

BECKHOFF New Automation Technology

Manual | EN

TF5100

TwinCAT 3 | NC I

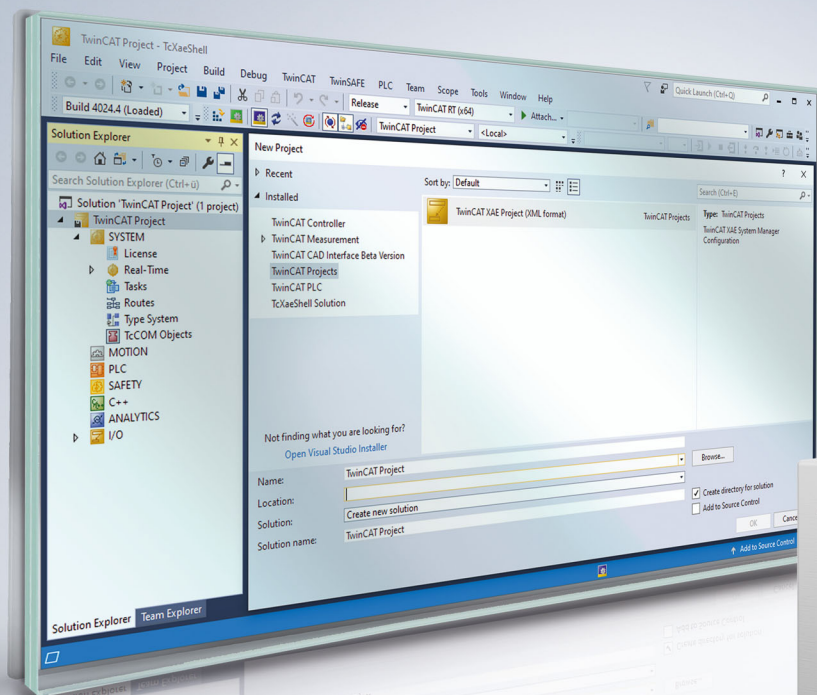


Table of contents

1 Foreword	7
1.1 Notes on the documentation	7
1.2 For your safety	7
1.3 Notes on information security	9
2 Introduction	10
3 Usermode Runtime	11
4 User interface in the TwinCAT 3 Engineering environment	13
4.1 Outline	13
4.2 Interpolation Channel	14
4.3 Interpreter element	16
4.3.1 Interpreter online window	17
4.3.2 "Interpreter" tab	19
4.3.3 "M-Functions" tab	20
4.3.4 "R parameters" tab	21
4.3.5 "Zero point" tab	22
4.3.6 "Tools" tab	23
4.3.7 "Editor" tab	23
4.3.8 "MDI" tab	24
4.4 Group element	25
4.4.1 "General" tab	25
4.4.2 "DXD" tab	26
4.4.3 "Settings" tab	30
4.4.4 "Online" tab	31
4.4.5 "3D-Online" tab	32
5 GST Reference Manual	33
5.1 General Notes	33
5.2 Preprocessor	33
5.3 Combining G-Code and ST	35
5.4 G-Code (DIN 66025)	37
5.4.1 Comments	37
5.4.2 Execution Order	38
5.4.3 Mutual Exclusive G-Codes	38
5.4.4 Rapid Traverse (G00)	39
5.4.5 Linear Interpolation (G01)	39
5.4.6 Circular Interpolation (G02, G03, IJK, U)	40
5.4.7 Dwell Time (G04)	42
5.4.8 Accurate Stop (G09, G60)	43
5.4.9 Delete Distance to go (G31)	43
5.4.10 Tool Radius Compensation (D, G40, G41, G42)	43
5.4.11 Zero Offset Shifts (G53, G54...59)	45
5.4.12 Working Plane and Feed Direction (G17, G18, G19, P)	47
5.4.13 Inch/metric dimensions (G70, G71, G700, G710)	48
5.4.14 Dimensional Notation (G90, G91)	50

5.4.15	M-Functions (M)	51
5.4.16	R-Parameters	52
5.4.17	H, S, and T parameters	53
5.4.18	General Codes (F, N, Q, X, Y, Z, A, B, C)	54
5.5	ST - Structured Text (IEC 61131-3)	55
5.5.1	Comments	55
5.5.2	Literals	56
5.5.3	Native Data Types	59
5.5.4	Userdefined Types	60
5.5.5	Control Structures	61
5.5.6	Jump statement	62
5.5.7	Userdefined Functions	63
5.5.8	Standard Functions	64
5.6	CNC Functions	71
5.6.1	Strings and Messages	71
5.6.2	Transformations	72
5.6.3	Circular Movement	78
5.6.4	Centerpoint Correction	79
5.6.5	Tools	79
5.6.6	Synchronization	81
5.6.7	Query of Axes	82
5.6.8	Current Point	83
5.6.9	Tool Radius Compensation	83
5.6.10	Suppression of G-Code Blocks	84
5.6.11	Zero Offset Shift	85
5.6.12	Units	86
5.6.13	Trigonometric (Unit Aware)	87
5.6.14	Feed Mode	88
5.6.15	Feed Interpolation	89
5.6.16	Streaming of Large G-Code Files	89
5.6.17	Vertex Smoothing	90
5.6.18	Automatic Accurate Stop	92
5.6.19	Spline Interpolation	93
5.6.20	Dynamic Override	96
5.6.21	Programming reference	97
5.6.22	Center Point Reference of Circles	98
5.6.23	Change in axis dynamics	98
5.6.24	Change in path dynamics	99
5.7	Transformations	99
5.7.1	Modification of the Effective Transformation T and its Effect	100
5.7.2	Components of the Effective Transformation T	101
5.7.3	Applying Transformations	101
5.7.4	Revoking Transformations	101
5.7.5	Restoration of Stack	102
5.8	Error Reporting	102
5.8.1	Error Messages	103

5.8.2	Compile-Time Errors and Runtime Errors	103
5.8.3	Errors in G-Code	104
5.8.4	Preprocessing	105
5.9	General Command Overview	105
5.10	Comparative Command Overview	116
6	Classic Dialect Reference Manual	127
6.1	Basic Principles of NC Programming	127
6.1.1	Structure of an NC Program.....	127
6.1.2	Block Skipping.....	128
6.1.3	Look-Ahead.....	128
6.1.4	Smoothing of Segment Transitions	130
6.1.5	Co-ordinate System	130
6.1.6	Dimensional Notation	130
6.1.7	Working Plane and Feed Direction	131
6.1.8	Inch/metric dimensions	132
6.1.9	Single Block Operation.....	134
6.1.10	Arithmetic Parameters.....	135
6.2	Programming Movement Statements.....	137
6.2.1	Referencing	137
6.2.2	Rapid Traverse.....	137
6.2.3	Linear Interpolation	138
6.2.4	Circular Interpolation	139
6.2.5	Helix	141
6.2.6	Dwell Time	142
6.2.7	Accurate Stop.....	142
6.2.8	Feed interpolation	142
6.2.9	Zero Offset Shifts	143
6.2.10	Target Position Monitoring	146
6.2.11	Contour definitions	148
6.2.12	Rotation.....	149
6.2.13	Mirror.....	152
6.2.14	Smoothing of segment transitions.....	153
6.2.15	Circular Smoothing.....	158
6.2.16	Automatic Accurate Stop.....	159
6.2.17	Delete Distance to Go	160
6.2.18	Modulo Movements.....	160
6.2.19	Auxiliary axes	162
6.3	Supplementary Functions	165
6.3.1	M-Functions	165
6.3.2	H, T and S Parameters	169
6.3.3	Decoder stop.....	170
6.3.4	Jumps.....	171
6.3.5	Loops	173
6.3.6	Subroutine techniques	174
6.3.7	Dynamic Override	176
6.3.8	Altering the Motion Dynamics	176

6.3.9	Change of the Reduction Parameters.....	177
6.3.10	Change of the Minimum Velocity	179
6.3.11	Read Actual Axis Value.....	179
6.3.12	Skip virtual movements	180
6.3.13	Messages from NC program	181
6.4	Tool Compensation	181
6.4.1	Tool Data.....	181
6.4.2	Selecting and Deselecting the Length Compensation	184
6.4.3	Cartesian Tool Translation	184
6.4.4	Cutter Radius Compensation	187
6.4.5	Orthogonal Contour Approach/Departure	192
6.4.6	Path Velocity in Arcs	192
6.4.7	Bottle Neck Detection.....	193
6.5	Command overview	194
6.5.1	General command overview	194
6.5.2	@-Command Overview	197
7	PLC NCI Libraries.....	199
7.1	PLC Library: Tc2_NCI	199
7.1.1	Configuration.....	199
7.1.2	NCI POU's	207
7.1.3	Parts program generator	274
7.1.4	Function blocks for compatibility with existing programs	283
7.1.5	Obsolete.....	311
7.2	PLC Library: Tc2_PlcInterpolation	313
7.2.1	FB_NciFeedTablePreparation.....	315
7.2.2	FB_NciFeedTable	316
7.2.3	Types and Enums	318
8	Samples	330
9	Support and Service	331
10	Appendix.....	332
10.1	Display of the parts program	332
10.2	Display of technology data	334
10.3	Displaying the remaining path length	339
10.4	Parameterisation	339
10.4.1	Path override (interpreter override types)	342
10.5	Cyclic Channel Interface	344

1 Foreword

1.1 Notes on the documentation

This description is intended exclusively for trained specialists in control and automation technology who are familiar with the applicable national standards.

The documentation and the following notes and explanations must be complied with when installing and commissioning the components.

The trained specialists must always use the current valid documentation.

The trained specialists must ensure that the application and use of the products described is in line with all safety requirements, including all relevant laws, regulations, guidelines, and standards.

Disclaimer

The documentation has been compiled with care. The products described are, however, constantly under development.

We reserve the right to revise and change the documentation at any time and without notice.

Claims to modify products that have already been supplied may not be made on the basis of the data, diagrams, and descriptions in this documentation.

Trademarks

Beckhoff®, ATRO®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, MX-System®, Safety over EtherCAT®, TC/BSD®, TwinCAT®, TwinCAT/BSD®, TwinSAFE®, XFC®, XPlanar®, and XTS® are registered and licensed trademarks of Beckhoff Automation GmbH.

If third parties make use of the designations or trademarks contained in this publication for their own purposes, this could infringe upon the rights of the owners of the said designations.



EtherCAT® is a registered trademark and patented technology, licensed by Beckhoff Automation GmbH, Germany.

Copyright

© Beckhoff Automation GmbH & Co. KG, Germany.

The distribution and reproduction of this document, as well as the use and communication of its contents without express authorization, are prohibited.

Offenders will be held liable for the payment of damages. All rights reserved in the event that a patent, utility model, or design are registered.

Third-party trademarks

Trademarks of third parties may be used in this documentation. You can find the trademark notices here: <https://www.beckhoff.com/trademarks>.

1.2 For your safety

Safety regulations

Read the following explanations for your safety.

Always observe and follow product-specific safety instructions, which you may find at the appropriate places in this document.

Exclusion of liability

All the components are supplied in particular hardware and software configurations which are appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH & Co. KG.

Personnel qualification

This description is only intended for trained specialists in control, automation, and drive technology who are familiar with the applicable national standards.

Signal words

The signal words used in the documentation are classified below. In order to prevent injury and damage to persons and property, read and follow the safety and warning notices.

Personal injury warnings

 DANGER
Hazard with high risk of death or serious injury.
 WARNING
Hazard with medium risk of death or serious injury.
 CAUTION
There is a low-risk hazard that could result in medium or minor injury.

Warning of damage to property or environment

NOTICE
The environment, equipment, or data may be damaged.

Information on handling the product



This information includes, for example:
recommendations for action, assistance or further information on the product.

1.3 Notes on information security

The products of Beckhoff Automation GmbH & Co. KG (Beckhoff), insofar as they can be accessed online, are equipped with security functions that support the secure operation of plants, systems, machines and networks. Despite the security functions, the creation, implementation and constant updating of a holistic security concept for the operation are necessary to protect the respective plant, system, machine and networks against cyber threats. The products sold by Beckhoff are only part of the overall security concept. The customer is responsible for preventing unauthorized access by third parties to its equipment, systems, machines and networks. The latter should be connected to the corporate network or the Internet only if appropriate protective measures have been set up.

In addition, the recommendations from Beckhoff regarding appropriate protective measures should be observed. Further information regarding information security and industrial security can be found in our <https://www.beckhoff.com/secguide>.

Beckhoff products and solutions undergo continuous further development. This also applies to security functions. In light of this continuous further development, Beckhoff expressly recommends that the products are kept up to date at all times and that updates are installed for the products once they have been made available. Using outdated or unsupported product versions can increase the risk of cyber threats.

To stay informed about information security for Beckhoff products, subscribe to the RSS feed at <https://www.beckhoff.com/secinfo>.

2 Introduction

The TwinCAT NCI stands for 'numerical control interpolation' and is the NC system for interpolated path movements.

TwinCAT NCI offers 3D interpolation (interpreter, setpoint generation, position controller), an integrated PLC with an NC interface and an I/O connection for axes via the fieldbus.

NCI can be used to drive 3 path axes and up to 5 auxiliary axes per channel. In addition, master/slave couplings can be formed. In combination with TwinCAT Kinematic Transformation (TF511x), complex kinematic systems can be controlled via NCI.

Programming is done with a dedicated NC program, based on DIN 66025, with its own language extensions (cf. [Classic Dialect Reference Manual](#) [► 127]) or directly from the PLC with the [PLC Library: Tc2_PlcInterpolation](#) [► 313].

Installation preconditions

As of TwinCAT 3.1 Build 4026, TwinCAT products are installed via the TwinCAT Package Manager. Detailed instructions on installing products can be found in the chapter [Installing workloads](#) in the [TwinCAT 3.1 Build 4026 installation instructions](#).

You can obtain a basic TwinCAT installation via the following workloads:

- TwinCAT.Standard.XAE (Engineering)
- TwinCAT.Standard.XAR (Runtime)

For TF5100 | TwinCAT 3 NCI please install the workloads:

- TF5100.NCI.XAE (Engineering)
- TF5100.NCI.XAR (Runtime)

TF5100 TwinCAT NCI is installed up to and including TwinCAT 3.1 Build 4024 with the TwinCAT Setup. Further details on installation can be found in the instructions [Installation up to TwinCAT 3.1 Build 4024](#).

Target system

Windows 10, Windows CE (only Classic Interpreter)

Minimum Plattform-Level: 40

Overview

Chapter	Contents
XAE user interface [► 13]	Description of the parameters and functionalities for the interpreter in the TwinCAT 3 Engineering environment (XAE)
Interpreter [► 127]	Interpreter programming instructions.
PLC NCI Libraries [► 199]	Description of the special NCI libraries
Samples [► 330]	Samples for using TwinCAT NCI with PLC and parts program, and for direct motion control from the PLC with the Tc2_PlcInterpolation library
Appendix [► 339]	Parameterization, cyclic channel interface

Further information

- [ADS Return Codes](#)
- [ADS Specification of the NC](#)

3 Usermode Runtime

The TF5100 TwinCAT 3 NCI function is partially supported (GST interpreter, PLC interpolation) by the TwinCAT 3 Usermode Runtime. The Classic interpreter is not supported.

