion. |

# 7.3 Interface for spindle as change position

| **DB 72 Data block** | **Spindle as change position Interface NCK -> PLC** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
| | Interfaces | | | | | | | |
| DBB 0 | INT 8 | INT 7 | INT 6 | INT 5 | INT 4 | INT 3 | INT 2 | INT 1 |
| DBB 1 | INT 16 | INT 15 | INT 14 | INT 13 | INT 12 | INT 11 | INT 10 | INT 9 |
| DBB 2 | Ackn INT 8 | Ackn INT 7 | Ackn INT 6 | Ackn INT 5 | Ackn INT 4 | Ackn INT 3 | Ackn INT 2 | Ackn INT 1 |
| DBB 3 | Ackn INT 16 | Ackn INT 15 | Ackn INT 14 | Ackn INT 13 | Ackn INT 12 | Ackn INT 11 | Ackn INT 10 | Ackn INT 9 |
| DBB n+0 | Tool remains in spindle | Remove manual tool | Load manual tool at change | OldTool in BL No. (n+42) | T0 | Prepare change | Change tool (initiated by M06) | Obligatory change |
| DBB n+1 | Data in the extended range (DB 1072) | Res. | Res. | Res. | Res. | Res. | Res. | Acknowl-edgment status = 3 |
| DBB n+2 | Assigned channel (8bit-Int) | | | | | | | |
| DBB n+3 | Tool management number (8bit-Int) | | | | | | | |
| DBD n+4 | $P_VDITCP[0] User-definable parameter 0 (DWord) | | | | | | | |
| DBD n+8 | $P_VDITCP[1] User-definable parameter 1 (DWord) | | | | | | | |
| DBD n+12 | $P_VDITCP[2] User-definable parameter 2 (DWord) | | | | | | | |
| DBW n+16 | Buffer identifier (Int), (fixed value 9998) corresponds to "Target position for new tool" | | | | | | | |
| DBW n+18 | Relative location (target) in buffer magazine (Int) | | | | | | | |
| DBW n+20 | Magazine no. (source) for new tool (Int) | | | | | | | |
| DBW n+22 | Location no. (source) for new tool (Int) | | | | | | | |
| DBW n+24 | Magazine no. (target) for old tool (Int) | | | | | | | |
| DBW n+26 | Location no. (target) for old tool (Int) | | | | | | | |
| DBW n+28 | New tool: Location type (Int) | | | | | | | |
| DBW n+30 | New tool: Size on left (Int) | | | | | | | |
| DBW n+32 | New tool: Size on right (Int) | | | | | | | |
| DBW n+34 | New tool: Size at top (Int) | | | | | | | |
| DBW n+36 | New tool: Size at bottom (Int) | | | | | | | |
| DBB n+38 | Tool status for new tool | | | | | | | |
| | Manual tool | 1:1 exchange | | Master tool | Tool to be loaded | Tool to be unloaded | Locked, but ignore | Identifier for tools in the buffer |
| DBB n+39 | Tool status for new tool | | | | | | | |

| DB 72<br>Data block | Spindle as change position<br>Interface NCK -> PLC | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Tool was in use | Tool, fixed-location-coded | Tool is being changed | Prewarning limit reached | Measure tool | Tool locked | Enable tool | Active tool |
| DBW n+40 | New tool: Internal T number of NCK (Int) | | | | | | | |
| DBW n+42 | If DBX (n+0.4) = 1, then the buffer location of the old tool must be entered here | | | | | | | |
| DBW n+44 | Original magazine of new tool | | | | | | | |
| DBW n+46 | Original location of the new tool | | | | | | | |

Start address of the spindle:

Spindle 1: n = 4
Spindle 2: n = 52
Spindle 3: n = 100

n = (m-1)*len + 4
m = location number of change position
len = 48

**Note**

If only M06 is programmed, only free parameters, channel, tool management number and the bit for "Perform change" are updated.

| DB72.DBX0.0 - 1.7 | Active status of interface 1- 16 |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | Associated interface has a valid data record, a tool change request of tool preparation has been initiated. |
| Signal state 0 | Operation for this interface has ended. Is reset by FC 8/FC 6. |

| DB72.DBX2.0-3.7 | "auto" acknowledgement of interface 1-16 |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | When setting (edge) the bit, the pending command is acknowledged with status_1. |
| Signal state 0 | Operation for this interface has ended. Is reset by the basic program. |

| DB72.DBX(n+0).0 | Command code: Obligatory change |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The new tool is fixed-location-coded. |

| DB72.DBX(n+0).1 | Command code: Perform change with M06 |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | M06 command was programmed for tool change, the tool change can now take place |

| DB72.DBX(n+0).2 | Command code: Prepare change |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | Prepare new tool for change. If necessary, move location for old tool to spindle. |

| DB72.DBX(n+0).3 | Command code: T0 |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | Indicates that T0 has been programmed (no-load traversing of spindle). |

| DB72.DBX(n+0).4 | Command code: Old tool in buffer |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The buffer number of the tool to be changed is written in DB72.DBW (n+42) |

| DB72.DBX(n+0).5 | Command code: Load manual tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | A manual tool is to be loaded. The HMI displays the tool which is to be loaded. |

| DB72.DBX(n+0).6 | Command code: Unload manual tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The tool is to be changed via manual operation. |

| DB72.DBX(n+0).7 | Command code: Tool remains in spindle |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The bit is set at change from spindle to spindle. Initiated e.g. by reset and start mode or block search. |

**Note**

The bit in DBB (n+0).2 (prepare change) is not reset by the system with a change command. The bits in DBB(n+0) ... are current only if the corresponding interface bit in DBB0 is set to "1". However, the user can reset the bits when required.
If DBX(n+0).1 and DBX(n+0).2 are present at the same time, it means that T and M06 were programmed in one block.

| DB72.DBX(n+1).0 | "auto" ackn negative |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The bit is only evaluated in conjunction with "auto" ackn. If it is set, then the auto acknowledge is negative, i.e. with status_3. |

| DB72.DBX(n+1).7 | Command: Data in the extended range |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The signal is set if a tool is prepared in a multitool or is loaded into a multitool. DB 72 contains the data of the multitool, the data of the selected tool is available in DB 1072.<br>For T0 the signal is not set. |

| DB72.DBB(n+2) | Assigned channel |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Number of channel for which active interface applies. |

| DB72.DBB(n+3) | Tool management No. |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Associated tool management No. (TO area). |

| DB72.DBD(n+4) | User-definable parameter 0 (DInt) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | If you need to send a value to the PLC via the part program, the transfer can be programmed with $P_VDITCP[0];. Values are transferred at T call. |

| DB72.DBD(n+8) | User-definable parameter 1 (DInt) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | If you need to send a value to the PLC via the part program, the transfer can be programmed with $P_VDITCP[1];. |

| DB72.DBD(n+12) | User-definable parameter 2 (DInt) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | If you need to send a value to the PLC via the part program, the transfer can be programmed with $P_VDITCP[2] |

| DB72.DBW(n+16) | Buffer magazine No. (fixed value 9998)<br>Target position for new tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Magazine No. 9998 (buffer magazine); target magazine for new tool. |

| DB72.DBW(n+18) | Location in buffer magazine (spindle) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location No. of buffer magazine to which the new tool must be loaded. This is normally the spindle. The location number defined for this particular buffer during commissioning is output. |

| DB72.DBW(n+20) | Magazine No. (source) for new tool to be loaded at change |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | No. of magazine from which the new spindle tool comes. |
| corresponding to ... | DBW(n+22) |

| DB72.DBW(n+22) | Location No. (source) for new tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location No. of the magazine from which the new spindle tool comes. |
| corresponding to ... | DBW(n+20) |

| DB7.2DBW(n+24) | Magazine No. (target) for old tool to be removed at change |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Number of magazine in which the tool to be removed at change will be placed. |
| corresponding to ... | DBW(n+26) |

| DB72.DBW(n+26) | Location No. (target) for new tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Magazine location for tool that is unloaded at change. |

| DB72.DBW(n+28) | New tool: Location type |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | The location type of the new spindle tool is entered here. |
| corresponding to ... | Tool size: Left, right, top, bottom. |

| DB72.DBW(n+30) | New tool: Size left |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size **left** in half locations for the new spindle tool. |

| DB72.DBW(n+32) | New tool: Size right |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size **right** in half locations for the new spindle tool. |

| DB72.DBW(n+34) | New tool: Size top |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size **top** in half locations for the new spindle tool. |

| DB72.DBW(n+36) | New tool: Size bottom |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size **bottom** in half locations for the new spindle tool. |

| DB72.DBW(n+38) | Tool status for new tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Bit 0 = active tool<br>Bit 1: Enable tool<br>Bit 2: Tool locked<br>Bit 3: Measure tool<br>Bit 4: Prewarning limit reached<br>Bit 5: Tool is being changed<br>Bit 6: Tool is fixed-location-coded<br>Bit 7: Tool was in use<br>Bit 8: Tool in the buffer<br>Bit 9: Ignore locked<br>Bit 10: To be unloaded<br>Bit 11: To be loaded<br>Bit 12: Master tool<br>Bit 13: Reserved<br>Bit 14: 1:1 exchange<br>Bit 15: Manual tool |

| DB72.DBW(n+40) | New tool: Internal T number of NCK |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Display of internal T number of NCK for the new spindle tool. |
| Signal state 0 | . |

| DB72.DBW(n+42) | Buffer location of old tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | If DB72.(n+0.4) = 1, the buffer location of the old tool must be entered here. This can be any buffer (also a gripper). |

| DB72.DBW(n+44) | Original magazine of new tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Owner magazine of the new tool<br>Corresponds to NCK variables $A_MYMN[T-No]<br>If the new tool is located in the magazine, then this value is identical with DB72.DBW(n+20).<br>If the new tool is located in the buffer (e.g. gripper), then the magazine No. is entered here from where the tool originally came. |

| DB72.DBW(n+46) | Original location of new tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Owner location of the new tool<br>Corresponds to NCK variable $A_MYMLN[T-No] |
| Signal state 0 | . |

# 7.4 Interface for turrets as change position

| **DB 73 Data block** | **Turret as change position Interface NCK -> PLC** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
| | Interfaces | | | | | | | |
| DBB 0 | INT 8 | INT 7 | INT 6 | INT 5 | INT 4 | INT 3 | INT 2 | INT 1 |
| DBB 1 | INT 16 | INT 15 | INT 14 | INT 13 | INT 12 | INT 11 | INT 10 | INT 9 |
| DBB 2 | Ackn INT 8 | Ackn INT 7 | Ackn INT 6 | Ackn INT 5 | Ackn INT 4 | Ackn INT 3 | Ackn INT 2 | Ackn INT 1 |
| DBB 3 | Ackn INT 16 | Ackn INT 15 | Ackn INT 14 | Ackn INT 13 | Ackn INT 12 | Ackn INT 11 | Ackn INT 10 | Ackn INT 9 |
| DBB n+0 | Res. | Remove manual tool | Res. | Res. | T0 | Res. | Perform change, initiation: T No. | Obligatory change |
| DBB n+1 | Data in the extended range (DB 1073) | Res. | Res. | Res. | Res. | Res. | Res. | Acknowl-edgment status = 3 |
| DBB n+2 | Assigned channel (8bit-Int) | | | | | | | |
| DBB n+3 | Tool management number (8bit-Int) | | | | | | | |
| DBD n+4 | $P_VDITCP[0] User-definable parameter 0 (DWord) | | | | | | | |
| DBD n+8 | $P_VDITCP[1] User-definable parameter 1 (DWord) | | | | | | | |
| DBD n+12 | $P_VDITCP[2] User-definable parameter 2 (DWord) | | | | | | | |
| DBW n+16 | Reserved | | | | | | | |
| DBW n+18 | Reserved | | | | | | | |
| DBW n+20 | Magazine No. of turret (Int) | | | | | | | |
| DBW n+22 | Location No. of new tool (Int) | | | | | | | |
| DBW n+24 | Reserved | | | | | | | |
| DBW n+26 | Location No. of old tool (Int) | | | | | | | |
| DBW n+28 | New tool: Location type (Int) | | | | | | | |
| DBW n+30 | New tool: Size on left (Int) | | | | | | | |
| DBW n+32 | New tool: Size on right (Int) | | | | | | | |
| DBW n+34 | New tool: Size at top (Int) | | | | | | | |
| DBW n+36 | New tool: Size at bottom (Int) | | | | | | | |
| DBBn+38 | Tool status for new tool | | | | | | | |
| | Manual tool | 1:1 exchange | | Master tool | Tool to be loaded | Tool to be unloaded | Locked, but ignore | Identifier for tools in the buffer |
| DBB n+39 | Tool status for new tool | | | | | | | |
| | Tool was in use | Tool, fixed-location-coded | Tool being changed | Prewarning limit reached | Measure tool | Tool locked | Enable tool | Active tool |

| DB 73<br>Data block | Turret as change position<br>Interface NCK -> PLC |
|---|---|
| DBW n+40 | New tool: Internal T number of NCK (Int) |
| DBW n+42 | Original location of new tool in this circular magazine |

Start address of the turret:

Turret, 1: n = 4
Turret 2: n = 48
Turret 3: n = 92

n = (m-1)*len + 4
m = location No.of change position
len = 44

Example for change position 3: n = (3-1)*n44 + 4 = 2*44 + 4= 88 + 4 = 92

| DB73.DBX0.0 - 1.7 | Active status of interface 1- 16 |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | Associated interface has a valid data record. |
| Signal state 0 | Operation for this interface has ended. Is reset by FC 7. |

| DB73.DBX2.0 - 3.7 | "auto" acknowledgement of interface 1-16 |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | When setting (edge) the bit, the pending command is acknowledged with status_1. |
| Signal state 0 | Operation for this interface has ended. Is reset by the basic program. |

| DB73.DBX (n+0).0 | Command code: Obligatory change |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | |
| Signal state 0 | |
| Corresponding to ... | Position of participating tools |

| DB73.DBX(n+0).1 | Command code: Perform change |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | Execute tool change |

| DB73.DBX(n+0).3 | T0 |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | Indicates that T0 has been programmed |

| DB73.DBX(n+1).7 | Command: Data in the extended range |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Signal state 1 | The signal is set if a tool is loaded into a multitool. DB 73 contains the data of the multitool, the data of the selected tool is available in DB 1073.<br>For T0 the signal is not set. |

| DB73.DBX(n+1).30 | "auto" ackn negative |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | The bit is only evaluated in conjunction with "auto" ackn. If it is set, then the auto acknowledge is negative, i.e. with status_3. |

| DB73.DBB (n+2) | Assigned channel |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Number of channel from which the T word was programmed. |

| DB73.DBB (n+3) | Tool management number |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Associated tool management number (TO area) of channel. |

**Note**

The bits in DBB(n+0) (obligatory change, execute change, ...) are not reset by the system. They are current only if the corresponding interface bit in DBB0 is set to "1". However, the bits can be reset by the user if necessary.