GST interpreter

In addition to the general user mode runtime installation, the following packages must also be installed on the Usermode Runtime system in order to use the GST interpreter:

- TwinCAT.XARUM.NCPTP
- TwinCAT.XAR.NCI.GST

The GST interpreter is an ADS server which is started by the Usermode Runtime. To do this, the StartManConfig.xml file with the following content must be set up in the 3.1\Target directory of the Usermode Runtime (for example: *C:\ProgramData\Beckhoff\TwinCAT\3.1\Runtimes\UmRT_Default\3.1\Target*) once the function has been installed.

```
<StartMan>
  <TwinCATServers>
    <TwinCATServer Enabled="1">
      <Name>TcMcGst</Name>
      <Path>C:\Program Files (x86)\Beckhoff\TwinCAT\3.1\Components\Mc\Nci\TcMcGst.exe</Path>
    </TwinCATServer>
  </TwinCATServers>
</StartMan>
```

Each Usermode Runtime instance has its own registry: TcRegistry.xml. This defines the default directories for the GST interpreter. If the TcRegistry.xml file needs to be edited, the associated Usermode Runtime instance must not be started.

```
<TcRegistry>
  <Key Name="HKLM">
    <Key Name="Software">
      <Key Name="Beckhoff">
        <Key Name="TwinCAT3">

          <Key Name="Nc">
            <Key Name="TcMcGst">
              <Value Name="searchpath" Type="SZ">C:\ProgramData\Beckhoff\TwinCAT\Mc\Nci\</
Value>
              <Value Name="workingdirectory" Type="SZ">C:
\ProgramData\Beckhoff\TwinCAT\Mc\Nci\UmRT_Default\</Value>
            </Key>
          </Key>
        </Key>
      </Key>
    </Key>
  </TcRegistry>
```

GST interpreter and Fast As Possible mode

The GST interpreter is an ADS server outside the runtime in the Windows context. This means that the state of the GST interpreter is not taken into account when the cycle tick is presented in the Fast As Possible modes of the Usermode Runtime. This can result in the NC executing the Motion commands faster than the interpreter sends the commands to the NC. This results in unrealistic dynamic progressions and a lack of smoothing. To prevent this, when using the Fast As Possible mode in conjunction with the GST interpreter, the lookahead of the NC should be monitored and switched to cyclic mode if the value falls below a threshold so that the interpreter has the chance to fill the lookahead again.

```
IF fbSetRtMode.bExecute = FALSE THEN
  IF io.X.NcToPlc.SafEntries > nSafEntriesThreshold THEN
    IF fbSetRtMode.rtMode <> E_RtMode.RtMode_FastAsPossible THEN
      fbSetRtMode.rtMode := E_RtMode.RtMode_FastAsPossible;
      fbSetRtMode.bExecute := TRUE;
    END_IF
  ELSIF fbSetRtMode.rtMode <> E_RtMode.RtMode_Cyclic THEN
    fbSetRtMode.rtMode := E_RtMode.RtMode_Cyclic;
    fbSetRtMode.bExecute := TRUE;
  END_IF
ELSIF NOT fbSetRtMode.bBusy THEN
```

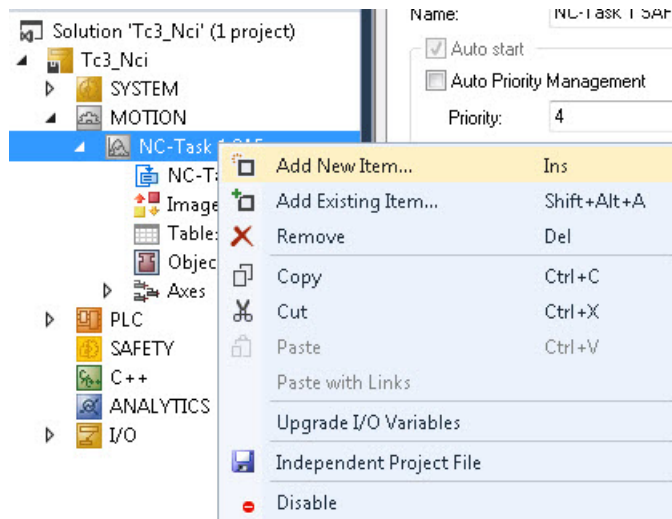
```
    fbSetRtMode.bExecute := FALSE;  
END_IF  
fbSetRtMode();
```

4 User interface in the TwinCAT 3 Engineering environment

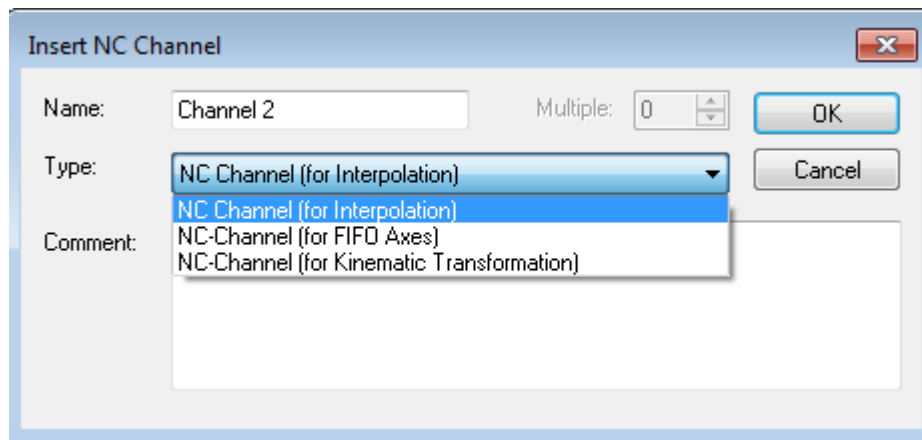
4.1 Outline

In order to be able to use the interpolation, add an interpolation channel in the XAE . This applies to the interpreter and the PLC Library: Tc2_PlcInterpolation [► 313].

1. Create an NC channel.



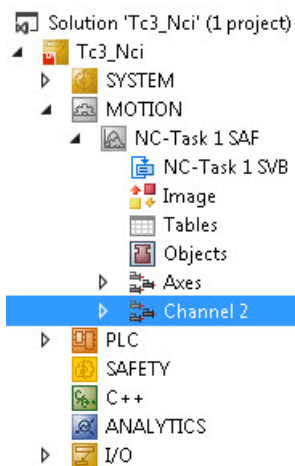
2. In the selection box select the NC channel for the interpolation.



3. Assign PTP axes to it from the PLC via a function block.

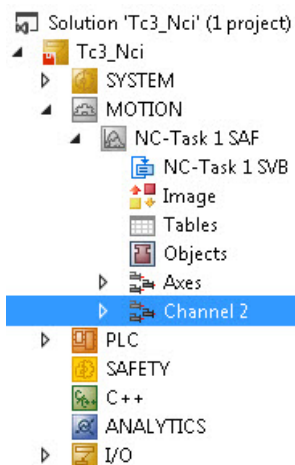
The created channel consists of the following elements:

<u>Interpolation Channel</u> [► 14]	Description of the properties pages embedded in the 'interpolation' element.
<u>Interpreter Element</u> [► 16]	Description of the properties pages embedded in the 'Interpreter' element
<u>Group element</u> [► 25]	Description of the properties pages embedded in the 'group' element



Notice Axis-specific parameters for NCI can be found in the axis parameterization under subitem 'NCI parameters'.

4.2 Interpolation Channel

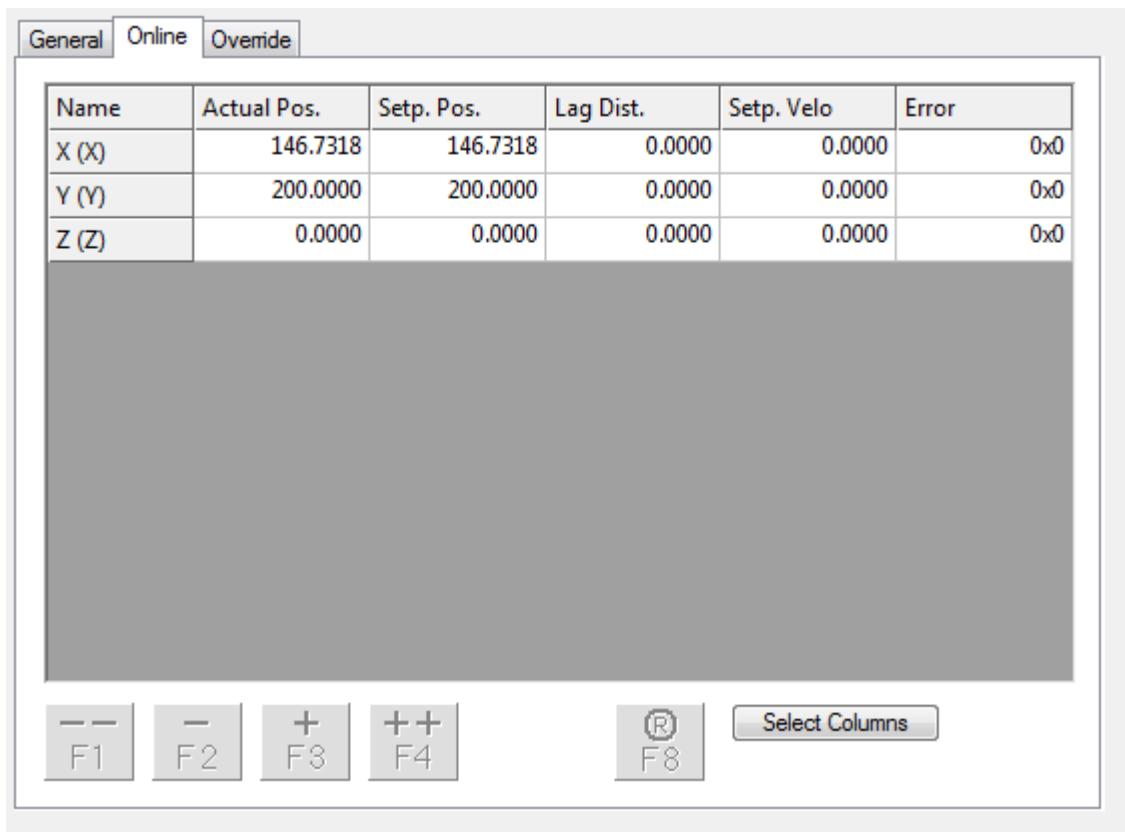


Click on the interpolation channel to display the following dialogs:

"Online" tab

All the axes in the current Interpolation Group [**► 25**] will be listed. Currently shown:

- Actual positions
- Set positions
- Following errors
- Set velocities and
- Error Codes

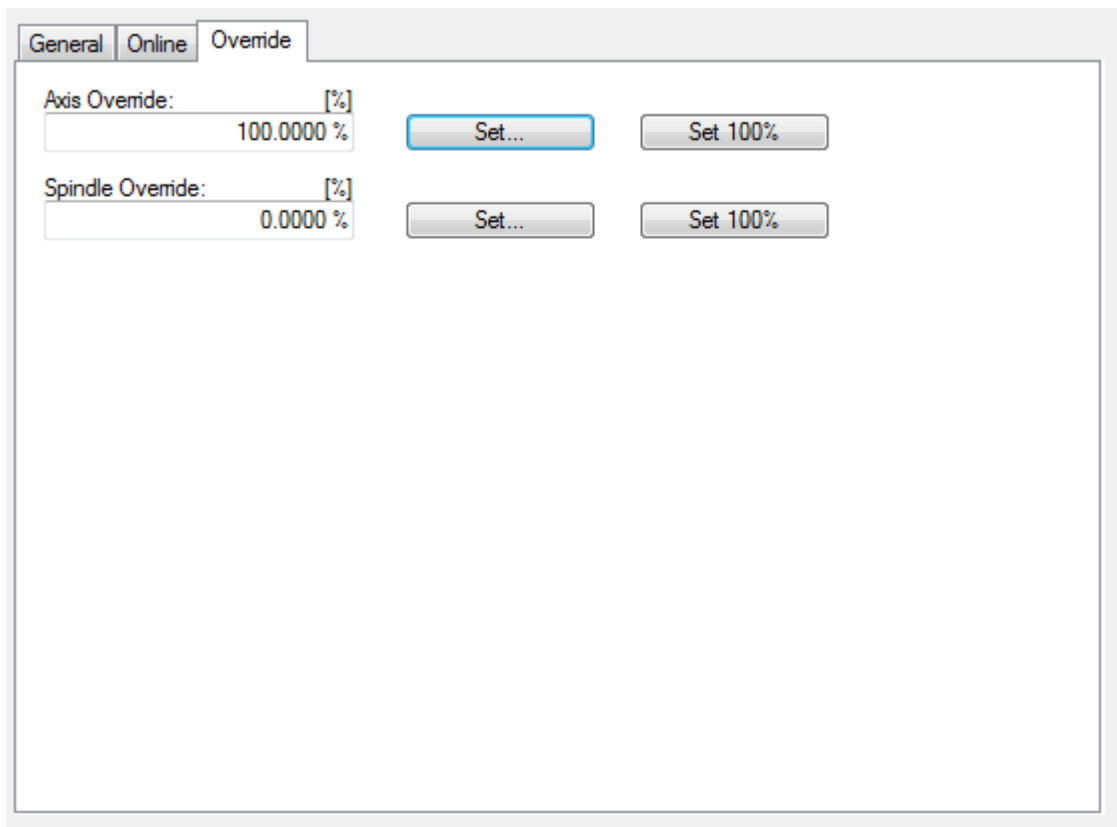


"Override" tab

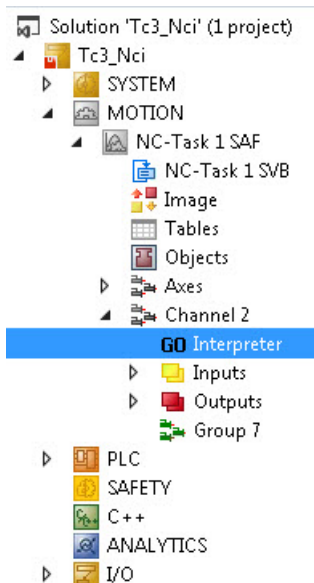
The channel override for the axes can be read and set on the 'Override' page. If PLC is running and the [cyclical channel interface \[► 344\]](#) is being written, the override set here will be overwritten by the PLC.

Further information on the override principle can be found under [Path override \(interpreter override types\) \[► 342\]](#).

The spindle override is described by the cyclic channel interface, although it is currently not supported.