| DB73.DBD (n+4) | User-definable parameter 0 (DInt) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | If you need to send a value to the PLC via the part program, the transfer can be programmed with $P_VDITCP[0] = value. Parameters 0-2 are transferred with the T command. |

| DB73.DBD(n+8) | User-definable parameter 1 (DInt) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | If you need to send a value to the PLC via the part program, the transfer can be programmed with $P_VDITCP[1] = value. |

| DB73.DBD (n+12) | User-definable parameter 2 (DInt) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | If you need to send a value to the PLC via the part program, the transfer can be programmed with $P_VDITCP[2] = value. |

| DB73.DBW (n+16) | Reserved |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | |

| DB73.DBW (n+18) | Reserved |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | |

| DB73.DBW (n+20) | Magazine No. of new tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Magazine No. of the new tool, which should be processed. |
| Corresponding to ... | DBW(n+22) |

| DB73.DBW (n+22) | Location No. of new tool to be loaded at change |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location No. of the new tool, which should be processed. |
| Corresponding to ... | DBW(n+20) |

| DB73.DBW (n+24) | Reserved |
|---|---|
| Edge evaluation | |
| Meaning | |

| DB73.DBW (n+26) | Location No. of old tool to be unloaded |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location No. of the old tool (used up to now for machining). |
| Signal state 0 | . |

| DB73.DBW (n+28) | New tool: Location type |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | The location type of the new tool is entered here. |
| corresponding to ... | Tool size: Left, right, top, bottom |

| DB73.DBW (n+30) | New tool: Size left |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size **left** in half locations for the new tool. |

| DB73.DBW (n+32) | New tool: Size right |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size **right** in half locations for the new tool |

| DB73.DBW (n+34) | New tool: Size top |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size **top** in half locations for the new tool |

| DB73.DBW (n+36) | New tool: Size bottom |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size **bottom** in half locations for the new tool |

| DB73.DBW (n+38) | Tool status for new tool |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Bit 0: Active tool<br>Bit 1: Enable tool<br>Bit 2: disabled<br>Bit 3: Measure tool<br>Bit 4: Prewarning limit reached<br>Bit 5: Tool being changed<br>Bit 6: Tool is fixed-location-coded<br>Bit 7: Tool was in use<br>Bit 8: Tool in the buffer<br>Bit 9: Ignore locked<br>Bit 10: To be unloaded<br>Bit 11: To be loaded<br>Bit 12: Master tool<br>Bit 13: Reserved<br>Bit 14: 1:1 exchange<br>Bit 15: Manual tool |

| DB73.DBW (n+40) | New tool: Internal T No. of NCK |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Display of internal T no. of NCK for the new tool. Tool management variables can be read/written via FB2/FB3 using this T No. |

| DB73.DBW (n+42) | Original location of new tool in this circular magazine |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | |

# 7.5 Interface for loading/unloading magazine (multitool) (DB 1071)

| **DB 1071 Data block** | **Magazine, loading/unloading (multitool) NCK -> PLC interface** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
| DBW n+0 | Distance coding | | | | | | | |
| DBW n+2 | Multitool location number | | | | | | | |
| DBD n+4 | Multitool distance | | | | | | | |
| DBW n+8 | Multitool number | | | | | | | |
| DBW n+10 | Multitool location number | | | | | | | |
| DBW n+12 | Toolholder | | | | | | | |
| DBW n+14 | Reserved | | | | | | | |
| DBW n+16 | Reserved | | | | | | | |
| DBW n+18 | Reserved | | | | | | | |

Starting address of loading/unloading points:

Loading/unloading point 1: n = 0
Loading/unloading point 2: n = 20
Loading/unloading point 3: n = 40
Loading/unloading point 4: n = 60

| **DB1071.DBW(n+0)** | **Distance coding** |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Type of distance coding of the multitool (corresponds to $TC_MTP_KD<br>1 = location number<br>2 = distance<br>3 = angle |
| Signal state 0 | |

| **DB1071.DBW(n+2)** | **Multitool location number** |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Number of locations of the multitool |
| Signal state 0 | |

| **DB1071.DBD(n+4)** | **Multitool location distance** |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Distance of the MT location to be positioned from the reference location (real value). In accordance with the distance coding |
| Signal state 0 | |

| DB1071.DBW(n+8) | Multitool number |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Internal T number of the multitool |
| Signal state 0 | |

| DB1071.DBW(n+10) | Multitool location number |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location number within the multitool (which the system positions to) |
| Signal state 0 | |

| DB1071.DBW(n+12) | Toolholder |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Spindle or toolholder number |
| Signal state 0 | |

# 7.6 Interface for spindle (multitool) (DB 1072)

| **DB 1072 Data block** | **Spindle (multitool) Interface NCK -> PLC** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
| DBW n+0 | Distance coding | | | | | | | |
| DBW n+2 | Multitool location number | | | | | | | |
| DBD n+4 | Multitool distance | | | | | | | |
| DBW n+8 | Multitool number (new tool) | | | | | | | |
| DBW n+10 | Multitool location number (new tool) | | | | | | | |
| DBW n+12 | Multitool number (old tool) | | | | | | | |
| DBW n+14 | Multitool location number (old tool) | | | | | | | |
| DBW n+16 | Location type | | | | | | | |
| DBW n+18 | Tool size, left | | | | | | | |
| DBW n+20 | Tool size, right | | | | | | | |
| DBW n+22 | Tool size, top | | | | | | | |
| DBW n+24 | Tools size, bottom | | | | | | | |
| DBW n+26 | Tool status | | | | | | | |
| DBW n+28 | T number of the tool | | | | | | | |
| DBW n+30 | Toolholder | | | | | | | |
| DBW n+32 | Original magazine of new tool | | | | | | | |
| DBW n+34 | Original location of new tool | | | | | | | |
| DBW n+36 to DBW n+48 | Reserved | | | | | | | |

Initial addresses of spindles:
Spindle 1: n = 0
Spindle 2: n = 50
Spindle 3: n = 100

| **DB1072.DBW(n+0)** | **Distance coding** |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Type of distance coding of the multitool (corresponds to $TC_MTP_KD<br>1 = location number<br>2 = distance<br>3 = angle |
| Signal state 0 | |

| DB1072.DBW(n+2) | Multitool location number |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Number of locations of the multitool |
| Signal state 0 | |

| DB1072.DBD(n+4) | Multitool location distance |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Distance of the MT location to be positioned from the reference location (real value). In accordance with the distance coding |
| Signal state 0 | |

| DB1072.DBW(n+8) | Multitool number (new tool) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Internal T number of the (new) multitool |
| Signal state 0 | |

| DB1072.DBW(n+10) | Multitool location number (new tool) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location number within the multitool (where the new tool is located |
| Signal state 0 | |

| DB1072.DBW(n+12) | Multitool number (old tool) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Internal T number of the (old) multitool.<br>The T number is entered here if the preparation or the change to a tool is realized within the same multitool (which, due to a previous change, is located on the toolholder). It is identical with DB 1072.DBW(n+8) |
| Signal state 0 | |

| DB1072.DBW(n+14) | Multitool location number (old tool) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location number within the multitool (where the old tool is located).<br>The location number - where the old tool is located - is entered here if the preparation or the change to a tool is realized within the same multitool (which, due to a previous change, is located on the toolholder). |
| Signal state 0 | |

| DB1072.DBW(n+16) | New tool: Location type |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location type of the new tool (of the programmed tool in the multitool). |
| Corresponding to ... | Tool size: Left, right, top, bottom |

| DB1072.DBW(n+18) | New tool: Size left |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size to the left in half locations of the new tool (of the programmed tool in the multitool) |
| Signal state 0 | |

| DB1072.DBW(n+20) | New tool: Size right |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size to the right in half locations of the new tool (of the programmed tool in the multitool) |
| Signal state 0 | |

| DB1072.DBW(n+22) | New tool: Size top |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size to the top in half locations of the new tool (of the programmed tool in the multitool) |
| Signal state 0 | |

| DB1072.DBW(n+24) | New tool: Size bottom |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size to the bottom in half locations of the new tool (of the programmed tool in the multitool) |
| Signal state 0 | |

| DB1072.DBW(n+26) | Tool status for new tool: |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Tool status of the programmed tool in the multitool<br>Corresponds to parameter $TC_TP8[T_No]<br>Bit 0: = active tool<br>Bit 1: Enable tool<br>Bit 2: Tool locked<br>Bit 3: Measure tool<br>Bit 4: Prewarning limit reached<br>Bit 5: Tool is being changed<br>Bit 6: Tool is fixed-location-coded<br>Bit 7: Tool was in use<br>Bit 8: Tool in the buffer<br>Bit 9: Ignore locked<br>Bit 10: To be unloaded<br>Bit 11: To be loaded<br>Bit 12: Master tool<br>Bit 13: Reserved<br>Bit 14: 1:1 exchange<br>Bit 15: Manual tool |
| Signal state 0 | |

| DB1072.DBW(n+28) | New tool: Internal T number of NCK |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Display of internal T number of NCK for the new spindle tool (of the programmed tool in the multitool) |
| Signal state 0 | |

| DB1072.DBW(n+30) | Toolholder |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Spindle or toolholder number to which the change refers (the multitool that is to be changed) |
| Signal state 0 | |

| **DB1072.DBW(n+32)** | **Original magazine of new tool** |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Owner magazine of the new tool<br>Corresponds to NCK variables $A_MYMN[T-No]<br>If the new tool is located in the magazine, then this value is identical with DB72.DBW(n+20).<br>If the new tool is in the buffer (e.g. gripper), then the magazine No. is entered here from where the tool originally came.<br>The new tool has the same owner location as the multitool onto which it is loaded. |
| Signal state 0 | |

| **DB1072.DBW(n+34)** | **Original location of new tool** |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Owner location of the new tool<br>Corresponds to NCK variable $A_MYMLNT[T-No]<br>If the new tool is located in the magazine, then this value is identical with DB72.DBW(n+20).<br>If the new tool is in the buffer (e.g. gripper), then the magazine No. is entered here from where the tool originally came.<br>The new tool has the same owner location as the multitool onto which it is loaded. |
| Signal state 0 | |

# 7.7 Interface for revolver (multitool) (DB 1073)

| **DB 1073 Data block** | **Revolver (multitool) Interface NCK -> PLC** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
| DBW n+0 | Distance coding | | | | | | | |
| DBW n+2 | Multitool location number | | | | | | | |
| DBD n+4 | Multitool distance | | | | | | | |
| DBW n+8 | Multitool number (new tool) | | | | | | | |
| DBW n+10 | Multitool location number (new tool) | | | | | | | |
| DBW n+12 | Multitool number (old tool) | | | | | | | |
| DBW n+14 | Multitool location number (old tool) | | | | | | | |
| DBW n+16 | Location type | | | | | | | |
| DBW n+18 | Tool size, left | | | | | | | |
| DBW n+20 | Tool size, right | | | | | | | |
| DBW n+22 | Tool size, top | | | | | | | |
| DBW n+24 | Tools size, bottom | | | | | | | |
| DBW n+26 | Tool status | | | | | | | |
| DBW n+28 | T number of the tool | | | | | | | |
| DBW n+30 | Toolholder | | | | | | | |
| DBW n+32 | Original magazine of new tool | | | | | | | |
| DBW n+34 | Original location of new tool | | | | | | | |
| DBW n+36 to DBW n+48 | Reserved | | | | | | | |

Initial addresses of the revolver:
Spindle 1: n = 0
Spindle 2: n = 50
Spindle 3: n = 100

| **DB1073.DBW(n+0)** | **Distance coding** |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Type of distance coding of the multitool (corresponds to $TC_MTP_KD<br>1 = location number<br>2 = distance<br>3 = angle |
| Signal state 0 | |

| DB1073.DBW(n+2) | Multitool location number |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Number of locations of the multitool |
| Signal state 0 | |

| DB1073.DBD(n+4) | Multitool location distance |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Distance of the MT location to be positioned from the reference location (real value). In accordance with the distance coding |
| Signal state 0 | |

| DB1073.DBW(n+8) | Multitool number (new tool) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Internal T number of the (new) multitool |
| Signal state 0 | |

| DB1073.DBW(n+10) | Multitool location number (new tool) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location number within the multitool (where the new tool is located |
| Signal state 0 | |

| DB1073.DBW(n+12) | Multitool number (old tool) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Internal T number of the (old) multitool.<br>The T number is entered here if the preparation or the change to a tool is realized within the same multitool (which, due to a previous change, is located on the toolholder). It is identical with DB 1072.DBW(n+8) |
| Signal state 0 | |

| DB1073.DBW(n+14) | Multitool location number (old tool) |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location number within the multitool (where the old tool is located).<br>The location number - where the old tool is located - is entered here if the preparation or the change to a tool is realized within the same multitool (which, due to a previous change, is located on the toolholder). |
| Signal state 0 | |

| DB1073.DBW(n+16) | New tool: Location type |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Location type of the new tool (of the programmed tool in the multitool). |
| Corresponding to ... | Tool size: Left, right, top, bottom |

| DB1073.DBW(n+18) | New tool: Size left |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size to the left in half locations of the new tool (of the programmed tool in the multitool) |
| Signal state 0 | |

| DB1073.DBW(n+20) | New tool: Size right |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size to the right in half locations of the new tool (of the programmed tool in the multitool) |
| Signal state 0 | |

| DB1073.DBW(n+22) | New tool: Size top |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size to the top in half locations of the new tool (of the programmed tool in the multitool) |
| Signal state 0 | |

| DB1073.DBW(n+24) | New tool: Size bottom |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Specification of the tool size to the bottom in half locations of the new tool (of the programmed tool in the multitool) |
| Signal state 0 | |

| DB1073.DBW(n+26) | Tool status for new tool: |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Tool status of the programmed tool in the multitool<br>Corresponds to parameter $TC_TP8[T_No]<br>Bit 0: = active tool<br>Bit 1: Enable tool<br>Bit 2: Tool locked<br>Bit 3: Measure tool<br>Bit 4: Prewarning limit reached<br>Bit 5: Tool is being changed<br>Bit 6: Tool is fixed-location-coded<br>Bit 7: Tool was in use<br>Bit 8: Tool in the buffer<br>Bit 9: Ignore locked<br>Bit 10: To be unloaded<br>Bit 11: To be loaded<br>Bit 12: Master tool<br>Bit 13: Reserved<br>Bit 14: 1:1 exchange<br>Bit 15: Manual tool |
| Signal state 0 | |

| DB1073.DBW(n+28) | New tool: Internal T number of NCK |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Display of internal T number of NCK for the new spindle tool (of the programmed tool in the multitool) |
| Signal state 0 | |

| DB1073.DBW(n+30) | Toolholder |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Spindle or toolholder number to which the change refers (the multitool that is to be changed) |
| Signal state 0 | |

| **DB1073.DBW(n+32)** | **Original magazine of new tool** |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Owner magazine of the new tool<br>Corresponds to NCK variables $A_MYMN[T-No]<br>If the new tool is located in the magazine, then this value is identical with DB72.DBW(n+20).<br>If the new tool is in the buffer (e.g. gripper), then the magazine No. is entered here from where the tool originally came.<br>The new tool has the same owner location as the multitool onto which it is loaded. |
| Signal state 0 | |

| **DB1073.DBW(n+34)** | **Original location of new tool** |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | Owner location of the new tool<br>Corresponds to NCK variable $A_MYMLNT[T-No]<br>If the new tool is located in the magazine, then this value is identical with DB72.DBW(n+20).<br>If the new tool is in the buffer (e.g. gripper), then the magazine No. is entered here from where the tool originally came.<br>The new tool has the same owner location as the multitool onto which it is loaded. |
| Signal state 0 | |