4.3 Interpreter element



Click on “Interpreter” to show the following property pages and the online window:

4.3.1 Interpreter online window

Name	Actual Pos.	Setp. Pos.	Lag Dist.	Setp. Velo	Er...
X (X)	3207.7262	3207.7262	0.0000	99.9180	0x0
Y (Y)	1988.3170	1988.3170	0.0000	3.9967	0x0
Z (Z)	0.0000	0.0000	0.0000	0.0000	0x0
Q1 (Q1)	0.0000	0.0000	0.0000	0.0000	0x0
Q2 (Q2)	0.0000	0.0000	0.0000	0.0000	0x0

Actual Program Line:

```
N20 G01 X1000
N30 G01 X3000
N40 G01 X3500 Y2000
```

Program Name:

Interpreter State: Buffer Size (Byte):

Channel State:

Axes

As on the "Online" properties page in the interpolation channel, this window lists all axes currently included in the interpolation group. Values for the following parameters are displayed:

- Actual positions
- Set positions
- Following errors
- Set velocities and
- Current error codes

Actual Program Line

The Actual Program Line shows the current NC block to be processed in the block execution. The last row in the window is the current block.

Unlike this, the current block is in the middle row in the case of GST.

As for nearly all the parameters, the program display can be read off via ADS. This can be used to display the current NC blocks in a Visual Basic application, for example (see ADS device documentation - ADS Interface NC).

Program name

Displays the name of the currently loaded program. This does not necessarily have to be the program displayed in Editor.

Interpreter status

The interpreter status indicates the current status of the interpreter state machine. The complete list is given below. As PLC evaluation does not require all status information, only the most important parameters are explained.

Status	Description
ITP_STATE_IDLE	The interpreter is in idle state when there is no NC program loaded as yet or when a group reset is being executed. The interpreter also goes into idle state when a current program is stopped. In the case a

Status	Description
	group reset must be executed in order to prevent error 0x42C5. It is therefore recommended to execute a group reset after stopping via the PLC.
ITP_STATE_READY	After successful loading of an NC program, the interpreter is in ready state. After a program has been successfully processed and exited, the interpreter goes into ready state. In the meantime, however, other states are accepted.
ITP_STATE_ABORTED	If a runtime error occurs during the processing of an NC program, the interpreter goes into aborted state. The actual error code is given in the channel status.
ITP_STATE_SINGLESTOP	This status is only accepted in <u>Single Block Mode</u> [► 134]. As soon as the entry has been sent from the interpreter to the NC core, the interpreter goes into this mode.

● **Querying the interpreter status during program execution**

i Since the interpreter status may change between different states during program execution, we recommend querying it with a negative logic. During program execution the interpreter state is not necessarily ITP_STATE_RUNNING. If the program was executed successfully, the interpreter is subsequently always in Ready state (see also Samples [► 330]).

● **End of program**

i The end of the program is characterized by an M function. Therefore either M2 or M30 are being used. If the M function is missing at the end of the program, the status of the interpreter could return wrong values.

Interpreter status return values

```

0 ITP_STATE_INITFAILED
1 ITP_STATE_IDLE
2 ITP_STATE_READY
3 ITP_STATE_STARTED
4 ITP_STATE_SCANNING
5 ITP_STATE_RUNNING
6 ITP_STATE_STAY_RUNNING
7 ITP_STATE_WRITETABLE
8 ITP_STATE_SEARCHLINE
9 ITP_STATE_END
10 ITP_STATE_SINGLESTOP
11 ITP_STATE_ABORTING
12 ITP_STATE_ABORTED
13 ITP_STATE_FAULT
14 ITP_STATE_RESET
15 ITP_STATE_STOP
16 ITP_STATE_WAITFUNC
17 ITP_STATE_FLUSHBUFFERS

```

Channel status

The channel status indicates the current error state of the channel. If an error occurs during NC program loading or runtime, the corresponding error code is displayed here. If, for example, an axis following error occurs during processing, the NC program is stopped and the channel status will have a value unequal 0. The channel status should therefore always be checked in the PLC, in order to be able to respond to errors. The channel status is always 0 during normal operation.

Loading buffer

The current size of the loading buffer for the interpreter is displayed here. Select the "Interpreter" tab to change the value.

4.3.2 "Interpreter" tab

Type

The interpreter type can be selected in the Type selection box. Available are

- the [GST-interpreter \[► 33\]](#). GST combines native DIN 66025 based G-code with programming extensions of Structured Text as a higher level language.
- The DIN 66025 based [NC-interpreter \[► 127\]](#) (Classic Dialect) with @-command register function extensions.
- The selection of none if the [PlcInterpolation \[► 313\]](#) library is used.

As default setting the GST-interpreter is set. To employ the NC-interpreter with register function extensions you have to select it explicitly.

Loading Buffer Size

The loading buffer for the interpreter can be edited here. Note that the memory required in the interpreter is substantially greater than the size of the NC-file. The maximum permitted loading buffer size is limited to 64 MB.



Changing the Loading Buffer Size

If the size of the loading buffer is changed, it is absolutely necessary to execute a TwinCAT restart.

G70/G71 Factor

If a switch from [G71 \[► 132\]](#) (millimeters - default) to G70 takes place in the parts program, the conversion factor is stored here. This conversion factor only has to be edited if the base reference system is not millimeters.

If for example the machine was calibrated based on inches and G70 is activated in the parts program, the G70 factor should be set to 1 and the G71 factor should be set to 1/25.4.

Save/Restore

At runtime the Save function can be used to save a “snapshot” of the current parameters. The checkboxes can be used to specify the parameters to be saved. The Save function generates the file ‘SnapShot.bin’ in the TwinCAT\CNC directory.

The Restore function loads the file saved with the Save function. This function is solely intended for debugging purposes.

4.3.3 "M-Functions" tab

	No	HShake	Fast	Reset (3,6,...)	Comment
M	26	BM	None		
M	31	AM	BMAutoRe...		
M	50	None	AM	55	
M	51	None	AM	55	
M	52	None	AM	55	

AM = After Move
BM = Before Move



Use only with interpreter

This tab is irrelevant for operation with the library Tc2_PlcInterpolation.

Shows the currently parameterized M-functions. On this page new M-functions can be added, or existing ones modified.

A more detailed description of the available parameters can be found in the interpreter description under [M-functions \[► 165\]](#).



Parameterization of M-functions

If M-functions are re-parameterized, subsequent activation of the configuration and a TwinCAT restart is required.

4.3.4 "R parameters" tab

General	Interpreter	M-Functions	R-Parameter	Zero Points	Tools	Editor	MDI
R 0- 4	9.000000	789.000000	0.000000	56.000000	0.000000		
R 5- 9	0.100000	0.005000	45.000000	0.000000	45.000000		
R 10- 14	0.000000	45.000000	0.000000	7.100000	0.000000		
R 15- 19	78.000000	0.000000	456.000000	0.000000	0.000000		
R 20- 24	0.000000	0.000000	0.000000	0.000000	0.000000		
R 25- 29	80.000000	120.000000	5846.000000	0.000000	0.000000		
R 30- 34	0.000000	0.000000	0.000000	0.188900	0.000000		
R 35- 39	0.000000	0.000000	0.000000	0.000000	0.000000		

The currently applicable R parameters are displayed on the 'R parameters' properties page. During the test phase it is possible to, for example, initialize or change R parameters here. R parameters are generally edited, however, from the NC program or if necessary, from the PLC.

You can find further information about R parameters in the interpreter description under [R Parameters](#) [► 135].

4.3.5 "Zero point" tab

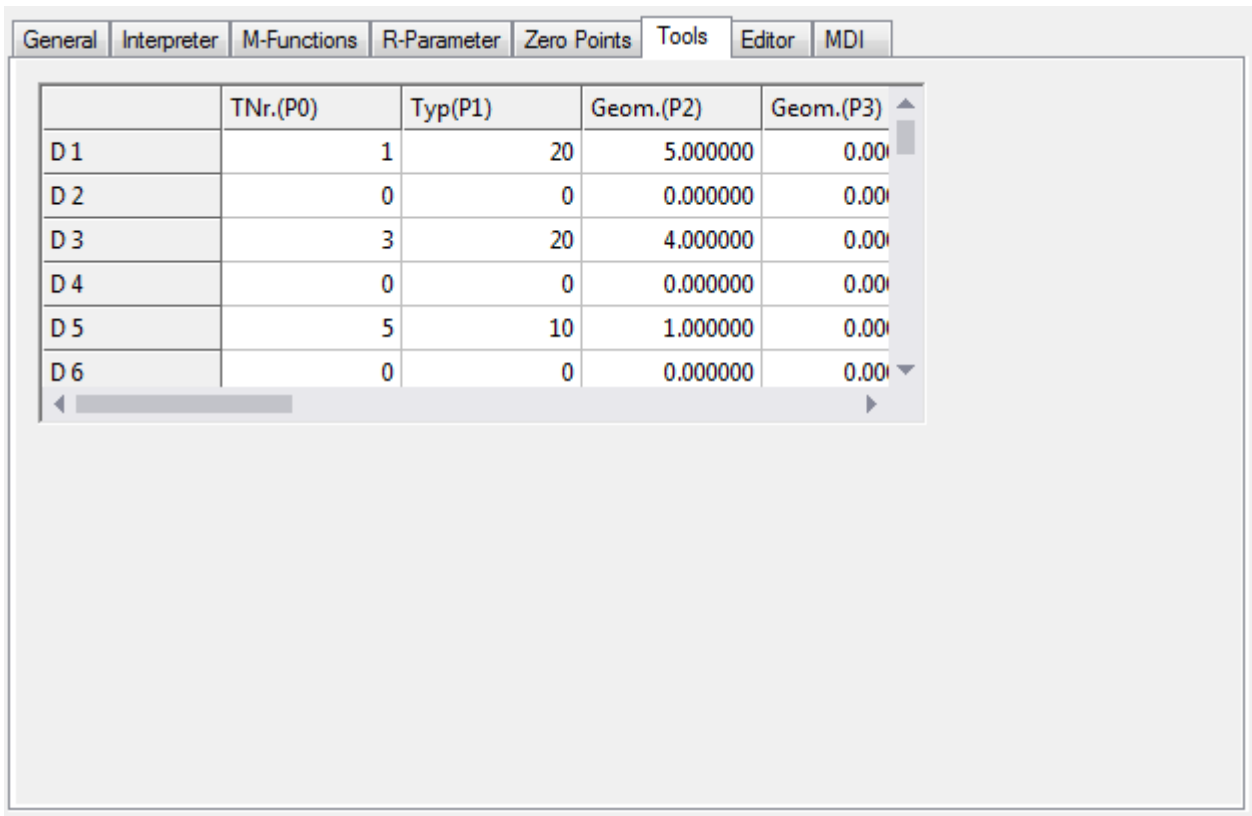
General Interpreter M-Functions R-Parameter Zero Points Tools Editor MDI								
	P54 F	P54 G	P55 F	P55 G	P56 F	P56 G	P57 F	P57
X	100.000...	50.0000...	0.000000	0.000000	0.000000	0.000000	0.000000	0.0
Y	10.0000...	20.0000...	1.000000	0.000000	0.000000	0.000000	0.000000	0.0
Z	45.0000...	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.0

The current zero shift values for the axes within the interpolation group are displayed here. The parameters P54..P59 represent for the corresponding G code. As for the R parameters, the zero shift values can be edited from here.

Notice Columns F & G (e.g. P54 F & P54 G) exist for historical reasons and are added for each parameter.

You can find further details of the effects in the interpreter description under [zero shifts](#) [► 143].

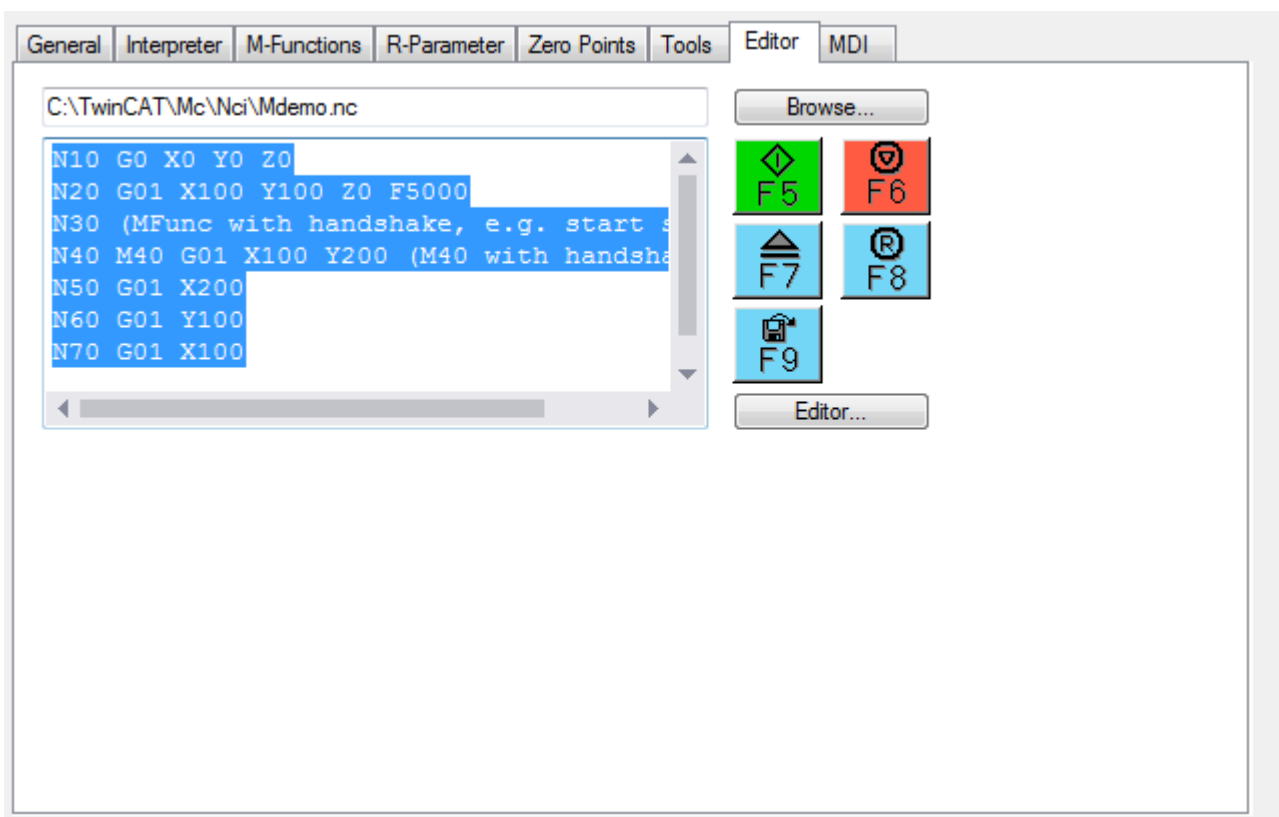
4.3.6 "Tools" tab



You can edit the data for the tool compensation on the "Tools" property page.

More detailed parameter descriptions can be found in the interpreter description under [tool compensations](#) [► 181].

4.3.7 "Editor" tab



The editor is used to display and edit the NC programs.

Browse... Opens a dialog with which existing NC programs can be selected and displayed.



Remote Connection: Load NC-File from Target System

If the target system is connected via a remote connection, the NC-file has to be selected from the target system and cannot be loaded from the local machine.

F5 Starts the currently loaded NC program.



The NC program displayed in the editor does not necessarily have to be the currently loaded program.

F6 Stops the currently running NC program.

F7 Loads the NC program displayed in the editor.



File coding

Ensure that the text file containing the NC program is encoded in ANSI or UTF-8 format. Other text encodings (e.g. UTF-8 BOM) may contain hidden special characters that lead to syntax errors when loading.

F8 Executes a group reset.

F9 Saves the NC program currently displayed in the editor under the same name.

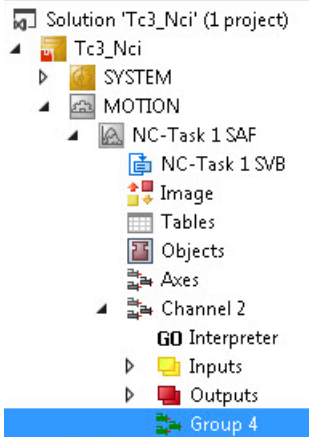
Editor... Opens a larger window in which the NC program is displayed.

4.3.8 "MDI" tab



MDI stands for "Manual Data Interface". It can be used to enter individual NC blocks directly from the TwinCAT 3 Engineering environment (XAE). Processing is started and stopped via F5 and F6 respectively.

4.4 Group element



General [▶ 25]

DXD [▶ 26]

Settings [▶ 30]

Online [▶ 31]

3D-Online [▶ 32]

4.4.1 "General" tab

group ID

The group ID is shown on the "General" page. This is required for group-specific ADS commands.

Create symbols

In order to be able to access path variables symbolically, select symbol generation for the group here.

4.4.2 "DXD" tab

General	DXD	Settings	Online	3D-Online	
Parameter	Offline Value	Online Value	Type	Unit	
Curve Velocity Reduction Mode	'COULOMB' ▾		E		
Velocity Reduction Factor for C0-Transition	0.1		F		
Velocity Reduction Factor for C1-Transition	1.0		F		
Critical Angle for Segment Transition 'Low'	10.0		F	°	
Critical Angle for Segment Transition 'High'	75.0		F	°	
Minimum velocity at segment transitions	0.0		F		
Global Soft Position Limits (for x,y,z-axes)	TRUE ▾		B		
Interpreter Override Type	Reduced ▾		E		
Enable calculation of the total remaining chord length	FALSE ▾		B		
Maximum number of transferred jobs per nc cycle [1 ... 20]	1		D		
SAF cycle time divisor	1		D		
User defined SAF table length [128 ... 1024]	128		D		

The NCI group parameters are written on the "DXD" properties page.

Curve velocity reduction method

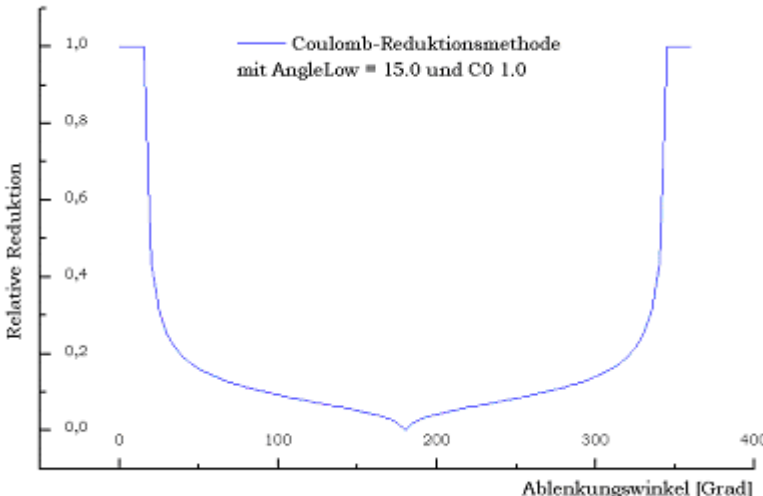
The curve velocity reduction method is only effective for C0 transition (see [Classification of Segment Transitions](#) [► 339])

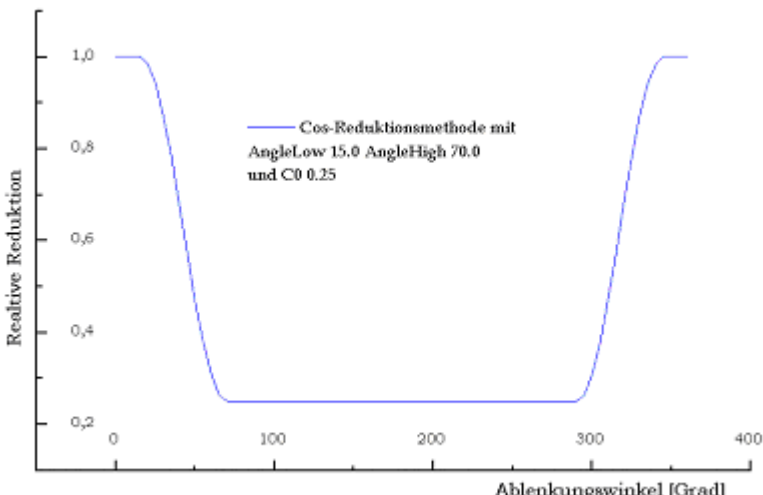
Defines of the curve velocity reduction method

```

0 Coulomb
1 Cosinus
2 VeloJump
3 DeviationAngle (not yet released)

```

Method	Description
Coulomb	The coulomb reduction method is a dynamic process analogous to the Coulomb scattering. The deflection angle φ in the transition point is the angle between the tangents of the path at the end of the segment S1 and the tangent of the path at the start of segment S2. The velocity is set to the velocity at infinity, in analogy to Coulomb scattering, $V_k \propto (\tan(0.5(\pi-\varphi)))^{1/2}$ and then reduced via the C0 factor. $V_k \leftarrow C0 V_k$. In the case of a motion reversal ($\varphi=180$) the reduction is always $V_k = C0$. As the reduction in the case of small deflection angles is drastic, there is an angle $\varphi_{low} \in [0, 180]$ from which full reduction takes effect. To avoid reduction, set $\varphi_{low} = 180$. For full reduction (down to $\varphi = 0$), set $C0 = 0.0$ and $\varphi_{low} = 0$. 

Method	Description
Cosine	The cosine reduction method is a purely geometrical process. It involves: - the C0 factor $\in [0, 1]$, - an angle $\varphi_{\text{low}} \in [0, 180]$, - an angle $\varphi_{\text{high}} \in [0, 180]$ with $\varphi_{\text{low}} < \varphi_{\text{high}}$ Reduction scheme: $\varphi < \varphi_{\text{low}}$: no reduction: $V_k \leftarrow V_k$, $\varphi_{\text{high}} < \varphi$: reduction by the C0 factor: $V_k \leftarrow C0 \cdot V_k$ $\varphi_{\text{low}} < \varphi < \varphi_{\text{high}}$: partial reduction continuously interpolating between cases 1 and 2, proportional to the cos function in the range $[0, \pi/2]$. For full reduction (down to $\varphi = 0$), set $C0 = 0.0$ and $\varphi_{\text{low}} = 0$ and φ_{high} very small but not equal to 0 (e.g. $1.0E-10$) 
VeloJump	It is a geometrical procedure for determining the segment transition velocity at a C0 transition. The procedure reduces the path velocity as required, so that the step change in velocity does not exceed the specified limit value. It is calculated based on the following formula: $\text{VeloJump factor} \cdot \text{cycle time} \cdot \min(\text{acceleration; deceleration})$. Further information: ► 339

Velocity reduction factor C0 transition

Reduction factor for C0 transitions. The effect depends upon the reduction method.

$C0 \in [0.0, 1]$

Velocity reduction factor C1 transition

First, V_{link} is set to the lower of the two segment target velocities:

$V_{\text{link}} = \min(V_{\text{in}}, V_{\text{out}})$.

The geometrically induced absolute step change in acceleration $AccJump$ in the segment transition is calculated depending on the geometry types G_{in} and G_{out} , and the plane selection G_{in} and G_{out} of the segments to be connected, at velocity V_{link} .

If this is greater than $C1$ times the path acceleration/(absolute) deceleration $AccPathReduced$ permissible for the geometries and planes, the velocity V_{link} is reduced until the resulting step change in acceleration is equal to $AccPathReduced$.

If this value is less than V_{min} , then V_{min} takes priority.

Notice When changing the dynamic parameters, the permissible path acceleration for the geometries and planes and thereby the reaction of the reduction changes automatically.

Reduction factor for C1 transitions: $C1 \geq 0.0$

Critical angle, segment transition 'low'

Parameters for φ_{low} (see [curve velocity reduction method](#) [► 26]).

Critical angle, segment transition 'high'

Parameters for φ_{high} (see [curve velocity reduction method](#) [► 26]).

Minimum velocity at segment transitions

Each NCI group has a minimum path velocity $V_{min} \geq 0.0$. The actual velocity should always exceed this value. User-specified exceptions are: programmed stop at segment transition, path end and override requests which lead to a velocity below the minimum value. A systemic exception is a motion reversal.

With the reduction method DEVIATIONANGLE the deflection angle is $\varphi \geq \varphi_h$, in which case the minimum velocity is ignored. V_{min} must be less than the set value for the path velocity (F word) of each segment.

The minimum velocity can be set to a new value $V_{min} \geq 0.0$ in the NC program at any time. The unit is mm/sec.

Global soft position limits (for x,y,z-axes)

Parameters for enabling the software end positions of the path (see: [Parameterization](#) [► 341]).

Interpreter override type

Parameter for selecting the path override type (see [Path override \(interpreter override types\)](#) [► 342]).

Enable calculation of the total remaining chord length

Activates the calculation of the remaining path length. When the calculation of the remaining path length has been activated, it can be extracted via ADS afterwards. See also within the Appendix: [Displaying the Remaining Path Length](#) [► 339].

Maximum number of transferred jobs per nc cycle [1 ... 20]

Maximum number of commands to be transferred per NC cycle. With this parameter it is possible that the SVB task still runs slower than the SAF task and nevertheless sufficiently enough jobs are transposed so that the SAF table does not run out of jobs.

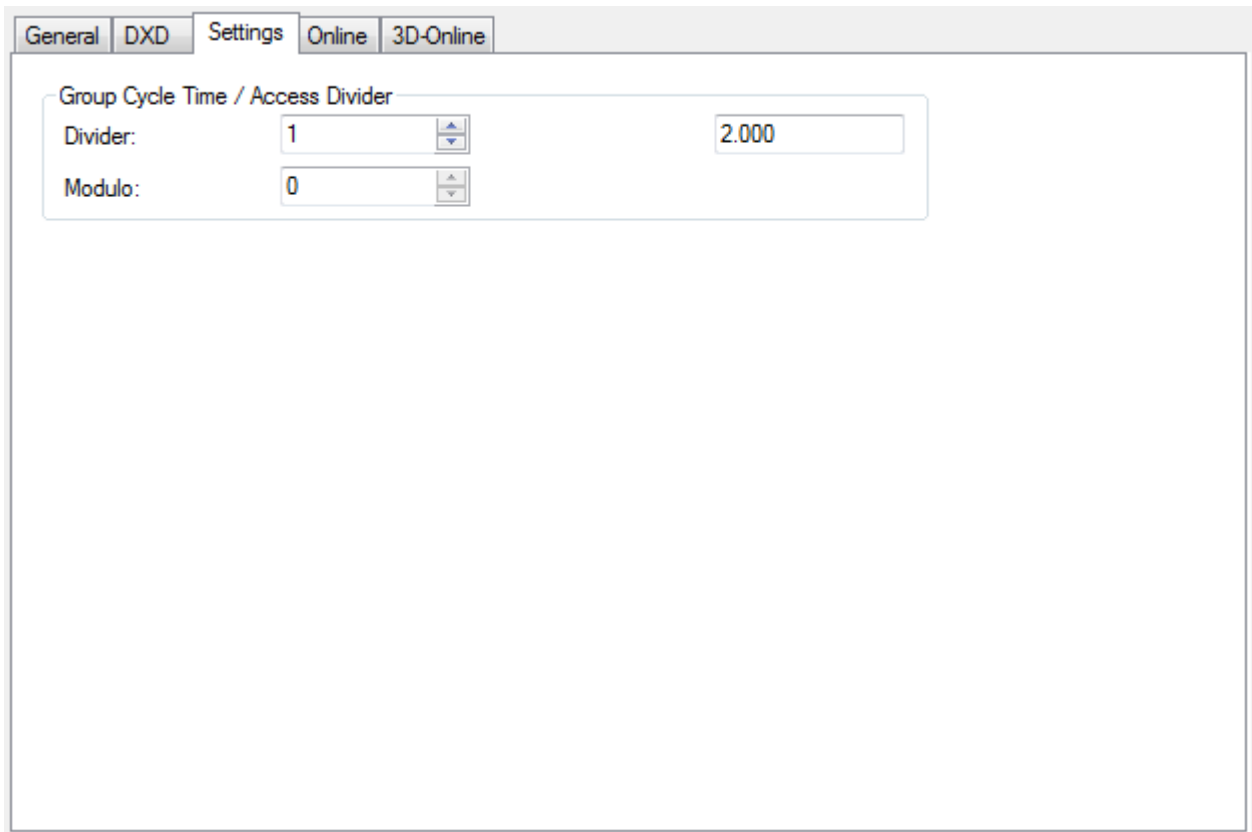
SAF cycle time divisor

The cycle time reduction ensures that the set value in the SAF is not calculated with the SAF cycle time, but with a time that is divided by the value specified here. For highly dynamic motions it may make sense to set the parameter to a value greater than 1, in order to minimize discretization inaccuracies. Increasing the SAF cycle time divisor results in the set value generator being called more frequently internally.

User-defined SAF table length

Parameter that defines the size of the SAF table and therefore the maximum number of cached SAF entries (look-ahead). If an NC program involves sequential movement of many very short segments, increasing this value can help to avoid an unintentional velocity reduction at the segment transitions.