# 7.8 Interface NC channels

Signals are also contained in the channel data blocks for tool management functions. The data relevant for tool management is in bold formatting.

| **DB 21-30 Data block** | **Signals to/from NC channel Interface PLC -> NCK** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Byte | Bit7 | Bit6 | Bit5 | Bit4 | Bit3 | Bit2 | Bit1 | Bit0 |
| DBB 1 | Activate program test | PLC action completed | CLC override | CLC stop | **Time monitoring active** | Synchronous action off | Enable protective area | Activate referencing |
| DBB 29 | **Tool block not effective** | **Deactivate wear monitoring** | **Deactivate workpiece counter** | Activate PTP traversal | Activate fixed feed 4 | Activate fixed feed 3 | Activate fixed feed 2 | Activate fixed feed 1 |
| Cyclic signals from NC channel | | | | | | | | |
| DBB 317 | **Tool missing** | PTP traversal active | | | | | | External language mode active |
| Change signals TM functions | | | | | | | | |
| DBB 344 | | | | | **Last replace-ment tool of the tool group** | **Transition to new replace-ment tool** | **Tool prewarning limit reached** | **Tool prewarning limit reached** |
| Transferred tool management functions | | | | | | | | |
| DBB 348 | **T number for tool management prewarning limit (DInt)** | | | | | | | |
| DBB 352 | **T number for tool limit value (DInt)** | | | | | | | |
| DBB 356 | **T number of new replacement tool (DInt)** | | | | | | | |
| DBD 360 | **T number of last replacement tool (DInt)** | | | | | | | |

| | |
|---|---|
| DB21.DBX1.3 | The user can start and stop tool life monitoring time using PLC signal "Time monitor active". The effectiveness of this control is set via MD 20310: TOOL_MANAGEMENT_MASK, bit 17. |

| | |
|---|---|
| DB21.DBX29.5 | Switches workpiece count monitoring on/off. |

| | |
|---|---|
| DB21.DBX29.6 | Switches wear monitoring on/off. |

| | |
|---|---|
| DB21.DBX29.7 | VDI signal "Tool disable ineffective" (bit value=1) means that the NCK does not process the tool status "Disabled" during tool search.<br>The signal is not effective, if the tool selection is realized using the Init blocks (Reset- and Start_Mode_Mask). If, for instance, it is to be possible to select a disabled spindle tool, then this must be set in machine data $MC_TOOL_CHANGE_ERROR_MODE. |

| | |
|---|---|
| DB21.DBX317.7 | Display in PLC that the programmed tool is missing. (Tool is either not available or cannot be used.) |

| **DB21.DBX 344.0 - 344.3** | **Modification signals of the tool management functions** |
|---|---|
| Edge evaluation | Signal(s) updated: Conditional |
| Meaning | A T number for tool prewarning limit, limit value, new replacement tool, last replacement tool has been output with a value at the interface at the beginning of an OB1 cycle together with the associated modification signal. In this case, the change signal indicates that the appropriate value is valid. |

# 7.9 Interface magazine configuration

| DB4 | Interface HMI -> PLC | |
|---|---|---|
| **Address** | **Meaning** | **Data type** |
| DBB 64 | Number of magazines including buffer magazines and loading magazines | BYTE |
| < | Beginning of repeat loop; number of repeats from DB4.DBB64 | |
| DBW65 (70, 75, ...) | Magazine number | INT |
| DBB67 (...) | Magazine type | BYTE |
| DBW68 (...) | Number of locations | INT |
| > | Return loop end | |
| Address = (contents DBB64*5) +65 | Number of spindles | BYTE |

# Alarms

# 8

## 8.1 Overview

| Alarm No. | Brief description |
|---|---|
| 6402 | Tool change not possible, magazine number does not exist. |
| 6403 | Tool change not possible, specified magazine location does not exist. |
| 6404 | Tool change not possible because the tool is not available or cannot be used. |
| 6405 | Command has invalid PLC acknowledgement parameter. |
| 6406 | PLC acknowledgement missing. |
| 6407 | Tool is to be set down at a location that does not meet the requirements for loading. |
| 6410 | One cutting edge of the monitored tool has reached a prewarning limit. |
| 6411 | One cutting edge of the monitored tool has reached a prewarning limit. |
| 6412 | One cutting edge of the monitored tool has reached a monitoring limit. |
| 6413 | One cutting edge of the monitored tool has reached a monitoring limit. |
| 6421 | No free location for tool in the magazine. |
| 6422 | Tool motion is not possible because the magazine has not been defined. |
| 6423 | Tool motion is not possible because no location in the magazine. |
| 6424 | Tool motion is not possible because tool not available or cannot be used. |
| 6425 | Tool motion is not possible because tool cannot be placed at the specified location in the magazine |
| 6430 | Workpiece counter: Overflow in table of monitored cutting edges. |
| 6431 | Function not permitted because TOOLMAN / TOOLMAN monitoring not activated. |
| 6432 | Function cannot be executed because there is no tool in the spindle. |
| 6433 | System variable not available for active tool management. |
| 6436 | The command cannot be programmed |
| 6438 | Inconsistent data change not permitted |
| 6441 | Writing of $P_USEKT not allowed. |
| 6450 | Tool change not possible because magazine-location number is not valid. |
| 6451 | No buffer magazine defined. |
| 6452 | Toolholder number / spindle number not defined. |
| 6453 | No relationship defined between toolholder number / spindle number and buffer magazine. |
| 6454 | Neither spindle nor buffer location has a distance relationship. |
| 6460 | Command can only be programmed for tools |
| 6462 | Command can only be programmed for magazines |
| 6464 | Command cannot be programmed for the actual multitool distance coding |
| 6924 | Tool data changed for program test. |
| 17001 | No more memory for tool magazine data. |
| 17020 | Illegal array index 1 |
| 17160 | No tool selected. |

| Alarm No. | Brief description |
|---|---|
| 17180 | Illegal D number. |
| 17181 | D No. not known. |
| 17182 | Illegal additive offset number. |
| 17188 | The D number specified in the channel TO unit is not unique. |
| 17189 | D number is not unique. |
| 17191 | Unknown tool identifier. |
| 17192 | No further replacement tools possible. |
| 17193 | The active tool is no longer in the toolholder |
| 17194 | No suitable tool found. |
| 17200 | Tool cannot be deleted |
| 17202 | Magazine data cannot be deleted. |
| 17212 | Manual tool must be changed. |
| 17214 | Remove manual tool from toolholder. |
| 17215 | Remove manual tool from buffer |
| 17216 | Manual tools must be changed. |
| 17218 | Tool cannot become a manual tool |
| 17220 | Tool does not exist. |
| 17224 | It is not possible on this system to select tool offsets for tools of the specified tool type. |
| 17230 | Duplo No. already assigned. |
| 17240 | Invalid tool definition. |
| 17242 | Manual tool cannot be set, as the function is not active |
| 17250 | Invalid magazine definition. |
| 17260 | Invalid magazine location definition. |
| 17262 | Incorrect tool-adapter assignment |
| 20150 | PLC terminates the interrupted command. |
| 20160 | PLC can terminate only incorrectly aborted commands. |
| 22066 | Tool motion not possible because specified tool is not in magazine. |
| 22067 | Tool change not possible because no tool ready for use in the tool group. |
| 22068 | No tool ready for use in the tool group. |
| 22069 | No tool ready for use in the tool group. |
| 22070 | Change tool into magazine. Repeat data backup. |
| 22071 | Tool has the status "active" in an "inactive" wear group. |
| 400601 | Incorrect configuration of loading points |
| 400602 | Incorrect spindle configuration |
| 400603 | Incorrect turret configuration |
| 400604 | Set change with M06 in machine data. |
| 410141 | Number of loading points too high |
| 410142 | Number of toolholders too high |
| 410143 | Number of turrets too high |
| 410151 | Magazine data for tool management missing in PLC. |

With machine dates MD11410 SUPPRESS_ALARM_MASK und MD11415 SUPPRESS_ALARM_MASK_2 it can be defined bit by bit which alarms should be suppressed.

| Bit | Alarm number |
|---|---|
| 2 | 16924 |
| 4 | 17189 |
| 5 | 22071 |
| 7 | 22070 |
| 8 | 6411, 6413 |
| 9 | 6410, 6412 |

## 8.2 Alarm description

| Alarm No. | |
|---|---|
| 6402 | Channel %1 Tool change not possible. Magazine no. %2 not available |
| Explanation | %1 = channel ID, %2 = magazine number<br>The desired tool change is not possible. The magazine with the specified number is not available. |
| Reaction | Alarm display.<br>Interface signals are set<br>NC start disable<br>NC stop for alarm |
| Remedy | Check whether the magazine data have been correctly defined.<br>Check whether the magazine is linked with the requested spindle through a distance relationship.<br>The user PLC program may have supplied incorrect data to the NCK. |
| Continue program | Cancel the alarm with the RESET button and start the part program again. |

| Alarm No. | |
|---|---|
| 6403 | Channel %1 Tool change not possible. Magazine no. %2 in magazine %3 not available |
| Explanation | %1 = channel ID %2 = magazine number, %3 = magazine location number<br>The desired tool change is not possible. The specified magazine location is not available in the specified magazine. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable<br>NC stop for alarm |
| Remedy | Check whether the magazine data have been correctly defined.<br>The user PLC program may have supplied incorrect data to the NCK. |
| Continue program | Cancel the alarm with the RESET button and start the part program again. |

| Alarm No. | |
|---|---|
| 6404 | Channel %1 tool change not possible. Tool %2 not available or cannot be used |
| Explanation | %1 = channel ID, %2 = string (identifier)<br>The desired tool change is not possible. The specified tool does not exist or cannot be used. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable<br>NC stop for alarm |
| Remedy | Check whether the part program has been correctly written<br>Check whether the tool data have been correctly defined<br>Check whether there is a replacement tool that can replace the specified tool. |
| Continue program | Cancel the alarm with the RESET button and start the part program again. |

| Alarm No. | |
|---|---|
| 6405 | Channel %1 command %2 has an invalid PLC acknowledgement parameter %3 identification %4 |
| Explanation | %1 = channel ID, %2 = command no. %3 = PLC acknowledgement parameter, %4 = error identification<br>The specified command has been answered by the PLC with an invalid acknowledgement in the actual combination. The following assignments are defined for a command number:<br>1 move tool, load or unload magazine<br>2 prepare for tool change<br>3 carry out tool change<br>4 prepare for tool change and execute with T command<br>5 prepare for tool change and execute with M command<br>7 complete interrupted tool command<br>8 check tool movement with reservation<br>9 check tool movement<br>0 transport acknowledgment<br>Parameters 2 and 3 designate the PLC command and the status number of the acknowledgment.<br>Example:<br>Parameter 4 of the alarm message is =10. It is not defined, for asynchronous tool motion, to reserve a buffer location. In the example, the NCK ignores the parameter. Additional possible reasons for the alarm: The tool change defined by the command cannot be executed. The magazine location specified in the invalid parameter does not exist in the magazine.<br>The fault identifier (%4) gives a more detailed description of the alarm:<br>0 not defined<br>1 status not permitted now, or non-defined status received from the PLC<br>2 source and/or target magazine number/location number not known<br>3 not defined<br>4 target magazine number and/or target location number for tool move command not the final target<br>5 not defined<br>6 source and/or target magazine number/location number for tool change not known<br>7 PLC command with inconsistent data: either magazine addresses in the VDI inconsistent or NCK command not equal to PLC acknowledgement, or both<br>8 PLC command with inconsistent data: When lifting a tool, asynchronous tool to be rejected was unloaded. NCK cannot execute a new selection.<br>9 PLC command with inconsistent data: The command acknowledgements want to bring a tool to a location where another tool is already located.<br>10 The asynchronous tool motion with reservation is only defined for movement from a magazine to a buffer. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable<br>NC stop for alarm |
| Remedy | Notify authorized personnel / service<br>PLC communication error: Correct the PLC program |
| Continue program | Cancel the alarm with the RESET button and start the part program again. |

| Alarm No. | |
|---|---|
| 6406 | Channel %1 PLC acknowledge for command %2 is missing |
| Explanation | %1 = channel ID, %2 = command No.<br>There is still no acknowledgement from the PLC for the tool change. The NCK cannot continue processing until it receives this acknowledgement for the specified command number. Possible command No. values are described under alarm 6405 |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Notify authorized personnel / service<br>PLC communication error: Correct PLC program.<br>It is possible to release NCK from the wait condition with the PLC command 7. This aborts the waiting command. |
| Continue program | Cancel the alarm with the RESET button and start the part program again. |

| Alarm No. | |
|---|---|
| 6407 | Channel %1 The tool %2 cannot be placed in magazine %3 on location %4. Invalid magazine definition! |
| Explanation | %1 = channel ID, %2 = string (identifier), %3 = magazine number, %4 = magazine location number<br>Using a tool change job or a check job, the tool should be placed at a location, whose definition does not fulfill the preconditions for loading.<br>Following error causes:<br>Location is locked or is not free<br>Tool type does not match the location type<br>Tool is possibly too large, adjacent locations are occupied |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable<br>NC stop for alarm |
| Remedy | Check as to whether the magazine data have been correctly defined (especially the location type)<br>Check as to whether the tool data have been correctly defined (especially the location type) |
| Continue program | Cancel the alarm with the RESET button and start the part program again. |

| Alarm No. | |
|---|---|
| 6410 | TO unit %1 tool %2 with duplo No. %3 has reached tool prewarning limit with D=%4 |
| Explanation | %1 = TO unit, %2 = tool identifier (name), %3 = duplo number, %4 = D number<br>Indicates that the specified D offset of the time, workpiece quantity or wear-monitored tool has reached its prewarning limit. If possible, specify the D number - if not, then the 4th parameter is assigned the value 0.<br>If the "additive offset" function is being used, then instead of the wear monitoring, an additive offset monitoring can also be active. The specific type of tool monitoring is a property of the tool (see $TC_TP9). The duplo No. specification has no additional significance if replacement tools are not being used. The alarm is triggered via the OPI interface (HMI, PLC). The channel context is not defined. The TO unit is therefore specified (see $MC_MM_LINK_TOA_UNIT). |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | For information only. The user must decide what to do. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6411 | Channel %1 Tool %2 Prewarning limit reached with D=%4 |
| Explanation | %1 = channel number, %2 = tool identifier (Name), %4 = D number<br>Indicates that the specified D offset of the time, workpiece quantity or wear-monitored tool has reached its prewarning limit. If possible, specify the D number - if not, then the 4th parameter is assigned the value 0.<br>If the "additive offset" function is being used, then instead of the wear monitoring, an additive offset monitoring can also be active. The specific type of tool monitoring is a property of the tool (see $TC_TP9). Specifying the duplo number has no additional significance here if replacement tools are not being used.<br>Limit is identified in the channel context.<br>The alarm is caused when executing the NC program. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | For information only. The user must decide what to do. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6412 | TO unit %1 tool %2 with duplo No.%3 has reached tool monitoring limit with D=%4 |
| Explanation | %1 = TO unit, %2 = tool identifier (name), %3 = duplo number, %4 = D number<br>Indicates that the specified D offset of the time, workpiece quantity or wear-monitored tool has reached its prewarning limit. If possible, specify the D number - if not, then the 4th parameter is assigned the value 0.<br>If the "additive offset" function is being used, then instead of the wear monitoring, an additive offset monitoring can also be active. The specific type of tool monitoring is a property of the tool (see $TC_TP9). The duplo No. specification has no additional significance if replacement tools are not being used. The alarm is triggered via the OPI interface (HMI, PLC). The channel context is not defined. The TO unit is therefore specified (see $MC_MM_LINK_TOA_UNIT). |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | For information only. The user must decide what to do. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6413 | Channel %1 Tool %2 has reached its monitoring limit with D=%4 |
| Explanation | %1 = channel number, %2 = tool identifier (Name), %4 = D number<br>Indicates that the specified D offset of the time, workpiece quantity or wear-monitored tool has reached its prewarning limit. If possible, specify the D number - if not, then the 4th parameter is assigned the value 0.<br>If the "additive offset" function is being used, then instead of the wear monitoring, an additive offset monitoring can also be active. The specific type of tool monitoring is a property of the tool (see $TC_TP9). The duplo No. specification has no additional significance if replacement tools are not being used. The alarm originates during NC program execution. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | For information only. The user must decide what to do. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6421 | Channel %1 tool motion not possible. There is no empty location for tool %2 duplo No. %3 in magazine %4 available |
| Explanation | %1 = channel ID, %2 = string (identifier), %3 = duplo number, %4 = magazine number<br>The requested tool motion command - initiated from the HMI or PLC - is not possible.<br>The tool cannot be moved in the specified tool magazine. There is no appropriate location available for this tool. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Check whether the magazine data have been correctly defined (e.g. it is not permissible that the magazine is locked).<br>Check whether the tool data have been correctly defined (e.g. the tool location type must match the permitted location types in the magazine).<br>Check whether, as a result of operating sequences, the magazine simply has no additional location to accommodate an additional tool.<br>Check whether a location type hierarchy has been defined - and whether this for example prohibits that a type "A" tool is placed in a free type "B" location. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6422 | Channel %1 tool motion not possible because magazine No. %2 not available! |
| Explanation | %1 = channel ID, %2 = magazine number<br>The requested tool motion command - initiated from the HMI or PLC - is not possible.<br>The magazine with the specified number is not available. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Check whether the magazine data is correctly defined.<br>If the PLC issued the command for motion: check whether the PLC program is correct.<br>If the HMI issued the command for motion: check whether the HMI command was assigned correct parameters. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6423 | Channel %1 tool motion not possible because magazine location No. %2 in magazine %3 not available! |
| Explanation | %1 = channel ID, %2 = magazine location number, %3 = magazine number<br>The requested tool motion command - initiated from the HMI or PLC - is not possible.<br>The specified magazine location is not contained in the specified magazine. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Check whether the magazine data is correctly defined. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6424 | Channel %1 tool motion not possible. Tool %2 not available or cannot be used |
| Explanation | %1 = channel ID, %2 = string (identifier)<br>The requested tool motion command - initiated from the HMI or PLC - is not possible. The state of the specified tool does not permit the tool to be moved. The specified tool is not defined or is not permitted for the command. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Check whether the tool state "being changed" is set. If yes, then initially the corresponding tool change command from the PLC must be terminated. The tool should then be able to be subsequently moved.<br>Check whether the tool data have been correctly defined.<br>Check whether the motion command was correctly parameterized.<br>Check whether the tool has already been loaded (if the alarm occurs when loading the tool). |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6425 | Channel %1 The tool %2 cannot be placed in magazine %3 on location %4. Invalid magazine definition |
| Explanation | %1 = channel ID, %2 = string (identifier), %3 = magazine number, %4 = magazine location number<br>The requested tool motion command - initiated from the HMI or PLC - is not possible.<br>Using a movement job, the tool is to be placed down at a location whose definition does not fulfill the preconditions for loading a tool. Following error causes:<br>Location is locked or is not free<br>Tool type does not match the location type.<br>Tool is possibly too large, adjacent locations all occupied.<br>If a tool is being loaded/unloaded<br>- the loading/unloading location must be a "loading point" type.<br>If a tool is being loaded/unloaded<br>- is the magazine involved linked with the loading/unloading location?<br>See $TC_MDP1, $TC_MDP2 |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Check whether the magazine data have been correctly defined.<br>Check whether, as a result of operating sequences, the magazine simply has no additional location to accommodate an additional tool.<br>Check whether a location type hierarchy has been defined - and whether this for example prohibits that a type "A" tool is placed in a free type "B" location.<br>Check whether the magazine involved is linked with the loading/unloading location - or has a defined distance.<br>Check whether the loading/unloading location is a "loading position" type.<br>See also $TC_MPP1 |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6430 | Workpiece counter: Overflow in table of monitored cutting edges |
| Explanation | No more cutting edges can be entered in the workpiece counter table. Only as many cutting edges can be noted for the workpiece counter as the total number of cutting edges that are possible in the NCK. This means that if from each tool, each cutting edge is precisely used for a workpiece, then the limit is reached.<br>If several workpieces are simultaneously machined at several toolholders/spindles, then across all workpieces 18100 MM_NUM_CUTTING_EDGES_IN_TOA cutting edges can be noted for the workpiece counter.<br>If the alarm is present, this means that the cutting edges that are used from now on are no longer monitored regarding the number of workpieces; and more precisely, until the table is emptied again, e.g. using the NC language command SETPIECE or the appropriate job from the HMI, PLC (PI service). |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Forgotten to decrement the workpiece counter?<br>Then program SETPIECE in the part program - or correctly incorporate the command for this purpose in the PLC program.<br>If the part program or the PLC program is correct, then additional memory space should be set for tool cutting edges using machine data $MM_NUM_CUTTING_EDGES_IN_TOA (only possible for those with the appropriate access authorization). |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6431 | Function not allowed. Tool management/tool management monitoring not activated |
| Explanation | Occurs when a data management function is called which is not available because tool management is deactivated or tool monitoring is not available. For example, the language commands GETT, SETPIECE, GETSELT, NEWT, DELT. |
| Reaction | Alarm display<br>Interface signals are set<br>Interpreter stop<br>NC start disable |
| Remedy | Please notify the authorized personnel / service.<br>Verify how the NC control shall be configured. Are tool management or tool monitoring necessary, but not activated?<br>Is a part program used that is designed for NC control with tool management/tool monitoring?<br>Either run the part program on the appropriate NC control or modify the part program.<br>Activate tool management/tool monitoring by setting the appropriate machine data. See $MN_MM_TOOL_MANAGEMENT_MASK, $MC_TOOL_MANAGEMENT_MASK.<br>Check whether the option necessary is set for this. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6432 | Function cannot be executed. There is no tool on the spindle |
| Explanation | An attempt was made to perform an operation that requires a tool to be located on the spindle. This can be the workpiece count monitoring function, for example. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Select another function, select another toolholder/spindle or locate a tool on the toolholder/spindle. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6433 | Channel %1 block %2 variable %3 not available with tool management |
| Explanation | %1 = channel number, %2 = block number, Label, %3 = source symbol<br>The system variable specified in %3 is not available with active tool management.<br>The function GETSELT should be used with $P_TOOLP. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Change program |
| Continue program | Clear the alarm with the delete key. |

| Alarm No. | |
|---|---|
| 6436 | Channel %1 block %2 command %3 cannot be programmed. Function %4 is not activated. |
| Explanation | %1 = channel number, %2 = block number, %3 = command, %4 = function<br>The command cannot be programmed due to a missing function enable or activation. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Correct the NC program |
| Continue program | |

| **Alarm No.** | |
|---|---|
| 6438 | Channel %1 block %2 inconsistent data modification is not permitted |
| Explanation | %1 = channel number, %2 = block number<br>For example, in a defined multitool, after creating the multitool location it is not permissible to change the distance coding $TC_MTP_KD. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Correct the NC program |
| Continue program | |

| **Alarm No.** | |
|---|---|
| 6441 | Writing of $P_USEKT not allowed. |
| Explanation | An attempt was made to write the value from $P_USEKT. This is not possible because the programming T="location number" with automatic setting of $P_USEKT is active. |
| Reaction | Alarm display<br>Interface signals are set<br>Interpreter stop<br>NC start disable in the channel |
| Remedy | Verify how the NC control should be configured (bit 16 and bit 22 in $MC_TOOL_MANAGEMENT_MASK).<br>Is a part program used that is designed for an NC control without T="location number" with automatic setting of $P_USEKT? It is not possible to start this program on the NC control with T="location number" with automatic setting of $P_USEKT.<br>Either run the part program on the appropriate NC control or modify the part program. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6442 | Channel %1 function cannot be executed. No tool at the required magazine/location %2 |
| Explanation | %1 = channel number, %2 magazine/location<br>It is probable that the PLC logic is incorrect. Tool change with reject tool is configured. Preparation command present. Selected tool is unloaded from its location (e.g. from the PLC). PLC acknowledges preparation command with "repeat tool selection" (e.g. status=7). NCK does not find the tool in the magazine location specified in the PLC command.<br>Or: Illegal operator intervention in a tool selection that is presently being executed (unloading the tool to be selected) has taken place. This is the reason that the PLC acknowledgement was unsuccessful. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | PLC programmers must observe the following:<br>Ensure that the tool is not removed from the specified magazine location (e.g. incorrect PLC program). The programmed tool change should not remove the tool before the final acknowledgment of a command= (unload).<br>However, it is possible to change the location of the tool to be loaded. The alarm supplements alarm 6405, if it contains the ID 8. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 6450 | Channel %1 tool change not possible. Invalid magazine location number %2 in the buffer magazine |
| Explanation | %1 = channel number, %2 magazine location number<br>The desired tool change is not possible. The specified magazine location is a toolholder/spindle - or is empty.<br>Using the language command TCI, only the buffer numbers may be programmed, which are not toolholder/spindle; i.e. the location number of a gripper is permitted. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Check whether the magazine data ($TC_MPP1) are correctly defined.<br>Check whether the program command causing the problem - e.g. TCI is correctly parameterized. |
| Continue program | |

| Alarm No. | |
|---|---|
| 6451 | Channel %1 tool change not possible. No buffer magazine defined. |
| Explanation | %1 Channel number<br>The desired tool change is not possible. No buffer has been defined. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Check whether the magazine data is correctly defined. |
| Continue program | |

| Alarm No. | |
|---|---|
| 6452 | Channel %1 block %2 tool change not possible. The toolholder No. / spindle No. = %3 is not defined. |
| Explanation | %1 = channel number, %2 toolholder No. / spindle No.<br>The desired tool change is not possible. The toolholder number / spindle number is not defined. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Check whether the toolholder No./spindle No. and magazine data are correctly defined. (See also the system variables $TC_MPP1, $TC_MPP5 of the buffer magazine). |
| Continue program | |

| Alarm No. | |
|---|---|
| 6453 | Channel %1 tool change not possible. No assignment between toolholder/spindle No. = %2 and buffer location %3 |
| Explanation | %1 = channel number, %2 toolholder No. / spindle No. %3 buffer location<br>The desired tool change is not possible. No relationship has been defined between the toolholder/spindle number and the buffer location LocNo. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Check whether the magazine data ($TC_MLSR) have been correctly defined.<br>Check whether the program command causing the problem (e.g. TCI) is correctly parameterized. |
| Continue program | |

| Alarm No. | |
|---|---|
| 6454 | Channel %1 tool change not possible. There is no distance relationship available. |
| Explanation | %1 Channel number<br>The desired tool change is not possible. Neither spindle nor buffer location has a distance relationship. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Check whether the magazine data ($TC_MDP2) are correctly defined.<br>Check whether the program command causing the problem (e.g. TCI) is correctly parameterized. |
| Continue program | |

| Alarm No. | |
|---|---|
| 6455 | Channel %1 block %2 tool change not possible. Magazine location No. %3 not available in magazine %4 |
| Explanation | %1 channel number %2 block number %3 magazine location number %4 magazine<br>The desired tool change is not possible. The specified magazine location is not available in the specified magazine. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Check whether the magazine data ($TC_MAP6 and $TC_MAP7 of the buffer magazine) are correctly defined.<br>Check whether the program command causing the problem (e.g. TCI) is correctly parameterized. |
| Continue program | |

| Alarm No. | |
|---|---|
| 6460 | Channel %1 block %2 command %3 can only be programmed for tools. %4 does not designate a tool |
| Explanation | %1 channel number %2 block number %3 command parameter<br>The specified command can only be programmed for tools. The command parameter is not a T number or not a tool name. If a multitool was programmed: The command cannot be programmed for multitools. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Correct the NC program |
| Continue program | |

| Alarm No. | |
|---|---|
| 6462 | Channel %1 block %2 command %3 can only be programmed for magazines. %4 does not designate a tool |
| Explanation | %1 channel number %2 block number %3 command parameter<br>The specified command can only be programmed for magazines. The command parameter is not a magazine number or not a magazine name. If a multitool was programmed: The command cannot be programmed for multitools. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Correct the NC program |
| Continue program | |

| **Alarm No.** | |
|---|---|
| 6464 | Channel %1 block %2 command %3 cannot be programmed for the actual multitool distance coding %4. |
| Explanation | %1 channel number %2 block number %3 command parameter<br>$TC_MTPPL can only be programmed, if $TC_MTP_KD has the value 2.<br>$TC_MTPPA can only be programmed, if $TC_MTP_KD has the value 3. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Correct the NC program |
| Continue program | |

| **Alarm No.** | |
|---|---|
| 6924 | Channel %1 caution: Program test changes tool management data |
| Explanation | %1 = channel number<br>Tool data is changed during program testing. The data cannot be automatically corrected after the end of the program test.<br>With this error message, the operator is prompted to make a data backup or after exiting, to download the data again. |
| Reaction | Alarm display |
| Remedy | Please notify authorized personnel / service.<br>Save tool data on HMI and reimport data after "ProgtestOff". |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 17001 | Channel %1 block %2 no more memory for tool / magazine data |
| Explanation | %1 = channel number, %2= block number, label<br>The number of following tools/magazine data sizes in the NC is specified by machine data:<br>- number of tools + number of grinding data blocks: MD18082 $MN_MM_NUM_TOOL<br>- number of cutting edges: MD18100 $MN_MM_NUM_CUTTING_EDGES_IN_TOA<br>Tools, grinding data blocks, cutting edges can be used independent of the tool management.<br>The memory for the following data is only available if the corresponding bit in MD18080 $MN_MM_TOOL_MANAGEMENT_MASK is set.<br>- number of monitoring data blocks: MD18100 $MN_MM_NUM_CUTTING_EDGES_IN_TOA<br>- number of magazines: MD18084 $MN_MM_NUM_MAGAZINE<br>- number of magazine locations: MD18086 $MN_MM_NUM_MAGAZINE_LOCATION<br>The following variable is determined by the software configuration: Number of magazine distance data sets: P2 permits 32 such spacing data blocks.<br>Definition:<br>- "grinding data blocks": Grinding data can be defined for a tool, types 400 to 499. Such a data record occupies additional memory, just as it is intended for a cutting edge.<br>- "monitoring data blocks": Each cutting edge of a tool can be supplemented by monitoring data.<br>- if the alarm occurs when writing to one of the $TC_MDP1/$TC_MDP2/$TC_MLSR parameters, then it must be checked whether machine data MD18077 $MN_MM_NUM_DIST_REL_PER_MAGLOC / MD18076 $MN_MM_NUM_LOCS_WITH_DISTANCE have been correctly set.<br>MD18077 $MN_MM_NUM_DIST_REL_PER_MAGLOC defines how many different index 1 data may be made for an index 2 value.<br>MD18076 $MN_MM_NUM_LOCS_WITH_DISTANCE defines how many different buffer locations can be specified in index 2.<br>If a multitool is to be created - or its locations - then the alarm indicates that either more multitools are to be created than is permitted in MD18083 $MN_MM_NUM_MULTITOOL - or if the alarm is generated when creating the multitool locations, then the alarm indicates that more multitool locations are to be created than permitted via MD18085 $MN_MM_NUM_MULTITOOL_LOCATIONS. |
| Reaction | Alarm display<br>Interface signals are set<br>Also reorganize correction block |
| Remedy | Please notify authorized personnel / service<br>Change machine data<br>Change NC program, i.e. reduce the number of variables that have been contested |
| Continue program | Clear the alarm with the RESET key. Restart the part program. |