4.4.3 “Settings” tab

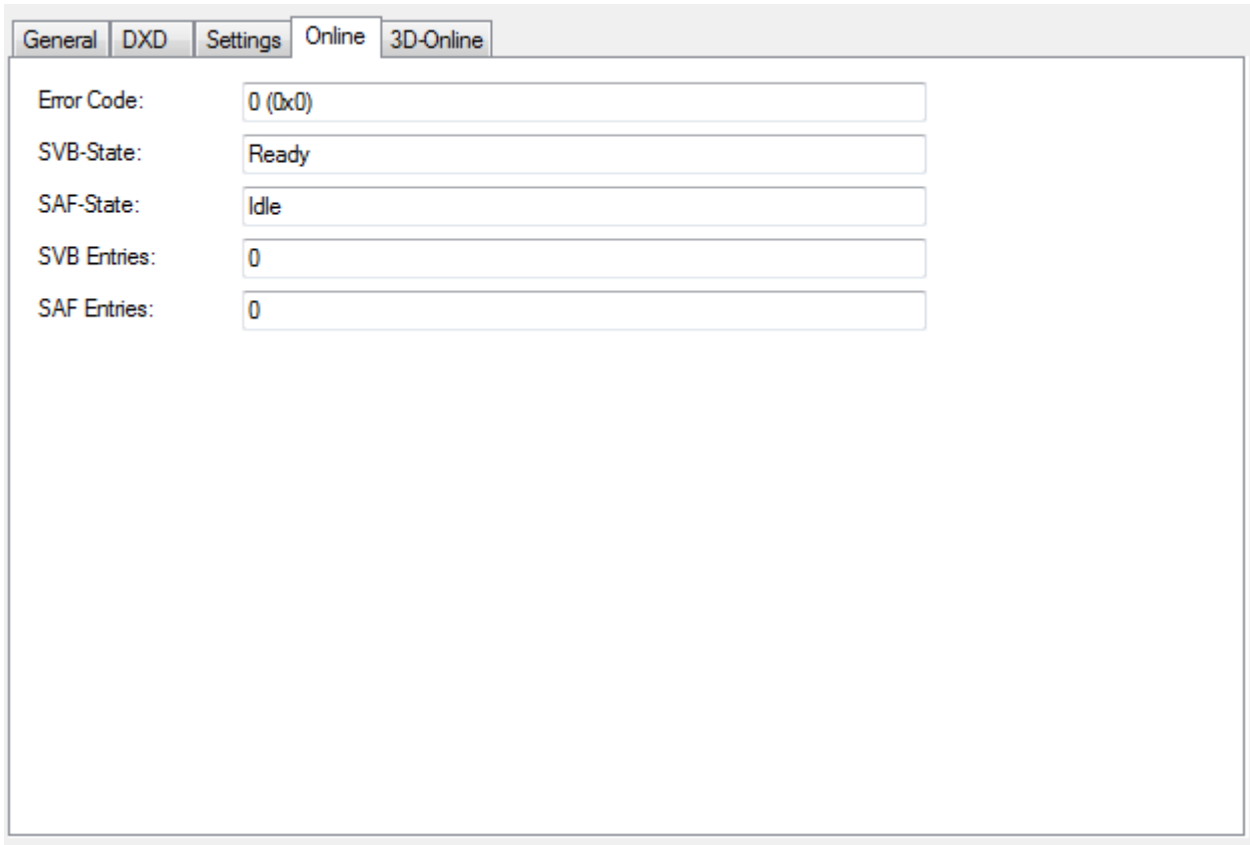


Under the "Settings" tab you can set the cycle time for the interpolation. The cycle time set here is a multiple of the cycle time of the SAF task.

i Using the cycle time in the "Settings" tab

The cycle time setting can be used if you have to select a cycle time for the interpolation that differs from the SAF task. Generally, the cycle time of the SAF task should be adjusted to set the cycle time.

4.4.4 "Online" tab



Field	Value
Error Code:	0 (0x0)
SVB-State:	Ready
SAF-State:	Idle
SVB Entries:	0
SAF Entries:	0

Error code

The current error code for the channel is displayed here. The value is the same as the value displayed in the online window of the interpreter under 'channel status [[▶ 16](#)]'

SVB status

SVB status displays the current block preparation status (SVB = **Satzvorbereitung**). Possible SVB states are:

```
ERROR
IDLE
READY
START
DRIVEOUT
CALIBRATE
MFUNC
SYNCREC
DELAY
MFUNCWAIT
SPINDLEWAIT
```

PLC evaluation of the SVB status is normally not necessary.

SAF status

SAF status displays the current block execution status (SAF = **Satzausführung**). Possible SAF states are:

```
ERROR
IDLE
CONTROL
RUN
RUN_DRIVEOUT
WAIT
```

PLC evaluation of the SAF status is normally not necessary.

SVB entries

Number of current SVB entries.

SAF entries

Number of current SAF entries.

4.4.5 "3D-Online" tab

	Nominal Assignment	Actual Assignment	
X:	X	X	Clear
Y:	Y	Y	Clear
Z:	Z	Z	Clear
Q1:	(none)	(none)	Clear
Q2:	(none)	(none)	Clear
Q3:	(none)	(none)	Clear
Q4:	(none)	(none)	Clear
Q5:	(none)	(none)	Clear

Accept Assignment

Clear Assignment

Target assignment

At this point the **interpolation group** is formed. The movement of the PTP axes, which are assigned to the path axes X, Y and Z, can then be based on interpolation.

Any PTP axes can be selected with the aid of the selection lists for the path axes X, Y and Z. Press the 'Apply' button to form the 3D group.

A comparably PLC function block is available in the [PLC Library: Tc2_NCI \[► 199\]](#). (See [CfgBuildExt3DGroup \[► 201\]](#))

Actual assignment

The current path axis configurations are displayed here. Use 'Delete' to remove individual axes from the 3D group.

Delete whole configuration

Resolves the complete 3D group. Here, too, a corresponding PLC function block is available in the [PLC Library: Tc2_NCI \[► 199\]](#). (See [CfgReconfigGroup \[► 203\]](#))

5 GST Reference Manual

5.1 General Notes

All GST-examples in this documentation presuppose the following assumptions:

- Initially, the tool is located at X0, Y0, Z0.
- All state-variables of the interpreter are set to their default values, except that the velocity is set to a nonzero value.

5.2 Preprocessor

Include Directive

```
#include "<path>"  
#include < <path> >
```

The `#include` directive inserts the contents of another file. The included file is referenced by its path. Typically, it is used to “import” commonly used code like e.g. libraries. Its behavior is similar to the C-Preprocessor.

Example:

In the following example file `a.nc` includes file `b.nc`. On execution of `a.nc` the interpreter internally replaces the include-line by the text of `b.nc`. Therefore, executing the program `a.nc` has the same effect as executing the program `c.nc`.

FILE `a.nc`:

```
G01 X0 Y0 F6000  
#include "b.nc"  
G01 X0 Y100
```

FILE `b.nc`:

```
G01 Z-2  
G01 X100  
G01 Z2
```

FILE `c.nc`:

```
G01 X0 Y0 F6000  
G01 Z-2  
G01 X100  
G01 Z2  
G01 X0 Y100
```

- If `path` is absolute, it is directly used to locate the included file. An absolute path must be surrounded by quotation marks.
- If `path` is relative and surrounded by quotation marks, it is appended to the directory of the including file to form the path of the included file.
- If `path` is enclosed in angle brackets, it is regarded to be relative to the paths in the `searchpath` list. The first entry in this list that leads to an existing file is used for inclusion. The `searchpath` list is supplied by the interpreter environment of the interpreter.

Example:

The following example assumes that the `searchpath` is set to the directories `c:\jjj` and `c:\kkk`. The file `aaa.nc` consists of a sequence of `#include`-directives that are explained in the following.

- The file `bbb.nc` is included using an absolute path. Therefore, its location is independent of the location of `aaa.nc`. Absolute referencing is useful for files that always reside at a fixed location on the filesystem.
- The file `ccc.nc` is referenced relative. It must reside in the directory of `aaa.nc` (the including file), which is `c:\mmm\`.
- The file `ddd.nc` is also referenced relative. It is expected to reside at `c:\mmm\ooo\ddd.nc`.
- The relative reference of `eee.nc` uses the sequence `'..'`, which refers to the parent directory. Therefore, the file `eee.nc` is expected in `c:\ppp\qqq\eee.nc`.
- The relative path of `fff.nc` is denoted in angle brackets. Therefore, the directories in the `searchpath` are considered, rather than the directory of `aaa.nc`. The file is expected in `c:\jjj\fff.nc` or `c:\kkk\fff.nc`. The first path that leads to an existing file is considered. If there is no file `fff.nc` in any directory of the `searchpath`, an error is reported.
- Finally, the file `ggg.nc` is expected in `c:\rrr\ggg.nc`. Both entries in the `searchpath` lead to this location.

FILE `c:\mmm\aaa.nc`:

```
#include "c:\nnn\bbb.nc"
#include "ccc.nc"
#include "ooo\ddd.nc"
#include "..\ppp\qqq\eee.nc"
#include <fff.nc>
#include <../rrr/ggg.nc>
```

- Each include-directive must be denoted on a dedicated line. Then, this entire line is replaced by the contents of the included file. An additional 'newline' character is appended.
- The include-directive may be used multiple times at arbitrary locations of the including file.
- If an included file does not exist, an error is reported.
- If the include directive is not placed at the first position of a line, an error is reported.
- Include directives in included files are also subject to replacement.
- An infinite loop due to recursive inclusion (e.g. A includes B, B includes C and C includes A) is detected and reported as an error.
- The same file may be included multiple times.



It is typically bad practice to include a file multiple times. Especially, if this feature is misused to factor out code. Instead, a function should be preferred to define code that is reused multiple times (see section [Userdefined Functions](#) [► 63]).

Example:

In the following example file `a.nc` includes file `b.nc` twice. The second inclusion is always expanded, independently of the enclosing condition by the `IF-THEN` expression. The included file `b.nc` itself includes file `c.nc`.

FILE `a.nc`:

```
G01 X100 F6000
#include "b.nc"
G01 Y100
! IF stVariable=47 THEN
#include "b.nc"
! END_IF;
```

FILE `b.nc`:

```
#include "c.nc"
G01 X0 Y0
```

FILE `c.nc`:

```
G01 Z0
```

Example:

File `x.nc` demonstrates a series of invalid include directives. The first three lines violate the rule that each include directive must be denoted on a dedicated line. In lines 4 and 5 the filename is not properly enclosed in quotation marks or angle brackets. In line 6 a nonexistent file is included. Line 7 violates the rule that the include directive always has to be placed at the first position of a line. Line 8 includes the file `y.nc`, which itself includes file `x.nc`. This loop is reported as an error.

FILE `x.nc`:

```
#include "a.nc" G01 X100
! #include "a.nc"
#include "a.nc"      #include "b.nc"
#include a.nc
#include "a.nc>
#include "non_existing_file.nc"
      #include "a.nc"
#include y.nc
```

FILE `y.nc`:

```
#include "x.nc"
```

5.3 Combining G-Code and ST

A GST-Program

```
<g-code>
<g-code>
! <st-code>
<g-code>
<g-code>
{
<st-code>
<st-code>
! <g-code>
<st-code>
<st-code>
}
<g-code>
<g-code>
```

A GST-file consists of sequences of G-code and sequences of ST-code that can be interleaved as shown above. Each program starts in G-code mode. The mode can be switched to ST for one line using an exclamation mark (!). The ST-mode ends at the end of line automatically.

As an alternative a block of ST-code can be defined using curly braces ('{...}'). This notation is more practical to define a long sequence of ST-code in a GST-program. Within the ST-block the G-code mode can be entered for one line using the exclamation mark. Thereby, the G-code mode ends at the end of line automatically.

G-Code Block

```
<address><value> <address>=<G-Expression> <address>{<ST-Expression>}
```

A line of G-code is called a **block**. It consists of a sequence of **words**. A word is a combination of an **address** (e.g. G or X) and a **value**. A value can be defined by a literal (e.g. 2.54), by a G-expression (e.g. 2*foo+1) or by an ST-expression (e.g. sin(foo**2)-1).

G-Code Expression

```
<address>=a+b-c*d/e
```

The result of the expression is used as the value of the word. The four basic arithmetic operations ('+', '-', '*', '/') can be used in a G-expression. They are evaluated as expected, i.e. all operations are left-associative and '*', '/' have a higher precedence than '+', '-'. Variables that have been declared in ST can also be used in a G-expression (with respect to their scope).

All computations are performed using type `LReal` (64-bit floating point according to IEEE 754). The value of an ST-variable is implicitly converted to type `LReal` according to the conversion rules of ST. If a type (e.g. `STRING`) cannot be converted, an error is reported.

● RESTRICTION:

i ST-variables that contain a number in their name (e.g. `x0`) cannot be used in a G-expression to avoid confusion with a G-Code like `x0`. This limitation does not apply to ST-expressions.

● RESTRICTION:

i Array variables, struct variables and objects cannot be used in a G-expression. This limitation does not apply to ST-expressions.

● RESTRICTION:

i Parentheses are not allowed in a G-expression as they are used to denote comments in G-Code. For the same reason function calls are not available. These limitations do not apply to ST-expressions.

Embedded ST-Expression

`<address>{<ST-Expression>}`

The result of the ST-expression is used as the value of the word. It must be convertible to `LReal`. Basically, an ST-expression is ST-Code that could be placed on the right hand side of an assignment. Other ST-Code (e.g. an ST-statement) is not allowed. However, extensive computations can be encapsulated in an ST-function that is then called in the ST-expression.

i An ST-expression should not have side effects, since the evaluation order of ST-expressions is generally undefined and may change in the future. Besides, this style of programming employing side effects is a bad programming style. For instance, an ST-expression should not call a function that contains G-Code.

Example:

- The following GST-program starts with a line of G-code that moves the tool rapidly to the origin.
- The line is followed by a line of ST-code that declares variable 'i'. The ST-mode is entered by the prefixed exclamation mark ('!'). After this line G-code mode resumes.
- The G-code in line 3 moves the tool down.
- Lines 4 to 8 define a block of ST-code that contains a FOR-loop. The code in this block is interpreted as ST-code, except for the G-code line in line 6. This line of G-code uses a G-expression to set the X-axis to $10 \cdot i$. The value of the Y-axis is defined using an ST-expression that is enclosed in curly braces. This expression evaluates to 0 if 'i' is even and to 10 otherwise.
- The programmed path of the program is shown in Figure "ExampleExpressions".

```
G00 X0 Y0 Z0
! VAR i : INT; END_VAR
G01 Z-1 F6000
{
FOR i := 1 TO 5 DO
!G01 X=i*10 Y{ (i MOD 2) *10 }
END_FOR;
}
```

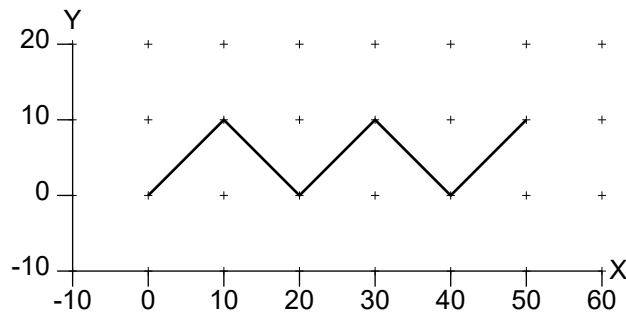


Figure "ExampleExpressions".

Suppression of G-Code Blocks

`/<n> <G-Code block>`

The execution of a G-Code block can be suppressed conditionally. If `'/<n>'` is prefixed and the n -th bit in an internal disable mask is set, the block is suppressed (not executed). The disable mask can be set by the PLC and by the ST-function `disableMaskSet`. If n is omitted, it has 0 value by default. [See section [Suppression of G-Code Blocks](#) [► 84].]