| Alarm No. | |
|---|---|
| 17020 | Channel %1 block %2 illegal array index 1 |
| Explanation | %1 = channel number, %2= block number<br>General:<br>A read or write access was programmed to a field variable with invalid 1st field Index. The valid field indices must be within the defined field size and the absolute limits (0 - 32 766).<br>[DPA]: PROFIBUS I/Os:<br>[DPA]: When reading/writing data, an invalid slot/I/O range index was used.<br>[DPA]: Cause:<br>[DPA]: 1.: Slot/I/O range index >= max. available number of slots/I/O ranges.<br>[DPA]: 2.: Slot/I/O range index references a slot/I/O range that is not configured.<br>[DPA]: 3.: Slot/I/O range index references a slot/I/O range that is not released for system variables.<br>[DPA]: The following specifically applies: If the alarm occurs when writing from one of the parameters $TC_MDP1/$TC_MDP2/$TC_MLSR,<br>[DPA]: then it must be checked as to whether MD18077 $MN_MM_NUM_DIST_REL_PER_MAGLOC has been correctly set<br>[DPA]: MD18077 $MN_MM_NUM_DIST_REL_PER_MAGLOC defines how many different index1 data can be made for an index2 value<br>If an MT number is programmed, then the value can collide with an already defined T number or an already defined magazine number. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Correct the data relating to the field elements for the access instruction corresponding to the defined size. When using an SPL in Safety Integrated, additional restrictions can apply to the field index via the option data. |
| Continue program | |

| Alarm No. | |
|---|---|
| 17050 | Channel %1 block %2 impermissible value |
| Explanation | %1 = channel number, %2= block number<br>A value was programmed that exceeds the value range or a limit value of a variable or a machine data.<br>For example - in a string variable (e g GUD or LUD) a string is to be written that is longer than the string length declared in the variable definition.<br>- if an invalid value is to be written into a tool or magazine management variable (e.g. illegal cutting edge number in $TC_DPCE[x,y] or illegal magazine location in $TC_MDP2[x,y]).<br>- an illegal value is to be written to $P_USEKT or $A_DPB_OUT[x,y].<br>- an illegal value is to be written to a machine data (e.g. MD10010 $MN_ASSIGN_CHAN_TO_MODE_GROUP[0] = 0).<br>- when accessing an individual frame element, a frame element other than TRANS, ROT, SCALE or MIRROR was addressed - or the CSCALE function was allocated a negative scale factor.<br>A multitool number, which collides with an already defined T number or an already defined magazine number, was programmed.<br>When programming DELMLOWNER: the command cannot be programmed with the T number of a tool, which is loaded in a multitool. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Only address frame components with the keywords intended for the purpose; program a scale factor within the limits 0.000 01 to 999.999 99. |
| Continue program | Clear the alarm with the RESET key. Restart the part program. |

| Alarm No. | |
|---|---|
| 17160 | Channel %1 block %2 no tool selected |
| Explanation | %1 = channel number, %2= block number, label<br>An attempt has been made to access the actual tool offset data via the system variables:<br>$P_AD[n]: Contents of parameter (n: 1 - 25)<br>$P_TOOL: Active D number (cutting edge number)<br>$P_TOOLL[n]: Active tool length (n: 1 - 3)<br>$P_TOOLR: active tool radius,<br>although no tool was previously selected. |
| Reaction | Alarm display<br>Interface signals are set<br>Interpreter stop<br>NC start disable |
| Remedy | Program or activate a tool offset in the NC program before using the system variables.<br>Example:<br>N100 G.. ... T5 D1 ...LF<br>With the channel-specific machine data:<br>22550: TOOL_CHANGE_MODE<br>new tool offset for M function<br>22560: TOOL_CHANGE_M_MODE<br>M function for tool change<br>defines whether activating a tool offset in the block is carried out with the T word or whether the new offset values are only computed with the M word for the tool change. |
| Continue program | Clear the alarm with the RESET key. Restart the part program. |

| Alarm No. | |
|---|---|
| 17180 | Channel %1 block %2 illegal D number |
| Explanation | %1 = channel number %2 = block number, label<br>In the displayed block, access is made to a D number (tool edge number) that is not defined and therefore not available. |
| Reaction | Alarm display<br>Interface signals are set<br>Interpreter stop<br>NC start disable |
| Remedy | Check tool call in the NC part program:<br>Correct cutting edge number programmed? If a cutting edge number is not specified, then the D number D1, set using machine data $MC_CUTTING_EDGE_DEFAULT is automatically active.<br>Tool parameters defined (tool type, length, …)? The dimensions of the tool cutting edge must have first been entered into the NCK from the operator panel or via a tool data file.<br>Description of the system variables $TC_DPx[t,d] as they are contained in a tool data file, x …offset parameter number P, t … associated tool number T, d …tool offset number D |
| Continue program | Clear the alarm with the RESET key. Restart the part program. |

| Alarm No. | |
|---|---|
| 17181 | Channel %1 block %2 T No.= %3, D No.= %4 does not exist |
| Explanation | %1 = channel number, %2 = block number, label, %3 = T number, %4 = D number<br>A D number has been programmed that the NCK does not recognize. As standard, the D number refers to the given T number. If the "flat D number" function is active, T = 1 is output. |
| Reaction | Alarm display<br>Interface signals are set<br>Offset block with reorganization |
| Remedy | In case of a programming error, eliminate the error with a correction block and continue the program run. If the data record is missing, then load the NCK with a data record for the specified T/D values (via HMI, with overstore) and continue program. |
| Continue program | Cancel the alarm with NC START and continue processing. |

| Alarm No. | |
|---|---|
| 17182 | Channel %1 block %2 illegal additive offset number |
| Explanation | %1 = channel number, %2= block number, label<br>An attempt was made to access a non-defined additive offset of the current tool edge. |
| Reaction | Alarm display<br>Interface signals are set<br>Offset block with reorganization |
| Remedy | Access the additive offset memory with $TC_SCP, $TC_ECP, check the additive offset selection DLx or tool selection Ty or offset selection Dz. |
| Continue program | Cancel the alarm with NC START and continue processing. |

| Alarm No. | |
|---|---|
| 17188 | Channel %1 D number %2 defined in tool T No. %3 and %4 |
| Explanation | %1 = channel number, %2 = D number, %3 = T number for first tool, %4 = T number for second tool<br>The specified D number %2 in the TO unit of channel %1 is not unique. The specified T numbers %3 and %4 each have an offset with the number %2. In addition, if tool management is active: The specified T numbers belong to tool groups with different identifiers. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Ensure uniqueness of the D numbering within the TO units.<br>Do not use the command that caused the problem if uniqueness is not needed in the following - CHKDNO. |
| Continue program | The alarm is for information purposes. You can suppress the alarm output by setting bit 4 in MD $MN_SUPPRESS_ALARM_MASK. |

| Alarm No. | |
|---|---|
| 17189 | Channel %1 D number %2 of tools defined on magazine/location %3 and %4 |
| Explanation | %1 = channel ID, %2 = D number, %3 = magazine No./ magazine location No. – "/" as separator, %4 = magazine No./ magazine location No. – "/" as separator<br>The specified D number %2 in the TO unit of channel %1 is not unique. The tools in the specified magazine locations %3 and %4 each have an offset with the number %2. In addition, if tool management is active: The specified T numbers belong to tool groups with different identifiers. |
| Reaction | Alarm display<br>Set interface signals |
| Remedy | For example, renaming D numbers ensures the uniqueness of D numbering within the TO unit<br>Do not use the command if the uniqueness is not required.<br>The alarm is an information alarm. It can be suppressed by setting bit 4 of MD 11410 SUPPRESS_ALARM_MASK. |
| Continue program | The alarm is no longer displayed when the alarm cause has been removed. No further operator action required. |

| Alarm No. | |
|---|---|
| 17191 | Channel %1 block %2 T= %3, does not exist, program %4 |
| Explanation | A tool identifier which the NCK does not recognize was programmed. |
| Reaction | Alarm display<br>Interface signals are set<br>Offset block with reorganization |
| Remedy | If the program pointer that contains the specified T identifier is at an NC block:<br>If the program is incorrect, then resolve the error using a correction block and continue the program.<br>If the data record is missing, then create a data record. This means loading the data record of the tool with all of the defined D numbers into the NCK (via the HMI, with overstore) and then continue the program.<br>If the program pointer that does not contain the T identifier is at an NC block:<br>The error occurred early in the program when programming T; however, the alarm is only output with the change command.<br>If the program is incorrect, e.g. T5 is programmed instead of T55, then a correction block can be used to correct the actual block; i.e. if there is only M06, then the block can be corrected to become T55 M06.<br>The incorrect T5 line remains in the program until it is terminated by a RESET or end of program.<br>In complex program structures with indirect programming, it may not be possible to correct the program. Then only a local workaround is possible using an overstore block - in the example with T55.<br>Create a data record if the data record is missing, i.e. load the data record for the tool with all defined D numbers to the NCK (via HMI, with overstore), program T with overstore and then continue the program. |
| Continue program | Cancel the alarm with NC START and continue processing. |

| Alarm No. | |
|---|---|
| 17192 | TO unit %1 invalid tool name of %2, duplo No. %3. No further replacement tools in %4 possible |
| Explanation | %1 = TO units number, %2 = tool identifier, %3 = duplo number of the tool to be renamed, %4 = group identifier<br>The tool with the specified tool identifier, duplo number cannot accept the group identifier.<br>Reason:<br>The maximum number of permitted replacement tools has already been defined.<br>As a result of allocating a name to the tool, the tool is newly allocated or reallocated in a tool group, which already has the maximum number of replacement tools permitted for this particular machine. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Define fewer replacement tools.<br>Unload replacement tools that are no longer required and delete their data in the NCK.<br>Request other settings for the maximum number from the machine manufacturer. |
| Continue program | The alarm is no longer displayed when the alarm cause has been removed. No further operator action required. |

| Alarm No. | |
|---|---|
| 17193 | Channel %1 block %2 the active tool is no longer on toolholder/spindle No. %3, program %4 |
| Explanation | %1 = channel number, %2 = block number, label, %3 = toolholder No., spindle No., %4 = program name<br>The tool on the specified toolholder/spindle on which the last tool change as master toolholder or master spindle was carried out, has been changed out.<br>Example:<br>N10 SETHTH(1)<br>N20 T="T1" ;tool change to master toolholder 1<br>N30 SETMTH(2)<br>N40 T1="T2" ;toolholder1 is only adjacent toolholder.<br>;Changing out the tool did not result in the offset being deselected.<br>N50 D5 ;New offset selection. There is currently no active tool to which D can refer. |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | Change the program:<br>Set the required spindle as main spindle or toolholder as master toolholder.<br>Then reset a possible main spindle or master toolholder. |
| Continue program | Cancel the alarm with NC START and continue processing. |

| Alarm No. | |
|---|---|
| 17194 | Channel %1 block %2 no suitable tool found |
| Explanation | %1 = channel number, %2= block number, label<br>An attempt was made to access a tool that has not been defined<br>The specified tool does not permit any access<br>A tool with the required properties is not available |
| Reaction | Alarm display<br>Interface signals are set<br>Offset block with reorganization |
| Remedy | Check access to the tool:<br>Has the language command been correctly parameterized?<br>As a result of its state, is the tool not in a position to permit an access? |
| Continue program | Cancel the alarm with NC START and continue processing. |

| Alarm No. | |
|---|---|
| 17200 | Channel % 1 block % 2 tool data cannot be deleted |
| Explanation | %1 = channel number, %2= block number, label<br>An attempt has been made to delete the tool data for a tool currently being used for machining from the part program. Tool data for tools involved in the current machining operation may not be deleted. This applies both for the tool preselected with T or that has been changed in place of another, and also for tools for which the constant grinding wheel peripheral speed or tool monitoring is active. |
| Reaction | Alarm display<br>Interface signals are set<br>Offset block with reorganization |
| Remedy | Check access to tool offset memory by means of $TC_DP1[t,d] = 0 or deselect tool. |
| Continue program | Cancel the alarm with NC START and continue processing. |

| Alarm No. | |
|---|---|
| 17202 | Channel %1 block %2 magazine data cannot be deleted |
| Explanation | %1 = channel number, %2= block number, label<br>You have attempted to delete magazine data that presently cannot be deleted. It is not possible to delete a magazine that currently has the state "Tool is moving". A tool adapter currently assigned to a magazine location cannot be deleted. A tool adapter cannot be deleted if machine data $MN_MM_NUM_TOOL_ADAPTER has the value -1. |
| Reaction | Alarm display<br>Interface signals are set<br>Offset block with reorganization |
| Remedy | If an attempt to delete a magazine is not successful<br>$TC_MAP1[m]=0 ; delete magazine with m=magazine No.<br>$TC_MAP1[0]=0 ; delete all magazines<br>$TC_MAP6[m]=0 ; delete magazines and all of the tools that they contain,<br>then it must be ensured that at the call instant, the magazine does not have the state "tool is moving".<br>If an attempt to delete a tool adapter was unsuccessful<br>$TC_ADPTT[a]=-1 ; delete adapter with number a<br>$TC_ADPTT[0]=-1 ; delete all adapters,<br>then beforehand it must be first released from the magazine location or the magazine locations from the data perspective. |
| Continue program | Cancel the alarm with NC START and continue processing. |

| Alarm No. | |
|---|---|
| 17212 | Channel %1 tool management: Manual tool %3, Duplo no. %2 load to the spindle/toolholder %4 |
| Explanation | %1 = channel number, %2 = duplo number, %3 = tool identifier, %4 = spindle/toolholder number<br>Indicates that the specified manual tool must be brought to the specified toolholder or spindle before the program is continued. A manual tool is a tool whose data are registered in the NCK, but which is not assigned to a magazine location. As a result, it is not fully accessible for the purpose of automatic tool changes by the NCK and generally speaking, also the machine.<br>The specified manual tool can also be a tool in a multitool. Then, the MT should be loaded. |
| Reaction | Alarm display |
| Remedy | Ensure that the specified tool is placed on the toolholder. The alarm is automatically canceled once the tool change ON command has been acknowledged by the PLC. |
| Continue program | The alarm is no longer displayed when the alarm cause has been removed. No further operator action required. |