5.4 G-Code (DIN 66025)

5.4.1 Comments

DIN 66025 Comment

`<g-code> ( <comment> ) <g-code>`

Text that is enclosed in round parentheses is treated as comment in G-Code (according to DIN 66025). The comment must not include further parentheses. A comment within round parentheses can extend for multiple blocks or lines and therefore may skip a carriage return, too.

Example:

The following example demonstrates the notation of comments in G-Code.

```
N10 G01 X0 Y-10 F3000
N20 G01 (activate linear interpolation) X10 (set X-coordinate to
10) Y0 F6000
(the next block results in a semicircle with center point
X10 Y10)
N30 G02 (activate clockwise interpolation) Y20 U10 (radius is 10)
M02
```

Line Comment

`<g-code> // <comment>`

Text between `'//'` and the end of line is treated as a comment in G-Code.

Example:

The following example demonstrates the notation of line comments in G-Code.

```
N10 G01 X10 F6000 // perform a linear movement to X10 Y0
// the next block results in a semicircle with center point X10 Y10
N20 G02 Y20 U10
M02
```

5.4.2 Execution Order

A block (line of G-code) consists of a sequence of words. The programmed order of words is not considered by the GST interpreter. Instead, the following execution order is obeyed that consists of 7 sequential and dependent steps.

1. Reference System	N*	Set block number.
	G17..G19	<u>Selection of a workingplane [► 47].</u>
	G70, G71, G700, G710	<u>Selection of a unit [► 48].</u>
	G90, G91	<u>Selection of absolute/ incremental programming [► 50].</u>
	D*, P*	Selection of a tool and its orientation.
2. Configuration	G40..G42	<u>(De-)activation of Tool Radius Compensation [► 43].</u>
	G53..G59	<u>Selection and programming of zero offset shift [► 45].</u>
	F*	Set velocity.
3. M-Function Pre	M*	<u>M-functions [► 51]</u> that are configured as “before”.
4. Parameter to PLC	H*, S*, T*	<u>H, S, and T parameters [► 53]</u>
5. Movement	Q*, G00..G03	Movement to a point.
	G09, G60	<u>Activation of accurate stop [► 43].</u>
6. Wait	G04	<u>Wait for a given duration [► 42].</u>
7. M-Function Post	M*	<u>M-functions [► 51]</u> that are configured as “after”.

The first step sets up the reference system. The second step configures following movements. Note that the second step may depend on the first one. E.g. the programmed velocity (F) considers a velocity unit (G700) that is programmed in the same block. Step three and the following steps perform actions like a movement.

5.4.3 Mutual Exclusive G-Codes

Certain combinations of G-Codes must not be programmed in the same block (line of G-Code). Such conflicting G-Codes typically set state variables to contradictory values (e.g. set length unit to mm and to inch). There are also combinations that use the same parameters and therefore must not be programmed in the same block (e.g. G58 and G59). Below is a list of groups of G-Codes. G-Codes that belong to the same group are in conflict.

- G00, G01, G02, G03, G04, G58, G59
Interpolations and programmed zero-offset-shift.
- G70, G71, G700, G710
Set unit for length and speed.
- G90, G91
Set absolute/ relative programming.
- G53, G54, G55, G56, G57
Deactivate/ select zero-offset-shift.
- G40, G41, G42
Deactivate/ activate Tool Radius Compensation.
- G17, G18, G19
Select workingplane.

5.4.4 Rapid Traverse (G00)

Command	G0 or G00
Cancellation	G01 [▶ 39], G02 oder G03 [▶ 40]

Set the interpolation mode to “rapid, linear”. The interpolation mode applies to this block and all succeeding blocks until it is reset by G01, G02 or G03. G00 is the default interpolation mode.

If G00 is active, programming of a point (see x) will result in a linear geometry segment that is processed with maximum velocity. The programmed velocity is not considered. G00 is typically used to position the tool. For machining G01 should be used, which considers the programmed velocity.



G01, G02, G03, G04, G58 and G59 are mutually exclusive. They must not be programmed in a common block.

Example:

The resulting path of the following example is shown in Figure “ExampleG00”. The first block N10 rapidly moves the tool to position X20, Y10, Z30. The resulting geometry segment is a line in space. The orientation remains unchanged. The second block N20 performs a rapid movement to X50, Y10, Z30. There is no need to denote G00 in this line, since interpolation is modal.

```
N10 G00 X20 Y10 Z30
N20 X50
M02
```

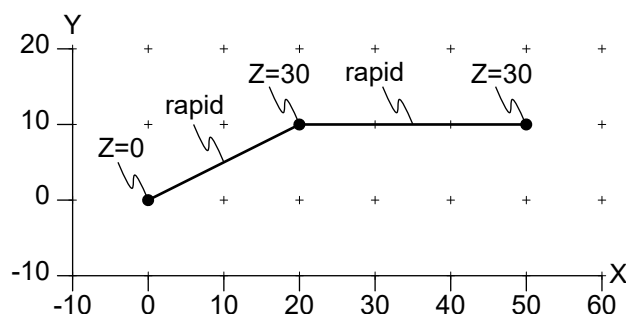


Figure “ExampleG00”.

5.4.5 Linear Interpolation (G01)

Command	G1 or G01 (default setting)
Cancellation	G00, G02 oder G03

Set the interpolation mode to “linear”. This interpolation mode is like G00, except that the path is machined with the programmed velocity. (See F.) The interpolation mode applies to this block and all succeeding blocks until it is reset by G00, G02 or G03.

```
N20 G01 X100.1 Y200 F6000
N30 X150
M02
```

5.4.6 Circular Interpolation (G02, G03, IJK, U)

G02 clockwise circular interpolation

Command	G2 or G02
Cancellation	G00 [► 39], G01 [► 39] or G03

Set the interpolation mode to “circular/helical, clockwise”. The interpolation mode applies to this block and all succeeding blocks until it is reset by G00, G01 or G03. If G02 is active, programming of a point will result in a circular (or helical) arc that is machined with the current velocity. (See [General Codes \(F, N, Q, X, Y, Z, A, B, C\) \[► 54\]](#).) In the following, a circular arc is regarded. The helical arc is covered later.

A circular arc starts at the current point and ends at the programmed point. It rotates around the working-plane normal (PCS, i.e. program coordinate system) in the center point. The center point can be defined using Centerpoint Programming or using Radius Programming.

Centerpoint Programming I, J, K

For Centerpoint Programming the center is standardly defined relative to the starting-point using the I, J, K parameters. The center point is the sum of the starting-point and the vector [I, J, K]. Alternatively, the center point can also be specified as absolute. For this the reference type must be set to absolute in advance with the ST command [circleCenterReferenceSet \[► 98\]](#). The I, J, K parameters are optional and have 0 value by default. If the starting-point and the endpoint are equal with respect to the workingplane, a full circle will be emitted.



CONSTRAINTS:

- The radius at the starting-point and at the endpoint must be equal. However, small deviations are allowed and corrected automatically, see [Centerpoint Correction \[► 79\]](#).
- The center point must not be equal to the starting-point or endpoint.

Radius Programming U

For Radius Programming the center point is derived from the radius that is given by the U parameter. Typically, there are two arcs of a given radius that lead from the starting-point to the endpoint. If the radius is positive, the shorter one is used, otherwise the longer one is chosen. Apart from that, the absolute value of the radius is regarded by the interpreter.



CONSTRAINTS:

- Radius Programming can by its nature not be used to program a full circle. This curvature can be programmed by Centerpoint Programming.
- The radius must not be zero.
- The radius must not be smaller than half of the distance between starting-point and endpoint with respect to the workingplane.

Helical

If the starting-point and endpoint do not lie in a plane that is parallel to the workingplane, a *helical movement* is performed.



TIP: moveCircle3D

The ST-function `moveCircle3D` is a more powerful way to define a circle or helix. It covers 3D-arcs and multiturn circles.

Example:

The following example results in the path that is shown in Figure “ExampleG00G02”. The block N10 uses Radius Programming to define a clockwise arc from X0 Y0 to X10 Y10 with radius 10. Because the radius is positive, the center point c1 of the shorter arc is chosen. In block N30 the center point c2 of the longer arc is used because the radius is negative. The block N50 uses Centerpoint Programming, where the center c3=[60, 0, 0] is the sum of the starting-point [50, 0, 0] and [I, J, K]=[10, 0, 0]. The block N70 defines a full circle with center point C04 because the starting-point and endpoint are equal. The block N90 defines a helical arc with center point C05 and height 30 (in Z-direction).

```

N01 G00 X0 Y0
N10 G02 X10 Y10 U10 F6000
N20 G00 X30 Y0
N30 G02 X40 Y10 U-10
N40 G00 X50 Y0
N50 G02 X60 Y10 I10
N60 G00 X80 Y0
N70 G02 J10
N80 G00 X110 Y0
N90 G02 J10 X120 Y10 Z30
M30

```

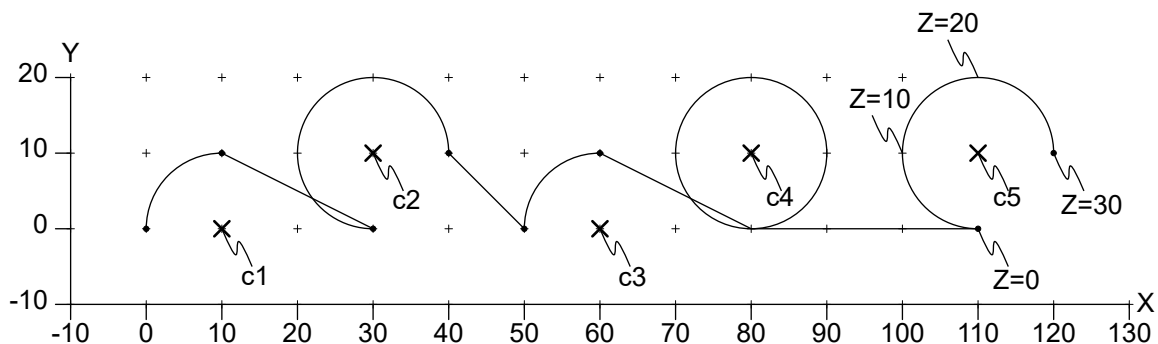


Figure “ExampleG00G02”.

G03 anticlockwise circular interpolation

Command	G3 or G03
Cancellation	G00 [▶ 39], G01 [▶ 39] or G02

Set the interpolation mode to “circular/ helical, counterclockwise”. This interpolation behaves similar to G02. The interpolation mode applies to this block and all succeeding blocks until it is reset by G00, G01 or G02.

Centerpoint Programming I<vx> J<vy> K<vz>

Defines the center point for circular movements. See G2, G3 for details. The center point is defined as $\text{currentPoint} + [vx, vy, vz]$. The current length unit is used for vx, vy, vz. The parameters I, J, K are optional and have a 0 default value.

Radius Programming U<v>

In the context of G2 or G3 the radius is set to $|v|$. The current length unit is used for v. If v is positive, the shorter arc is used to interpolate between the current and the next point. If v is negative, the longer one is used. See G2, G3 for details.

G303

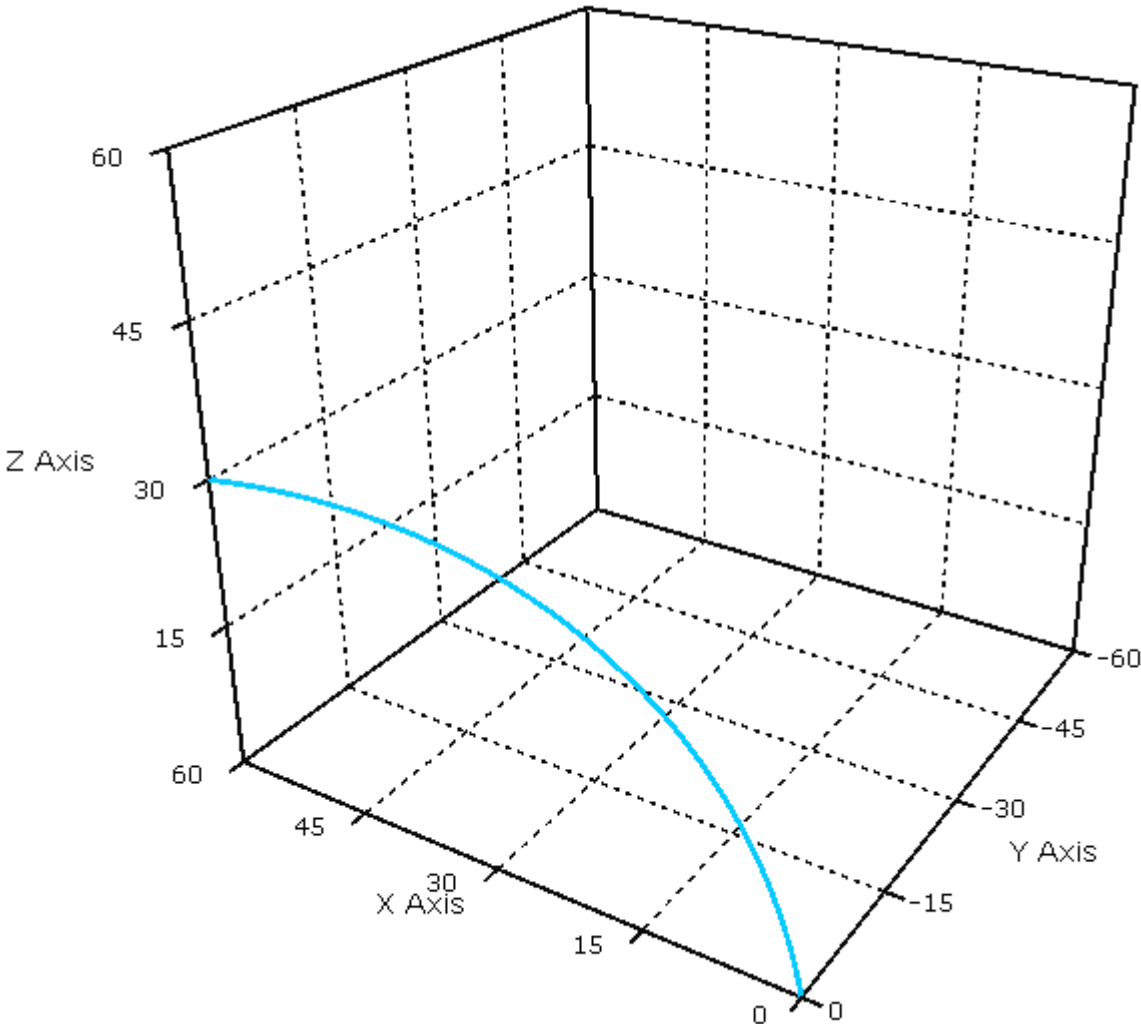
With G303 an circular arc (a CIP circle) can be programmed, that can be freely located in space.

The CIP circle can also be used to program a circle anywhere in space. For this purpose, it is necessary to program not only an endpoint but also some other point on the path.

So that the circle can be described unambiguously, it is necessary, that the three points (the starting point is given implicitly) must not be collinear. It is thus not possible to program a full circle in this way.

I, J and K are available as path point parameters. By default, their values are relative to the starting point of a circular path.

```
G90
N10 G01 F2000 X0 Y0 Z0          // P1 (start point): X, Y, Z,
N20 G303 I30 J-15 K15 X60 Y0 Z30 // P2 (path point): I, J, K
                                   // P3 (end point): X, Y, Z
N30 M02
```



Requirements G303

TwinCAT	GST
TwinCAT V3.1.4024.40	GST 3.1.8.62

5.4.7 Dwell Time (G04)

Command	G4 or G04
Cancellation	End of block
Parameter	F or X

Suspend machining for a given duration. The duration is defined by either X or F in the current time unit. (See unit for details.)

Example:

The following example assumes that the current time unit is set to seconds. On one execution of the program the machine moves to X10, waits for 1.5 seconds and then moves to X20.

```
N10 G01 X10 F6000
N20 G04 F1.5
N30 G01 X20
M02
```

5.4.8 Accurate Stop (G09,G60)

The accurate stop instruction is used, for example, when sharp contour corners must be manufactured. At the contour transition the set path velocity is reduced to zero and then increased again. This ensures that the programmed position is approached precisely.

G09 blockwise Accurate Stop - Nonmodal

Command	G9 or G09
Cancellation	End of block

G09 acts only on the set value side.

G60 Accurate Stop - Modal

Command	G60
Cancellation	G00 [▶ 39]

5.4.9 Delete Distance to go (G31)

Command	G31
Cancellation	End of block

G31 ("delete distance to go") is activated block by block via the NC program. This command enables deleting of the residual distance of the current geometry from the PLC with the function block [ItpDelDtgEx](#) [▶ 210]. In other words, if the command is issued while the block is processed, the motion is stopped with the usual deceleration ramps. The NC program then processes the next block. An error message is generated if the PLC command is not issued during the execution of a block with "delete distance to go" selected.

G31 always effects an implicit decoding stop, i.e. an exact positioning always occurs at the end of the block.

Example:

```
N10 G01 X0 Y0 F6000
N20 G31 G01 X2000
N30 G01 X0
N40 M02
```

Requirements

Development Environment	Target System
TwinCAT V3.1.4024.20	PC or CX (x86 or x64)

5.4.10 Tool Radius Compensation (D, G40, G41, G42)

D

D<v>

Select tool v. The new tool applies to its own block and all succeeding blocks until a new tool is selected. Tool 0 is special. Its selection deactivates any tool compensation. Tool 0 can be regarded as tool where all tool parameters are set to zero. It is selected by default.

Example:

In the following example tool 1 is defined to have a Y-offset of 10 and tool 2 to have an Y-offset of 20. Block N10 and block N50 use tool 0. Tool 1 applies to block N20 and to block N30. In block N40 tool 2 is active. Figure “ExampleD” shows the resulting programmed path (dotted line) and the resulting tool center point path (solid line).

```
!toolSet(index:=1, nr:=1, offsetY:=10);
!toolSet(index:=2, nr:=2, offsetY:=20);
N10 G01 X10 Y0 F6000
N20 G01 X20 Y0 D1
N30 G01 X30 Y0
N40 G01 X40 Y0 D2
N50 G01 X50 Y0 D0
M02
```

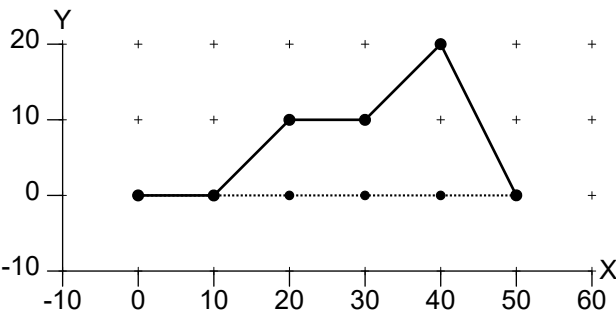


Figure “ExampleD”.

G40

Command	G40 (default setting)
Cancellation	G41 or G42

Deactivate Tool Radius Compensation (TRC).

G41

Command	G41
Cancellation	G40 or G42

Activate tool radius compensation (TRC). After activation the programmed path is shifted left by the radius of the currently selected tool. (See D.)



On activation, a tool with a nonzero index must be selected.

Example:

The following example demonstrates the activation and deactivation of tool radius compensation. The programmed path (dotted line) and the compensated path (solid/ dashed line) are shown in Figure “ExampleG40G41”.

- The first line of the GST program sets the `offset` parameter to 5 mm. Therefore, the adjacent segments of a gap are extended by 5 mm. The remaining gap is closed by a circular arc.
- The second line defines the approach and depart behavior to use a circular arc with a radius of 5 mm and an angle of 90 degree.
- The third line defines tool 1 to have a radius of 10.
- Block N10 describes a linear movement to [10,0,0].

- The next block N20 selects tool 1 and activates tool radius compensation, where D1 comes into effect before G40 is processed and G40 is active before X20 is processed. Therefore, the end of segment N20 is subject to TRC (tool radius compensation). The linear movement from the end of segment N10 to the end of segment N20 in the programmed path is substituted by an approach-segment (dotted line) from the end of N10 to the end of N20' in the compensated path.
- In the next three lines a linear movement along N30, N40 and N50 is programmed. Since segment N40 would result in a collision, it is eliminated from the compensated path.
- In the next line a circular arc along N60 is programmed. The gap between the end of N50' and the beginning of N60' is closed as described earlier.
- The line along N70 is the last segment that is subject to TRC (tool radius compensation), since its deactivation becomes active before the end of N80. The line along N80 is replaced by the depart-segment N80', similarly to the approach-segment.

```
!trcOffsetSet(offset:=5);
!trcApproachDepartSet(approachRadius:=5, approachAngle:=90, departRadius:=5, departAngle:=90);
!toolSet(index:=1, tooltype:=tooltypeMill, radius:=10);
N10 G01 X10 F6000
N20 X20 G41 D1
N30 X35
N40 X40
N50 Y20
N60 G02 X50 Y10 U10
N70 G01 X70
N80 X80 Y0 G40
N90 X90
M02
```

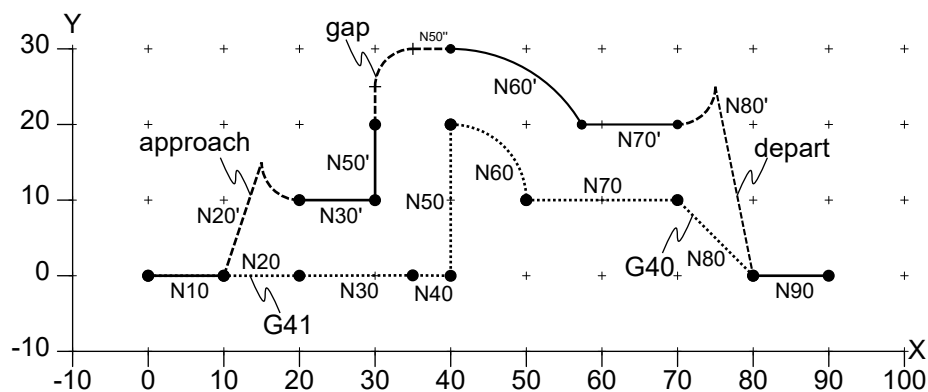


Figure "ExampleG40G41".

G42

Command	G41
Cancellation	G40 or G41

This function is the same as G41, except that the path is shifted to the right. See G41 for details.

5.4.11 Zero Offset Shifts (G53,G54...59)

G53 zero shift suppression

Command	G53 (default setting)
Cancellation	G54..G57

Deactivate any zero offset shift translation. This adjustment is the default. The deactivation becomes active also for the current block. See sections [Zero Offset Shift](#) [► 85] and G58/ G59 for details.

G54..G57 adjustable zero shift

Command	G54 G55 G56 G57
Cancellation	G53 or selection of another configurable zero shift

Activates the translation that is associated with the given G-Code (TZ54...TZ57). Also activates the translations of G58 and G59. The translations apply to the current block and all succeeding blocks until changed. See section [Zero Offset Shift](#) [► 85] for details.

G58, G59 programmable zero shift

Command	G58 or G59
Cancellation	G53

Set the translation that is associated with the given G-Code. The new translation value is given by the parameters X, Y, Z, which are mandatory. By default, the associated translations are zero. See section [Zero Offset Shift](#) [► 85] for details.

Example:

The resulting MCS (machine coordinate system) path and the applied translations of this example are shown in Figure “ExampleG54G58G59”.

- The first line sets the translation that is associated with G54 to [0, 5, 0].
- The next line sets the programmed translation of G58 to [0, 10, 0]. Since zero-offset-shifts are still disabled (default G53), the PCS (program coordinate system) and MCS (machine coordinate system) match.
- Accordingly, the block N20 results in a linear movement from MCS (machine coordinate system) coordinate [0, 0, 0] to [20, 0, 0].
- The next line activates G54 and programs a linear movement along N30, whereby G54 becomes active before the movement. The programmed PCS (program coordinate system) coordinate [40, 0, 0] is mapped to the MCS (machine coordinate system) coordinate [40, 15, 0].
- The next line sets the programmed transformation G59 to [0, 5, 0]. Thereby, the effective translation changes from [0, 15, 0] to [0, 20, 0]. Since the current MCS (machine coordinate system) coordinate must not be affected by this change, the current PCS (program coordinate system) coordinate is set to [40, -5, 0], implicitly.
- The succeeding ST-function `frameGet` stores these coordinates in [`pcsX`, `pcsY`, `pcsZ`].
- The next line merely programs the x-coordinate of the end of segment N50. Therefore, the PCS (program coordinate system) coordinate of the end of segment N50 is [60, -5, 0], which is mapped to the MCS (machine coordinate system) coordinate [60, 15, 0]. In other words: The translation G59 is active, but does not become apparent due to the adaption of the current PCS (program coordinate system) coordinate. (See section [Applying Transformations](#) [► 101] for details.)
- It becomes apparent by the last line, which sets the PCS (program coordinate system) coordinate of the end of segment N60 to [80, 0, 0]. This coordinate is mapped to the MCS (machine coordinate system) coordinate [80, 20, 0].

```
!zeroOffsetShiftSet(g:=54, x:=0, y:=5, z:=0);
N10 G58 X0 Y10 Z0
N20 G01 X20 Y0 F6000
N30 G54 X40 Y0
N40 G59 X0 Y5 Z0
!VAR pcsX, pcsY, pcsZ : LREAL; END_VAR
!frameGet(x=>pcsX, y=>pcsY, z=>pcsZ);
N50 X60
N60 X80 Y0
M02
```

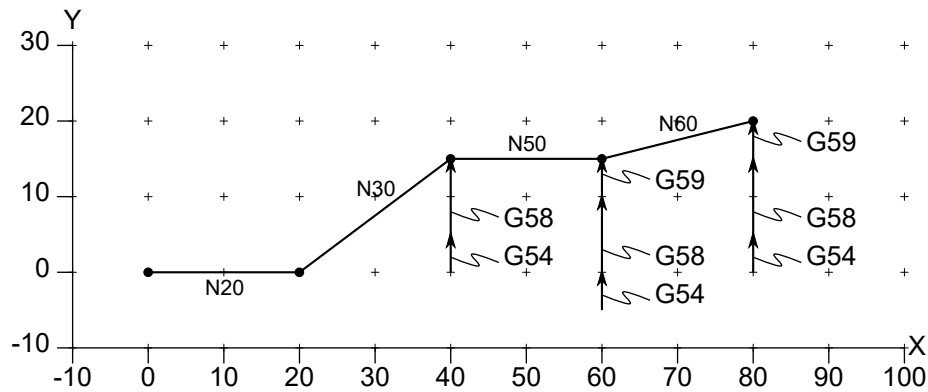


Figure "ExampleG54G58G59".

5.4.12 Working Plane and Feed Direction (G17, G18, G19, P)

G17 working plane XY

Command	G17 (default setting)
Cancellation	G18 or G19

Select **XY**-plane as workingplane, i.e. the workingplane normal is set to $[0, 0, 1]$. This workingplane is the default workingplane.

G18 working plane ZX

Command	G18
Cancellation	G17 or G19

Select **ZX**-plane as workingplane, i.e. the workingplane normal is set to $[0, 1, 0]$.

G19 working plane YZ

Command	G19
Cancellation	G17 or G18

Select **YZ**-plane as workingplane, i.e. the workingplane normal is set to $[1, 0, 0]$.

P Specification of the feed direction

P<v>

Switch tool orientation. The value of *v* must be 1 or -1. If *v* is negative, the tool points in the direction of the working plane normal. Otherwise, it points into the opposite direction.

Example:

The resulting MCS-path (MCS: machine coordinate system) of the following example is shown in Figure "ExampleP". The first line of the program defines Tool 1 to have a length of 10. G18 activates the **XZ**-workingplane.

N10: The end of segment N10 is not subject to any tool compensation as D0 is active.

N20: For segment N20 tool 1 is active with a positive tool orientation. To compensate the tool length the translation $[0, 10, 0]$ is applied. (See section [Transformations \[► 99\]](#) for details.) Thereby, the PCS (program coordinate system) endpoint $[20, 10, 0]$ of

N20 is mapped to the MCS (machine coordinate system) endpoint $[20, 20, 0]$. The MCS (machine coordinate system) point and the applied transformation are shown in Figure “ExampleP”.

N30: In block N30 the tool orientation is switched, which sets the translation to $[0, -10, 0]$. This translation is applied to the PCS (program coordinate system) endpoint of N30 resulting in the MCS (machine coordinate system) endpoint $[30, 0, 0]$.

N20..N90: The blocks N60..N90 are similar to N20..N50, except that the Y-coordinate is not programmed. Therefore, the tool length compensation does not become apparent, although it is active. That behavior happens because the current PCS (program coordinate system) point is always adapted on a changed transformation. (See section [Applying Transformations \[► 101\]](#) for details.)

```
!toolSet(index:=1, tooltype:=tooltypeDrill, length:=10);
G18
N10 X10 Y10 D0 F6000
N20 X20 Y10 D1
N30 X30 Y10 P-1
N40 X40 Y10 P1
N50 X50 Y10 D0
N60 X60 D1
N70 X70 P-1
N80 X80 P1
N90 X90 D0
M02
```

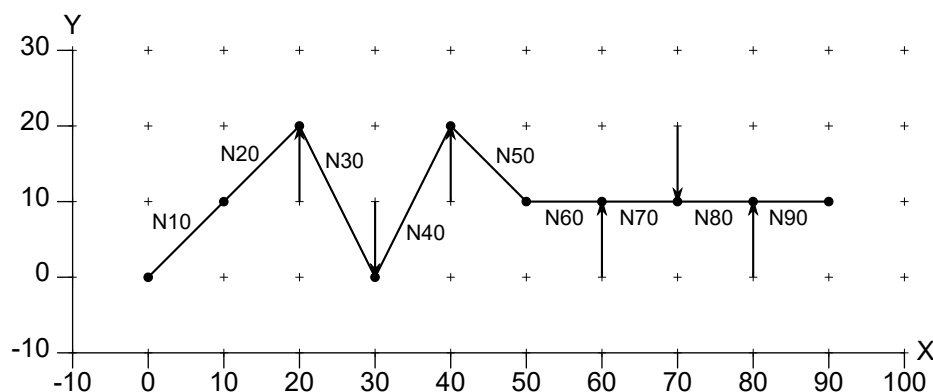


Figure “ExampleP”.