| Alarm No. | |
|---|---|
| 17214 | Channel %1 tool management: Remove manual tool %3 from spindle/toolholder %2. |
| Explanation | %1 = channel number, %2 = toolholder number %3 = tool identifier,<br>Indication that the specified manual tool must be removed from the specified toolholder or spindle before the program is continued. A manual tool is a tool whose data are registered in the NCK, but which is not assigned to a magazine location. As a result, it is not fully accessible for the purpose of automatic tool changes by the NCK and generally speaking, also the machine.<br>The specified manual tool can also be in a multitool. Then, the MT should be removed. |
| Reaction | Alarm display |
| Remedy | Ensure that the specified tool is removed from the toolholder. The alarm is automatically canceled once the tool change ON command has been acknowledged by the PLC. Manual tools can only be used efficiently if appropriately supported by the PLC program. |
| Continue program | The alarm is no longer displayed when the alarm cause has been removed. No further operator action required. |

| Alarm No. | |
|---|---|
| 17215 | Channel %1 tool management: Remove manual tool %3 from buffer %2. |
| Explanation | %1 = channel number, %2 = buffer location %3 = tool identifier,<br>Indication that the specified manual tool must be removed from the specified buffer before the program is continued. A manual tool is a tool whose data are registered in the NCK, but which is not assigned to a magazine location. As a result, it is not fully accessible for the purpose of automatic tool changes by the NCK and generally speaking, also the machine. |
| Reaction | Alarm display |
| Remedy | Ensure that the specified tool is removed from the toolholder. The alarm is automatically canceled once the tool change OFF command has been acknowledged by the PLC. Manual tools can only be used efficiently if appropriately supported by the PLC program. |
| Continue program | The alarm is no longer displayed when the alarm cause has been removed. No further operator action required. |

| Alarm No. | |
|---|---|
| 17216 | Channel %1 tool management: Remove manual tool from toolholder %4 and load manual tool %3, duplo No. %2. |
| Explanation | %1 = channel number, %2 = duplo number, %3 = tool identifier, %4 = toolholder (spindle) number<br>Indicates that the specified manual tool must be loaded in the specified toolholder or spindle before the program is continued and that the manual tool located there must be removed. A manual tool is a tool whose data are registered in the NCK, but which is not assigned to a magazine location. As a result, it is not fully accessible for the purpose of automatic tool changes by the NCK and generally speaking, also the machine. |
| Reaction | Alarm display |
| Remedy | Make sure that the manual tools are exchanged. The alarm is automatically canceled once the tool change ON command has been acknowledged by the PLC. Manual tools can only be used efficiently if appropriately supported by the PLC program. |
| Program continuation | The alarm is no longer displayed when the alarm cause has been removed. No further operator action required. |

| Alarm No. | |
|---|---|
| 17218 | Channel %1 block %2 tool number %3 cannot become a manual tool. |
| Explanation | %1 = channel number, %2 = block number, %3 = tool number<br>The specified tool has an owner location or there is a location in a real magazine reserved for this tool. As a consequence it cannot become a manual tool. |
| Reaction | Alarm display<br>Interface signals are set<br>Also reorganize correction block |
| Remedy | Correct the NC program<br>By programming "DELRMRES" ensure that there is no reference to a real magazine location |
| Program continuation | Clear the alarm with NC START or the RESET key and continue the program. |

| Alarm No. | |
|---|---|
| 17220 | Channel %1 block %2 tool does not exist |
| Explanation | %1 = channel number, %2= block number, label<br>If an attempt is made to access a tool using a T number, the tool name or the tool name and duplo No. that has not (yet) been defined, e.g. if tools are to be placed at magazine locations by programming $TC_MPP6 = "toolNo". This is possible only when both the magazine location and the tool specified by "toolNo" have been defined. |
| Reaction | Alarm display<br>Interface signals are set<br>NC start disable |
| Remedy | Correct the NC program |
| Continue program | |

| Alarm No. | |
|---|---|
| 17224 | Channel %1 block %2 tool T/D=%3 - tool type %4 is not permitted |
| Explanation | %1 = channel number, %2 = block number, label, %3 = contested T/D number, %4 = contested tool type<br>It is not possible on this system to select tool offsets for tools of the specified tool type. The multitude of tool types can be restricted by the machine manufacturer or by the individual control models.<br>Only use tool types permitted for this system. Check whether an error occurred when defining the tool. |
| Reaction | Alarm display<br>Interface signals are set<br>Interpreter stop<br>NC start disable |
| Remedy | Correct NC program or tool data |
| Continue program | Clear the alarm with NC START or the RESET key and continue the program. |

| Alarm No. | |
|---|---|
| 17230 | Channel %1 block %2 Duplo No. already assigned |
| Explanation | %1 = channel number, %2= block number, label<br>The attempt was made to write the duplo number of a tool using a duplo number that has already been assigned to another tool (different T number). |
| Reaction | Alarm display<br>Interface signals are set<br>Interpreter stop<br>NC start disable |
| Remedy | Correct the NC program |
| Continue program | Clear the alarm with NC START or the RESET key and continue the program. |

| Alarm No. | |
|---|---|
| 17240 | Channel %1 block %2 illegal tool definition |
| Explanation | %1 = channel number, %2= block number, label<br>An attempt was made to change tool data, which would subsequently destroy the data consistency or would result in a contradictory definition. |
| Reaction | Alarm display<br>Interface signals are set<br>Interpreter stop<br>NC start disable |
| Remedy | Correct the NC program |
| Continue program | Clear the alarm with NC START or the RESET key and continue the program. |

| Alarm No. | |
|---|---|
| 17242 | Channel %1 block %2 manual tool cannot be set as the function is not active |
| Explanation | %1 = channel number, %2= block number, label<br>The manual tool function is not active. The tool cannot accept the state "manual tool" ($TC_TP8[ToolNo], bit 15=1 or "H8000"). The "manual tool" function is activated using machine data $MC_TOOL_CHANGE_ERROR_MODE, bit 1. |
| Reaction | Alarm display<br>Interface signals are set<br>Also reorganize correction block |
| Remedy | Correct the NC program |
| Continue program | Clear the alarm with NC START or the RESET key and continue the program. |

| Alarm No. | |
|---|---|
| 17250 | Channel %1 block %2 illegal magazine definition |
| Explanation | %1 = channel number, %2= block number, label<br>An attempt was made to change magazine data, which would subsequently destroy the data consistency or would result in a contradictory definition. |
| Reaction | Alarm display<br>Interface signals are set<br>Interpreter stop<br>NC start disable |
| Remedy | Correct the NC program |
| Continue program | Clear the alarm with NC START or the RESET key and continue the program. |

| Alarm No. | |
|---|---|
| 17260 | Channel %1 block %2 illegal magazine location definition |
| Explanation | %1 = channel number, %2 = block number<br>An attempt was made to change magazine location data, which would subsequently destroy the data consistency or would result in a contradictory definition.<br>Example:<br>If parameter $TC_MPP1 (= location type) is written with "spindle/toolholder location, then a conflict is possible with the adjacent machine data $MN_MM_NUM_TOOLHOLDERS. A remedy is then either to increase $MN_MM_NUM_TOOLHOLDERS - if the control model permits this - or correct the magazine definition.<br>A tool must not be in two different magazine locations simultaneously - and a tool must not be contained in a multitool and a magazine location simultaneously. |
| Reaction | Alarm display<br>Interface signals are set<br>Also reorganize correction block |
| Remedy | Correct the NC program |
| Continue program | Clear the alarm with NC START or the RESET key and continue the program. |

| Alarm No. | |
|---|---|
| 17262 | Channel %1 block % illegal tool-adapter operation |
| Explanation | %1 = channel number, %2= block number, label<br>This alarm is generated if you attempt to define or cancel the assignment between a tool adapter and a magazine location and the selected location already has another tool adapter and/or is already holding a tool or, if you are canceling the assignment, there is still another tool in the location.<br>If machine data $MC_MM_NUM_SUMCORR has the value -1, then adapters cannot be generated on an adapter that has still not been defined using a write operation. While the machine data has this value, you can only write adapter data to adapters which have already been (automatically) assigned to magazine locations. |
| Reaction | Alarm display<br>Interface signals are set<br>Offset block with reorganization |
| Remedy | Allocate a maximum of one adapter to a magazine location.<br>It is not permissible that a tool is at the magazine location.<br>Machine data $MC_MM_NUM_SUMCORR with the value -1: If the alarm is generated when you are writing one of the system parameters $TC_ADAPTx (x=1,2,3,T), then you must change the write operation to ensure that it includes only adapter data which is already assigned to magazine locations. |
| Continue program | Clear the alarm with NC START or the RESET key and continue the program. |

| Alarm No. | |
|---|---|
| 20150 | Channel %1 tool management: PLC terminates interrupted command |
| Explanation | %1 = channel number<br>Indication that the PLC has terminated an interrupted command (with alarm output) from the tool management - "tool change". |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | For information only |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 20160 | Channel %1 tool management: PLC can only terminate incorrectly cancelled commands |
| Explanation | %1 = channel number<br>Indication that the PLC wanted to cancel an active command from the tool management (tool change); or that there is no command active to be cancelled. NCK rejects because the channel status is either "active" (cancel is then not allowed), or "reset" (then there is nothing to cancel). |
| Reaction | Alarm display<br>Interface signals are set |
| Remedy | For information only |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 22066 | Channel %1 tool management: Tool motion not possible since there is no tool %2 with duplo no. %3 not in magazine %4 |
| Explanation | %1 = channel number, %2 = string (identifier), %3 = duplo number, %4 = magazine number<br>The desired tool change is not possible. The specified tool is not contained in the specified magazine. (NCK cannot contain tools that are not assigned to a magazine. No operations (movement, change) can be performed with these tools. |
| Reaction | NC start disable<br>Alarm display<br>Interface signals are set<br>NC stop for alarm |
| Remedy | Please notify authorized personnel/service.<br>Ensure that the specified tool is contained in the required magazine - or program a different tool, which should be changed.<br>Check whether machine data $MC_RESET_MODE_MASK, $MC_START_MODE_MASK - and in turn the coupled machine data $MC_TOOL_RESET_NAME - match the actual definition data. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 22067 | Channel %1 tool management: Tool change not possible because no tool ready for use in tool group %2 |
| Explanation | %1 = channel number, %2 = string (identifier)<br>The desired tool change is not possible. The specified tool group does not contain a "ready to use" replacement tool which could be loaded. The tool monitoring function may have set all potentially suitable tools to the "disabled" status. |
| Reaction | NC start disable<br>Alarm display<br>Interface signals are set<br>NC stop for alarm |
| Remedy | At the time of the requested tool change, ensure that there is a tool that can be used in the specified tool group.<br>This can be achieved e.g. by replacing locked tools, or<br>by manually releasing a locked tool<br>Check that the tool data have been correctly defined. Have all intended tools in the group been defined with the specified identifier and loaded? |
| Continue program | Clear the alarm with the RESET key. Restart the part program. |

| Alarm No. | |
|---|---|
| 22068 | Channel %1 tool management: No tool ready for use in tool group %3 |
| Explanation | %1 = channel number, %2 = block number, label, %3 = string (identifier)<br>The specified tool group does not contain a "ready to use" replacement tool which could be loaded. The tool monitoring function may have set all potentially suitable tools to the "disabled" status. The alarm can occur in conjunction with alarm 14710 (error when generating the INIT block). In this specific situation, the NCK attempts, for example, to replace the locked tool on the spindle by an available replacement tool (which in this particular error case is not available).<br>The operator must resolve this conflict, e.g.by removing the tool on the spindle using a movement command away from the spindle (e.g. using an operator action at the HMI). |
| Reaction | NC start disable<br>Alarm display<br>Interface signals are set |
| Remedy | At the time of the requested tool change, ensure that there is a tool that can be used in the specified tool group.<br>For example, this can be achieved by replacing locked tools, or<br>by manually releasing a locked tool<br>Check that the tool data have been correctly defined. Have all intended tools in the group been defined with the specified identifier and loaded? |
| Continue program | Clear the alarm with NC START or the RESET key and continue the program. |

| Alarm No. | |
|---|---|
| 22069 | Channel %1 block %2 tool management: No tool available in tool group %3, program %4 |
| Explanation | %1 = channel number, %2 = block number, label, %3 = string (identifier), %4 = program name<br>The specified tool group does not contain a "ready to use" replacement tool which could be loaded. The tool monitoring function may have set all potentially suitable tools to the "disabled" status. Parameter %4 = program name facilitates the identification of the program containing the programming command (tool selection) that caused the error. This can be a subprogram or cycle, etc., which can no longer be identified from the display. If the parameter has not bee specified, then it is the currently displayed program. |
| Reaction | Alarm display<br>Interface signals are set<br>Offset block with reorganization |
| Remedy | At the time of the requested tool change, ensure that there is a tool that can be used in the specified tool group, e.g. by<br>replacing locked tools, or<br>by manually releasing a locked tool.<br>Check that the tool data have been correctly defined. Have all intended tools in the group been defined with the specified identifier and loaded? |
| Continue program | Clear the alarm with NC START or the RESET key and continue the program. |

| Alarm No. | |
|---|---|
| 22070 | TO unit %1 Please load tool T= %2 into magazine. Repeat data backup |
| Explanation | %1 = TO unit, %2 = T number of the tool<br>Only possible when tool management is active.<br>A data backup of the tool/magazine data has been started. The system has detected that the buffer magazine still contains one or more tools. During backup, these tools lose the information assigning them to a magazine and a location in the magazine. As a consequence it makes sense that at the time that data is backed up, all tools have been placed in the magazine.<br>If this is not the case, when data is re-imported there will be magazine locations that have the "reserved" status. It is then possible that this status must be manually reset.<br>In the case of tools with a fixed-location coding, the loss of information about their location in the magazine is equivalent to a general empty location search on any subsequent change back to the magazine. |
| Reaction | Interface signals are set.<br>Alarm display. |
| Remedy | Make sure that there are no tools stored in the buffer magazine before you start to back up data. Repeat the data backup after removing the tools from the buffer magazine. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| Alarm No. | |
|---|---|
| 22071 | TO unit %1 tool %2 duplo No. %3 is active but not in the current wear group |
| Explanation | %1 = TO units, %2 = T number of the tool, %3 = duplo number<br>The "Wear group" function is active. In addition, the "Set tool to active status" setting is applied if a new wear group is activated. It can also be programmed using the language command SETTA or started via an OPI analog function.<br>In this case, it is defined that now, more than one tool from the tool group has the "active" status. The tool which has the "active" status in an "inactive" wear group is specified in the alarm.<br>The alarm is an information alarm. It can be suppressed by setting bit 5 of MD 11410 SUPPRESS_ALARM_MASK. |
| Reaction | Alarm display<br>Set interface signals |
| Remedy | Before you start the machining operation, make sure that the "active" status is not set for any of the tools in the magazine. You can do this by programming command SETTIA. |
| Continue program | Clear the alarm with the cancel key. No further operator action required. |

| **Alarm No.** | |
|---|---|
| 400601 | Incorrect configuration of loading points |
| Explanation | The PLC configuration in DB4 does not match the NC Configuration. |
| Reaction | Alarm display |
| Remedy | Correct tool management commissioning. |
| Continue program | Power-down the control and power-up again |

| **Alarm No.** | |
|---|---|
| 400602 | Incorrect spindle configuration |
| Explanation | The PLC configuration in DB4 does not match the NC Configuration. |
| Reaction | Alarm display |
| Remedy | Correct tool management commissioning. |
| Continue program | Power-down the control and power-up again |

| **Alarm No.** | |
|---|---|
| 400603 | Incorrect turret configuration |
| Explanation | The PLC configuration in DB4 does not match the NC Configuration. |
| Reaction | Alarm display |
| Remedy | Correct tool management commissioning. |
| Continue program | Power-down the control and power-up again |

| **Alarm No.** | |
|---|---|
| 400604 | Set change with M06 in machine data |
| Explanation | Change is possible only with M06 for the magazine type used (box, chain). Check for invalid settings when using turret magazines. |
| Reaction | Alarm display |
| Remedy | In the channel-specific data 22550: TOOL_CHANGE_MODE should be set to the value 1. |
| Continue program | Internal |

| Alarm No. | |
|---|---|
| 410141 | Number of loading points too high |
| Explanation | The PLC configuration in DB 4 does not match the NC Configuration. |
| Reaction | Alarm display |
| Remedy | Correct tool management commissioning. |
| Continue program | Switch control system OFF and ON again. |

| Alarm No. | |
|---|---|
| 410142 | Number of toolholders too high |
| Explanation | The PLC configuration in DB 4 does not match the NC Configuration. |
| Reaction | Alarm display |
| Remedy | Correct tool management commissioning. |
| Continue program | Switch control system OFF and ON again. |

| Alarm No. | |
|---|---|
| 410143 | Number of turrets too high |
| Explanation | The PLC configuration in DB 4 does not match the NC Configuration. |
| Reaction | Alarm display |
| Remedy | Correct tool management commissioning. |
| Continue program | Switch control system OFF and ON again. |

| Alarm No. | |
|---|---|
| 410151 | Magazine data for tool management missing in PLC |
| Explanation | No magazine data available in the PLC. Commissioning has not been completed although tool management option has been activated. |
| Reaction | Alarm display |
| Remedy | Press the "Create PLC data" softkey via SINUMERIK Operate when commissioning tool management. |
| Continue program | Internal |

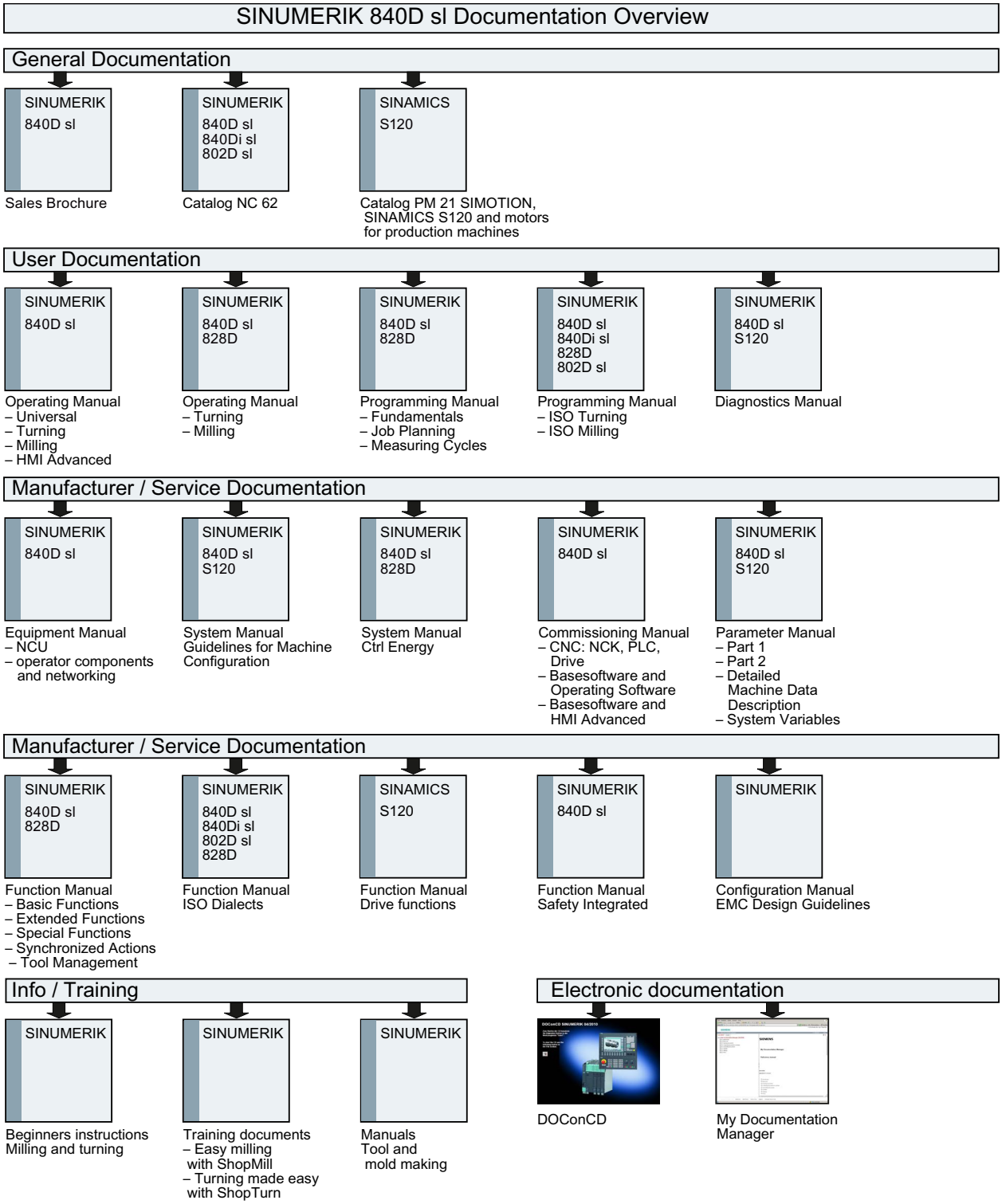
# Appendix A

## A.1 List of abbreviations

| | |
|---|---|
| ASUB | Asynchronous subroutine |
| C Bus | Communication bus |
| CC | Compile cycle or OEM or user area |
| CUTOM | CUTter radius cOMpensation: Tool radius compensation |
| DB | Data Block in the PLC |
| DBB | Data Block Byte in the PLC |
| DBW | Data Block Word in the PLC |
| DBX | Data Block Bit in the PLC |
| DDE | Dynamic Data Exchange |
| DW | Data Word |
| ENC | Encoder: Actual value encoder |
| EPROM | Erasable Programmable Read Only Memory: Erasable, electrically programmable read-only memory |
| FB | Function Block |
| FC | Function Call: Function block in the PLC |
| GUD | Global User Data |
| HEX | Abbreviation for hexadecimal number |
| HMI | Human Machine Interface |
| IBN | Commissioning |
| INC | Increment |
| INI | Initializing Data |
| ISO code | Special punched tape code, number of holes per character always even |
| K1 ... K4 | Channel 1 to channel 4 |
| MCS | Machine coordinate system |
| MD | Machine Data |
| MDI | Manual Data Input |
| MSD | Main Spindle Drive |
| NCK | Numerical Control Kernel |
| OA | Open Architecture |
| OB | Organization Block in the PLC |
| OEM | Original Equipment Manufacturer: Manufacturer whose products are marketed under a different name |
| OP | Operator Panel: Operating equipment |
| OPI | Operator Panel Interface |
| PI | Program Invocation: Programming Instance |
| PLC | Programmable Logic Controller: Interface control |

| | |
|---|---|
| T | Tool |
| TCA | ToolChangeAbsolute |
| TCI | ToolChangeIntermediateLocation |
| TLC | Tool Length Compensation |
| TM | Tool Management |
| TMBF | Tool Management Basic tool function (basic function) |
| TMFD | Tool management flat D number |
| TMMG | Tool magazine management |
| TMMO | Tool monitoring function or monitor |
| TO | Tool Offset |
| TOA | Tool Offset Active: Identifier (file type) for tool offsets |
| TOOLGNT | ToolGroupNumber OfTools |
| TOOLGT | TOOLGroupToolNumber |
| TRC | Tool Radius Compensation |
| USEKT | UserKindOfTools |
| V.24 | Serial interface (definition of the exchange lines between data terminal equipment and data communication equipment) |
| VDI | Virtual Device Interface: Virtual interface |
| WCS | Workpiece coordinate system |

# A.2 Documentation overview



# Glossary

## Access rights

Programs and other data are protected internally by a system of access rights based on seven levels: Three password levels for system manufacturers, machine manufacturers and users as well as a maximum of four keyswitch settings, which can be evaluated via the PLC.

## Alarms

All messages and alarms are displayed on the operator panel in plain text. with date and time as well as the appropriate symbol for the reset criterion. Alarms and messages are displayed separately.

1. Alarms and messages in the part program

   Alarms and messages can be displayed in plain text directly from the part program.

2. Alarms and messages from the PLC

   Alarms and messages for the machine can be displayed in plain text from the PLC program. No additional function block packages are required for this purpose.

## Approach machine fixed-point

Approach motion towards one of the predefined fixed machine points.

## Archiving

Reading out data and/or directories to an external memory device.

## Asynchronous subroutine (ASUB)

A part program which can be started asynchronously to (independently of) the current program status by an interrupt signal (e.g. "rapid NC input" signal).

## Auxiliary functions

Auxiliary functions can be used to transfer parameters to the PLC in -> part programs, where they trigger reactions which are defined by the machine manufacturer.

## Axes

In accordance with their functional scope, the CNC axes are subdivided into:

- Axes: interpolating path axes
- Auxiliary axes: non-interpolating feed and positioning axes with an axis-specific feedrate. Auxiliary axes are not involved in the actual machining, and include for example tool feeders and tool magazines.

### Axis identifier

In accordance with DIN 66217, axes for a right-handed, rectangular -> coordinate system are identified using X, Y, Z. The identifiers A, B, C are used for rotary -> axes turning around X, Y, Z. Other letters can be used to identify additional parallel axes.

### Axis/spindle interchange

An axis/spindle is permanently assigned to a specific channel via machine data. Using program commands it is possible to release an axis/spindle and assign it to another channel.

### Backup

Copies of the contents of storage medium (hard disk) are stored to an external memory device for the purpose of backing up and/or archiving data.

### Basic Coordinate System

Cartesian coordinate system, which is emulated by transforming to the machine coordinate system.
In the -> part program, the programmer uses the axis names of the Basic Coordinate System. The basic coordinate system exists in parallel to the -> machine coordinate system when no -> transformation is active. The difference between the systems relates to the axis identifiers.

### Block

Block is the term given to any files required for creating and processing programs.

### Block search

The block search function allows any point in the part program to be selected, at which machining must start or be continued. The function is provided for the purpose of testing part programs or continuing machining after a program abort.

### Booting

Loading the system program after power on.

### Channel

A channel is characterized by the fact that it can process a part program independently of other channels. A channel exclusively controls the axes and spindles assigned to it. Parts programs run on various channels can be coordinated by -> synchronization.

### Channel structure

The channel structure makes it possible to process the programs of individual channels simultaneously and asynchronously.

### Contour monitoring

The following error is monitored within a definable tolerance band as a measure of contour accuracy. Overloading of the drive, for example, may result in an unacceptably large following error. In such cases, an alarm is output and the axes are stopped.

### Cycle

Subroutine for executing a repetitive machining process on the workpiece.

### D number

Number for the tool offset memory.

### Data block

Data unit of the PLC that HIGHSTEP programs can access.
Data unit of the NC: Data modules contain data definitions for global user data. These data can be initialized directly when they are defined.

### Data word

A data unit, two bytes in size, within a PLC data block.

### Dimensions, metric and inches

Position and pitch values can be programmed in inches in the machining program. The control is set to a basic system regardless of the programmable dimensions (G70/G71).

### Editor

The editor makes it possible to create, edit, extend, join, and import programs/texts/program blocks.

### File type

Possible types of files, e.g. part programs, zero offsets, R parameters, etc.

### Fixed machine point

A point defined uniquely by the machine tool, such as the reference point.

### Fixed-point approach

Machine tools can approach fixed points such as the tool change point, loading point, pallet changing point etc. The coordinates of these points are saved in the controller. The controller traverses the relevant axes, if possible in rapid traverse.

### Frame

A frame is an arithmetic rule that transforms one Cartesian coordinate system into another Cartesian coordinate system. A frame contains the components work offset, rotation, scaling, mirroring.

### Identifiers

In accordance with DIN 66025, words are supplemented using identifiers (names) for variables (arithmetic variables, system variables, user variables), subprograms, key words, and words with multiple address letters. These supplements have the same meaning as the words with respect to block format. Identifiers must be unique. It is not permissible to use the same identifier for different objects.

### Increment

Travel path length specification based on number of increments. The number of increments can be stored as setting data or be selected by means of a suitably labeled key (i.e. 10, 100, 1000, 10000).

### Keyswitch

The keyswitch is the operating switch of the CPU. The keyswitch is operated using a key that can be withdrawn.
The keyswitch on the machine control panel has four settings, to which functions are assigned by the control operating system. Further, the keyswitch has three differently colored keys, which can be removed in the specified positions.

### Languages

The display texts of the operator navigation and the system messages and alarms are available in five languages:
German, English, French, Italian and Spanish.
Two of the specified languages are available in the control and can be selected (commissioning area).

### Machine axes

Axes that are physically present in the machine tool.

### Machine Control Panel

An operator panel on a machine tool with operating elements such as keys, rotary switches, etc., and simple indicators such as LEDs. It is used to directly influence the machine tool via the PLC.

### Machine Coordinate System

A coordinate system, which is related to the axes of the machine tool.

## Machine zero

Fixed point of the machine tool to which all (derived) measuring systems can be traced back.

## Machining channel

Via a channel structure, parallel sequences of movements, such as positioning a loading gantry during machining, can shorten unproductive times. Here, a CNC channel must be regarded as a separate CNC control system with decoding, block preparation and interpolation.

## Macro techniques

Individual instructions in the programming language can be linked to create one overall instruction. This condensed instruction sequence is called by a user-defined name in the CNC program and the macro command executed in accordance with the individual instructions.

## Magazine

In the tool management system, a distinction is made between:

- Real magazine

  Actual magazine for storing tools, the NCK is capable of managing several real magazines.

- Internal magazine

  All other positions in which a tool may be located are handled logically in the NCK as a magazine (or magazine location). There are precisely 2 internal magazines, the loading magazine and the buffer magazine.

- Virtual magazine

  This term is used in the HMI environment to refer to all the real and internal magazines of one TO unit.

- Active magazine

  Magazine which is linked to a spindle and from which a tool change can be executed.

- Background magazine

  A magazine which is linked to a previous magazine via system parameter $TC_MAP5. Generally, a tool change is only possible with prior relocation movement of the tools.

## Main block

A block prefixed by ":" containing all of the data required to start execution of a -> part program.

### Main program

-> Part program identified by a number or identifier in which further main programs, subroutines or -> cycles may be called.

### Main run

The part program blocks which have been decoded and prepared in the preprocessing run are executed in the main run.

### MDI

Control operating mode: Manual Data Input. In the MDI mode, individual program blocks or block sequences with no reference to a main program or subroutine can be input and executed immediately afterwards through actuation of the NC start key.

### Messages

All messages programmed in the part program and all alarms recognized by the system are displayed on the operator panel in plain text. Alarms and messages are displayed separately.

### Mirroring

Mirroring reverses the signs of the coordinate values of a contour, with respect to an axis. It is possible to mirror several axes simultaneously.

### NC

Numerical Control: Numerical control (NC) includes all components of machine tool control: NCK, PLC, HMI, Com.

### NCK

Numerical Control Kernel: Component of the NC that executes the part programs and basically coordinates the motion operations for the machine tool.

### NRK

Numerical Robotic kernel (operating system of the NCK)

### OEM

The scope for implementing individual solutions (OEM applications) has been provided for machine manufacturers, who wish to create their own operator interface or integrate technological functions in the control.

### Offset memory

Data range in the control, in which the tool offset data is stored.

### Oriented spindle stop

Stops the workpiece spindle with a specified orientation angle, e.g., to perform an additional machining operation at a specific position.

### Oriented tool retraction

RETTOOL: If machining is interrupted (e.g. when a tool breaks), a program command can be used to retract the tool in a user-specified orientation by a defined distance.

### Override

Manual or programmable control features, which enable the user to override programmed feedrates or speeds in order to adapt them to a specific workpiece or material.

### Part program

Series of instructions to the NC that act in concert to produce a particular workpiece. Likewise, this term applies to execution of a particular machining operation on a given raw part.

### Part program block

Part of a part program that is demarcated by a line feed. A distinction is made between main blocks and subblocks.

### PLC

Programmable Logic Controller: Programmable logic controller, component of the NC controller: Programmable controller for processing the control logic of the machine tool.

### PLC program memory

The PLC user program, the user data and the basic PLC program are stored together in the PLC user memory. The PLC user memory can be expanded up to 128 KB with memory expansions.

### Reference point

Point on the machine tool with which the measuring system of the machine axes is referenced.

### Reference point approach

If the utilized distance measuring system is not an absolute value encoder then it is necessary to perform a reference point approach to ensure that the actual values returned by the measuring system match the machine coordinate values.

### Replacement tool

Generally, a tool group contains several tools. For tool change purposes, only the identifier is specified in the part program. The tool with the "active" status is generally selected as the new tool. But if this is disabled, then one of the other -> twin tools, i.e. the replacement tool, is selected instead.

### Replacement tool, tool group

Replacement tools have the same identifier and only differ in the duplo number. The replacement tools assigned to one identifier are also referred to as a tool group.

### REPOS

- Repositioning to the contour per operator input

  The REPOS function can use the direction keys to reposition at the point of interruption.

- Repositioning to the contour per program

  Several approach strategies can be selected using program commands: Approach point of interruption, approach start of block, approach end of block, approach a point on the path between start of block and interruption.

### R-variables

Arithmetic parameter that can be set or queried by the programmer of the part program for any purpose in the program.

### Safety functions

The control has continually active monitoring functions, which detect malfunctions in the CNC, the programmable controller (PLC) and the machine at an early stage, in order to minimize the risk of damage to the tool, workpiece or machine. In the event of a fault, the machining operation is interrupted and the drives stopped. The cause of the malfunction is logged and output as an alarm. At the same time, the PLC is notified that a CNC alarm has been triggered.

### Setting Data

Data which communicates the properties of the machine tool to the NC, as defined by the system software.

## Softkey

A key whose name appears on an area of the screen. The choice of softkeys displayed is dynamically adapted to the operating situation. The freely assignable function keys are assigned defined functions in the software.

## Spindles

- Spindle = toolholder

  Toolholder is generally the location for the machining tool. However, the term “spindle” is frequently used in this general context.

- Main spindle = master spindle

  This is the spindle with the number defined by machine data MD $MC_SPIND_DEF_MASTER_SPIND. Language command SETMS(n) can be programmed to declare the spindle with number n as the master spindle. A channel has exactly one master spindle.

- Secondary spindle

  This term refers to all spindles that are not the master spindle.

## Standard cycles

Standard cycles are available for machining tasks that are frequently used:
For drilling/milling
for turning
The cycles available are listed in the operating area "program" under the "cycle support" menu. Once the desired machining cycle has been selected, the parameters required for assigning values are displayed in plain text and can be supplied with values.

## Subblock

Block prefixed by "N" containing information for a machining step, such as a position parameter.

## Subprogram

Sequence of statements of a part program that can be called repeatedly with different defining parameters. Cycles are a type of subprogram.

## Synchronization

Instructions in part programs for coordination of the operations in different channels at specific machining points.

## Synchronized axes

- Auxiliary function output

  During workpiece machining, technological functions can be output from the CNC program to the PLC. These auxiliary functions are used for example to control additional equipment for the machine tool, such as quills, grabbers, clamping chucks etc.

- Fast auxiliary function output

  For time-critical switching functions, the acknowledgement times for the auxiliary functions can be minimized and unnecessary hold points in the machining process can be avoided.

## System variables

A variable that exists without any input from the programmer of a part program. It is defined by a data type and the variable name preceded by the character $.

## Tool nose radius compensation

Contour programming assumes that the tool is pointed. Because this is not actually the case in practice, the curvature radius of the tool used must be communicated to the control which then takes it into account. The curvature center is maintained equidistantly around the contour, offset by the curvature radius.

## Tool offset

By programming a T function (5 decades, integer) in the block, you can select the tool. Every T number can be assigned up to 12 cutting edges (D addresses). The number of tools to be managed in the control is set while configuring.

## Tool radius compensation

In order to be able to directly program a required workpiece contour, the control must traverse a path equidistant to the programmed contour, taking into account the radius of the tool used (G41/G42).

## Transformation

Programming in a Cartesian coordinate system, execution in a non-Cartesian coordinate system (e.g. with machine axes as rotary axes).

## User interface

The user interface (UI) is the display medium for a CNC in the form of a screen. It is laid out with eight horizontal and eight vertical softkeys.

### Operating mode

An operating concept on a SINUMERIK control. The operating modes Jog, MDI and Automatic are defined.

### User memory

All programs and data, such as part programs, subprograms, comments, tool offsets, and work offsets/frames, as well as channel and program user data, can be stored in the shared CNC user memory.

### User program -> part program

### User-defined variable

Users can define variables in the -> part program or data block (global user data) for their own use. A definition contains a data type specification and the variable name. See also -> System variable.

### Variable definition

A variable definition includes the specification of a data type and a variable name. The variable names can be used to access the value of the variables.

### Work

Workpiece zero is the starting position for work. In machining operations programmed in work, the dimensions and directions refer to this system.

### Work memory

The working memory is a RAM memory in the -> CPU which is accessed by the processor to access the user program during program execution.

### Workpiece

The part to be produced/machined by the machine tool or a workpiece saved as directory in the program and other data. Workpieces should be resaved in a directory.

### Workpiece zero

The workpiece zero is the starting point for work. It is defined in terms of distances to the machine zero.

# Index


## $

$A_MONIFACT, 328
$A_MYMLN, 334
$A_MYMN, 334
$A_TOOLMLN, 327
$A_TOOLMN, 325
$A_USEDD, 341
$A_USEDND, 338
$A_USEDT, 339
$AC_MONMIN, 330
$AC_MSNUM, 355, 376
$AC_MTHNUM, 356, 376
$A-MONIFACT, 166
$P_AD[n], 354
$P_ADT[n], 354
$P_DLNO, 352
$P_ISTEST, 366
$P_MAGA, 351
$P_MAGDISL, 343
$P_MAGDISS, 343
$P_MAGHLT, 349
$P_MAGNA, 351
$P_MAGNDIS, 343
$P_MAGNH, 349
$P_MAGNHLT, 349
$P_MAGNREL, 345
$P_MAGNS, 344
$P_MAGREL, 345
$P_MAGS, 344
$P_MSNUM, 356, 376
$P_MTHNUM, 356, 376
$P_TC, 353
$P_TCANG[n], 354
$P_TCDIFF[n], 354
$P_TOOL, 352
$P_TOOLD, 337
$P_TOOLL[n], 353
$P_TOOLND, 328
$P_TOOLNDL, 337
$P_TOOLNG, 333
$P_TOOLNO, 351, 355
$P_TOOLNT, 336
$P_TOOLP, 352
$P_TOOLR, 353
$P_TOOLT, 336
$P_USEKT, $TC_TP11, 321
$P_VDITCP[x], 274
$TC_CARRx, 271
$TC_DPCx[t,D], 235
$TC_DPx[t,D], 232
$TC_MAMPx [n], 259
$TC_MAP10, 249
$TC_MAP3, 249
$TC_MAP8, 249
$TC_MAPCx[n], 250
$TC_MDPx[n,m], 256
$TC_MLSR[x,y], 268
$TC_MOPCx[t,D], 236
$TC_MOPx[t,D], 235
$TC_MPP1, 252
$TC_MPP5, 253
$TC_MPP6, 253
$TC_MPPCx[n,m], 254
$TC_MPPx[n,m], 250
$TC_MPTH[n,m], 255
$TC_SCPx[t,D], 237
$TC_TP1 and $TC_TP2, 241
$TC_TP3 to TP6, 241
$TC_TP7, 241
$TC_TP8, 242
$TC_TPCx[t], 246
$TC_TPGx[t], 245
$TC_TPx[t], 239

## A

Access protection, 25
Acknowledgment
    Simplified, 211
Activate (internally)
    Wear group, 32
Activate wear group, 32
Adapter transformation, 188
Adding tools during machining, 91
Asynchronous transfer, 205

## B

Background magazine, 33
Block execution, 81
Block search, 108
Block search (SSL), 110
Block search with calculation, 108

Block search, program test, 93
Block splitting, 82
Buffer, 27

## C

Chain and box-type magazines, 28
Changing the acknowledgement data, 209
CHKDM, 183, 277
CHKDNO, 183
Circular magazine, 30
Commissioning, 201
Consider adjacent location, 34
CRCEDN, 373
CREACE, 373
CREATO, 373
CRTOCE, 373
Cutting edge selection after tool change, 365

## D

D numbers of replacement tools, 276
Data, 14
DB 1071, 202
DB 1072, 202
DB 1073, 202
DB 71, 202
DB 72, 202
DB 73, 202
DB 74, 202
Decoupling the tool management from the spindle number, 116
DELDL, 279
DELECE, 373
DELETO, 373
DELMLOWNER, 319
DELMLRES, 318
DELT, 282
DELTC, 306
Disable (internally)
  Wear group, 33
Disable monitored tools, 172
Disable wear group, 32
DL - Programming, 185
Duplo number, 14, 15
DZERO, 279

## E

Empty spindle, 88
End acknowledgement, 208

## F

Failure search strategy, 138
Free adapter data records, 190
Free selection of D numbers for every T, 182

## G

GETACTT, 287
GETACTTD, 183, 278
GETDNO, 184, 278
GETEXET, 286
GETFREELOC, 315
GETSELT, 286
GETT, 282

## H

HMI
  Overview, 19

## I

Identifiers, 14, 15
Internally assigned T numbers, 14

## L

Loading magazine, 28
Loading points, 28
Loading stations, 28
Location coding, 70
Location-dependent offsets, 237
Location-dependent offsets, coarse, 238

## M

Magazine configuration, 24
Magazine-location-related adapter data records, 190
Magazines
  Real, 24
Main spindle, 83
Manual tools, 91
Manufacturer's configuration, 200
MMCSEM, 373
Monitoring status, 165
Monitoring types, 163
Multiple T selection, 88

## N

NCK
Overview, 19
NEWT, 280

## O

Operator panels, 14
OPI, 20, 229
OPI block AD, 270
OPI block TD, 239
OPI block TG, 245
OPI block TM, 247
OPI block TMC, 259, 268
OPI block TMV, 371
OPI block TO, 233, 235
OPI block TOE, TOET, 238
OPI block TOS, 237
OPI block TP, 250
OPI block TPM, 256
OPI block TS, 236
OPI block TT, 255
OPI block TU, 246
OPI block TUM, 250
OPI block TUP, 255
OPI block TUS, 236
Orientable toolholder, 271
Overview of data blocks, 202

## P

PI services, 373
PLC
Overview, 19
PLC - NCK interfaces, 22
PLC at unloading, 156
PLC in test mode, 113
PLC services, 216
Positioning, 162
POSM, 291
Predecoding, 81
Prepare to change tool in a secondary spindle, 83
Preparing and changing a tool, 68
Prewarning limit, 164
Program test, 113
Programming data
Tool and cutting edge data, 360
Programming T/M06, 67
Programming the tool selection, 364
Protection levels, 25

## Q

Quantity, 163

## R

Relative D no. for each T, 180
Relocating, 159
Relocation by the PLC, 159
Replace tool search strategy, 144
Replacement tool, 81
Replacement tools, 89
RESETMON, 303
Retroload program, 154

## S

Search for tool, 137
Search procedure for empty locations, 144
Search strategies, 137
Search strategy for empty locations, 140
Secondary spindle, 83
Service life, 163
SETDNO, 184, 279
SETMS, 288
SETMTH, 122, 289
SETPIECE, 167, 283
SETTIA, 300
Setting-up offset, 185
Setting-up offsets, 238
Several magazines in one channel or one TO unit, 124
Several spindles in one channel or TO unit, 115
Several spindles/toolholders, 123
Special cases
Empty spindle, 88
Multiple T selection, 88
Spindle number, 116
Spindle/buffer DB 72, 84
SSL, 110
Subroutine replacement technique, 358
SUPPRESS_ALARM_MASK, 467
Synchronization, 208
Synchronized actions, 99
System variables, 229

## T

T number
Internal, 15
T=location, 61
T=location number, 367

T=location, automatic tool selection, 323
TC_VAR, 114
TCA, 308
TCI, 313
Time monitoring, 167
TMBF, 12
TMCRTC, 373
TMCRTO, 373
TMFD, 12
TMFDPL, 374
TMFPBP, 374
TMGETT, 372, 374
TMMG, 12
TMMO, 12
TMMVTL, 374
TMPCIT, 374
TMPOSM, 374
TMRASS, 374
TOA area, 21
Tool change, 66
  Programming, 364
Tool change at the secondary spindle, 82
Tool change in the spindle, 84
Tool change of the main spindle, 82
Tool change preparation in a main spindle, 83
Tool change with turret, 88
Tool changes in the NCK using synchronized actions, 99
Tool changing errors, 90
Tool changing with T command, 69
Tool command
  Power failure., 200
Tool identifier, 14
Tool life decrementation, 166
Tool life monitoring, 166
Tool return transport, 70
Tool search, 137, 138
Tool search in wear group, 146
TOOL_MANAGEMENT_TOOLHOLDER, 116
TOOLGNT, 323
TOOLGT, 323
Toolholder, 70
Toolholder numbers, 120
Tool-related data, 239
Transport acknowledgement, 208
Traverse axes while tool is being changed, 83
TSEARC, 372, 374
Turret DB 73, 88

## V

VDI signal, 172

## W

Wear group, 31
Wear monitoring, 168
Workpiece count monitoring, 167