5.4.13 Inch/metric dimensions (G70, G71, G700, G710)

G70 dimensions in inches

Command	G70
Cancellation	G71, G700 or G710

Set the unit for lengths to *inch*. The new unit also applies to the current block. G70 is equivalent to the call `unitLengthSet(unitLengthInch)`. The unit for velocity is not affected. See [UnitLength \[► 86\]](#) and G71 for details.

G71 dimensions in millimeters

Command	G71
Cancellation	G70, G700 or G710

Set the unit for lengths to *millimeter*. The new unit also applies to the current block. G71 is equivalent to the call `unitLengthSet(unitLengthMillimeter)`. The unit for velocity is not affected. See [UnitLength](#) [► 86] for details.

Example:

In Figure “ExampleG70G71” the path of the following example is shown, which uses the unit *millimeter*.

- The first line of the program sets the unit for lengths to *inch*. This unit is used in the same line to interpret X2 in inch. Thus, the path N10 ends at position [50.8 mm, 0 mm, 0 mm].
- Accordingly, the next line moves the tool along N20 towards [50.8 mm, 25.4 mm, 0 mm].
- The last line sets the unit to *millimeter*. Therefore, the path N30 ends at position [80 mm, 25.4 mm, 0 mm]. Accordingly, the segment N30 is a horizontal line.

```
N10 G01 X2 G70 F6000
N20 G01 Y1
N30 G01 X80 Y25.4 G71
M02
```

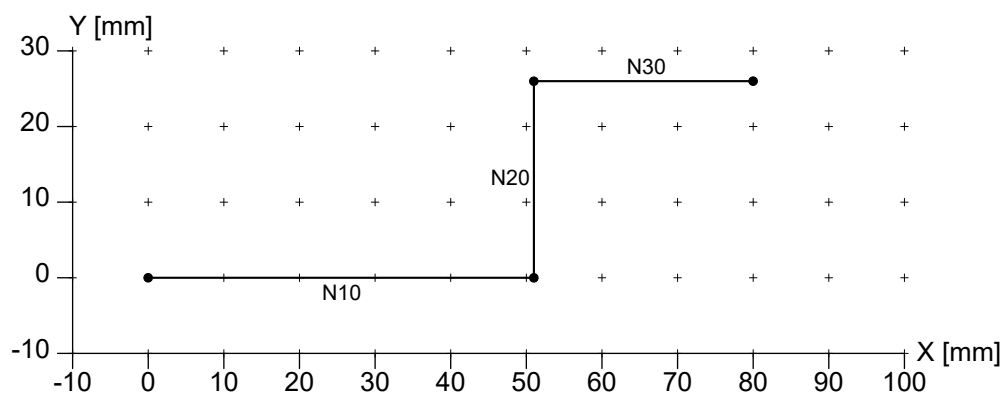


Figure “ExampleG70G71”.

G700 dimensions in inches with calculation of the feed

Command	G700
Cancellation	G70, G71 or G700

Like G70, but also applies to the interpretation of velocity. The new unit comes into effect in the current block. G700 is equivalent to the calls `unitLengthSet(unitLengthInch)` and `unitVelocitySet(unitLengthInch,unitTimeMinute)`.

G710 dimensions in millimeters with calculation of the feed

Command	G710
Cancellation	G70, G71 or G700

Like G71, but also applies to the interpretation of velocity. The new unit comes into effect in the current block. G710 is equivalent to the calls `unitLengthSet(unitLengthMillimeter)` and `unitVelocitySet(unitLengthMillimeter,unitTimeMinute)`.

Example:

The path of the following example is shown in Figure “ExampleG700G710”.

- The first line defines a linear movement to [1 in, 1 in, 0 in] with a velocity of 100 in/min.
- The second line sets the length unit to mm, but does not affect the velocity unit. It defines a movement to [30 mm, 10 mm, 0 mm] with a velocity of 50 in/min.

- The last line also sets the velocity unit to mm/min. Therefore, there is a movement to [40 mm, 20 mm, 0 mm] with a velocity of 1000 mm/min.

```
N10 G700 G01 X1 Y1 F100
N20 G71 G01 X50 Y10 F50
N30 G710 G01 X80 Y20 F1000
```

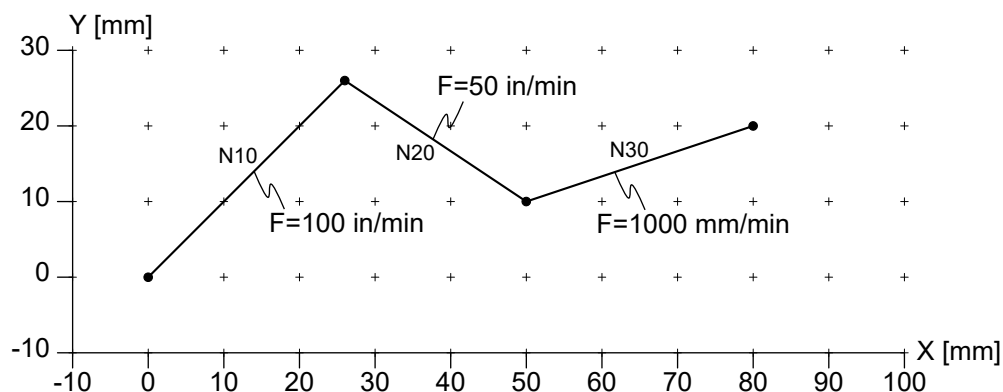


Figure "ExampleG700G710".

5.4.14 Dimensional Notation (G90, G91)

G90 absolute dimensions

Command	G90 (default setting)
Cancellation	G91

Switches to absolute coordinates. X, Y, Z are interpreted as absolute PCS (program coordinate system) coordinates. This adjustment is the default. The switch becomes active in its own block.

G91 relative dimensions

Command	G91
Cancellation	G90

Switches to relative coordinates. X, Y, Z are interpreted to be relative to the current point, i.e. the next point is computed as the sum of [X, Y, Z] and the current point. The switch has an effect for its own block.

● Implement Offsets Manually

i Using G91 and in this way switching to relative coordinates any Tool Offsets and Zero Shifts that have been defined earlier are not evaluated within these coordinates and therefore have to be defined and implemented manually within the framework of the G91-Code.

Example:

The path of the following example is shown in Figure "ExampleG90G91". The switch to G90/ G91 takes effect immediately.

```
N10 G90 G01 X10 Y20 F6000
N20 X20 Y10
N30 G91 X10 Y10
N40 X10 Y-10
N50 G90 X50 Y20
M02
```

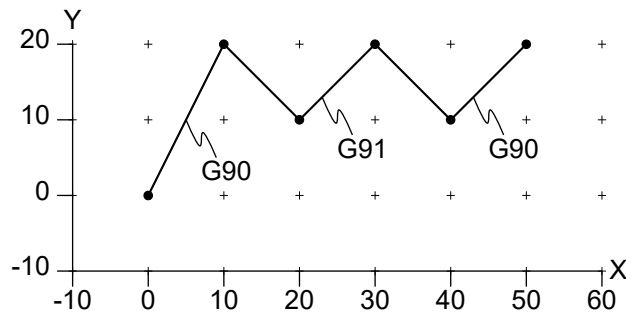


Figure "ExampleG90G91".

5.4.15 M-Functions (M)

M

M<v>

Triggers the M-function v. The timing and behavior depends on the definition of v in the development environment of TwinCAT.

M2 and M30 are internally defined. Both functions trigger a synchronization with the NC-channel. (See wait()-function, chapter [Synchronization](#) [► 81].) Both functions stop the execution of the GST-program. Due to this order the interpreter waits for the completion of the NC-channel before it stops.

In addition, M30 also resets all fast M-functions and H, S, T.



There must not be more than one M-function of type handshake in a block.



The M-functions M2 and M30 do not have to be defined by the user in the development environment of TwinCAT.

Example:

This example assumes the following definitions of M-functions:

M10:	Fast before move.
M11:	Fast after move.
M12:	Fast before move, auto-reset, reset M10, M11.
M20:	Handshake before move.
M21:	Handshake after move.
M02:	Program end.

Figure "ExampleM10M11M12M20M21" visualizes the programmed path and the activation of M-functions. The fast M-functions M10, M11 are reset by M12, which itself is reset automatically.

```
N10 G01 X10 F6000
N20 X30 M10 M20
N30 X50 M11 M21
```

```
N40 X70
N50 X90 M12
M02
```

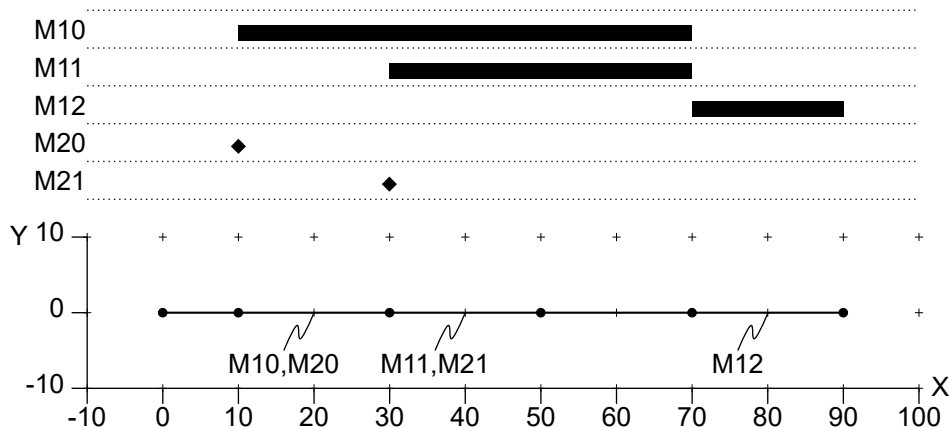


Figure "ExampleM10M11M12M20M21".

5.4.16 R-Parameters

Arithmetic Parameters

The arithmetic parameters, for short known as **R-parameters**, are interpreter variables that are named by an expression of the form "**R<n>**". Since 'n' is an integer in the range 0 . . 999, a total of 1000 **R-parameters** are available. The first 900 values **R0 . . R899** of these are local variables for the **NC** channel. They can only be accessed by the interpreter of the channel. The **R-parameters R900 . . R999** are declared globally. They exist only once for each **NC**, and all channels access the same storage. This kind of accessibility organization makes it possible to exchange data (e.g. for part tracing, collision avoidance etc.) beyond channel boundaries.

Assigning a Value to an R-Parameter

Assigning a value to an **R-parameter** is merely possible within **Structured Text**. There are two ways of assigning a value to an **R-parameter**. The value can be assigned directly or the **rSet** function can be employed. The function **rSet** is suitable to use when the index of the **R-parameter** to be assigned should not be determined until runtime.

Structured Text: Assigning an R-Parameter Value Directly

```
R<n> := LReal;
```

Example

```
!R1 := 7;
```

Structured Text: Assigning an R-Parameter Value with the "rSet" Function

```
rSet(index := LINT, value := LREAL)
```

Example

```
!rSet(1, 7);
```

Reading an R-Parameter Value

There are two ways of reading an **R-parameter**. An **R-parameter** can be used in **G-Code** directly or it can be extracted within **Structured Text** using the **rGet** function. The function **rGet** extracts an **R-parameter** value according to its index.

Structured Text: Reading an R-Parameter Value with the "rGet" Function

```
rGet(index := LINT) : LREAL
```

G-Code Example: Extracting an R-Parameter Value Directly

```
!R1 := 7;
N10 G01 X=R1 F6000
```

G-Code Example: Extracting an R-Parameter Value with the “rGet” Function

```
!R1 := 7;
N10 G01 X={rGet(1)} F6000
```

Example: Assigning and Extracting

```
{
VAR
    valueR1 : LREAL;
END_VAR

rSet(1, 7);
valueR1 := rGet(1);

R2 := 10;
R3 := R1 + R2;

!N10 G01 X=R1 Y0 Z=R2 F6000
!N20 G01 X={rGet(3)}

MSG(toString('R1 = ', valueR1, ', R2 = ', rGet(2), ', R3 = ', R3));
}
M02
```

Output:

```
R1 = 7.000000, R2 = 10.000000, R3 = 17.000000
```

● R-Parameters in Subroutines (Functions)

i Within a subroutine (function) an R-parameter has to be declared via a VAR_EXTERNAL declaration.

Example:

```
{
FUNCTION myFunction : LREAL
VAR_EXTERNAL
    R45: LREAL;
END_VAR
}

N10 G01 X=R45 F6000

!END_FUNCTION
```

Requirements

Development Environment	Target System
TwinCAT V3.1.4024.4 or 4022.32	PC or CX (x86 or x64)

5.4.17 H, S, and T parameters

The H, S, and T parameters are used to transfer parameters to the PLC during block execution.

Parameter	Data type	Use	Example
H parameter	DINT (32Bit signed)	Help parameter	N1 G1 X10 Y20 H=1020
S parameter	WORD	Spindle	N2 G1 X20 Y30 S=30
T parameter	WORD	Tool	N3 G1 X30 Y40 T4



- In contrast to the classic interpreter, the H parameter also acts before the movement in the GST interpreter, see [Execution Order \[► 38\]](#) of a block.
- No R parameter can be assigned to the T parameter.
- For the T parameter, assignment is performed without an assignment operator ('=').

5.4.18 General Codes (F, N, Q, X, Y, Z, A, B, C)

F

F<v>

Set velocity to v. Applies to the current block and all succeeding blocks until a new velocity is programmed. The unit for velocity selected currently is used. (See section [unitVelocitySet \[► 86\]](#) for details.) The default velocity is 0.



The velocity must be set to a nonzero value before a movement is programmed. Otherwise, an error is issued.

Example:

The first two segments N10 and N20 are processed with a velocity of 6000 mm/min, and the last segment N30 is processed with a velocity of 3000 mm/min.

```
N10 G01 X100 F6000
N20 G01 X200
N30 G01 X300 F3000
M02
```

N

N<v>

Set the block number to v. Typically, the block number is used to monitor the progress of the NC-program.

Q

Q<i>=<v>

Set the value of axis Q<i> to v where i must lie in the range 1 to 5. The Q-axes use linear interpolation.



The address letters Q and R are handled in a special way for historical reasons.



The address Q<i> has to be followed by a G-expression or by an ST-expression. The G-word Q1100 is invalid. Use Q1=100, instead.

Example:

The path of the following example is shown in Figure “ExampleQ”. The Q-axes are interpolated linear with the interpolation of a movement. The last block (N40) results in a linear interpolation of a Q-axis without a concurrent movement.

```
N10 G01 X30 Y0 Q1=100 F6000
N20 G02 X50 Y20 I20 Q2=200
N30 G01 X60 Q1=300 Q2=300
N40 Q1=0
M02
```

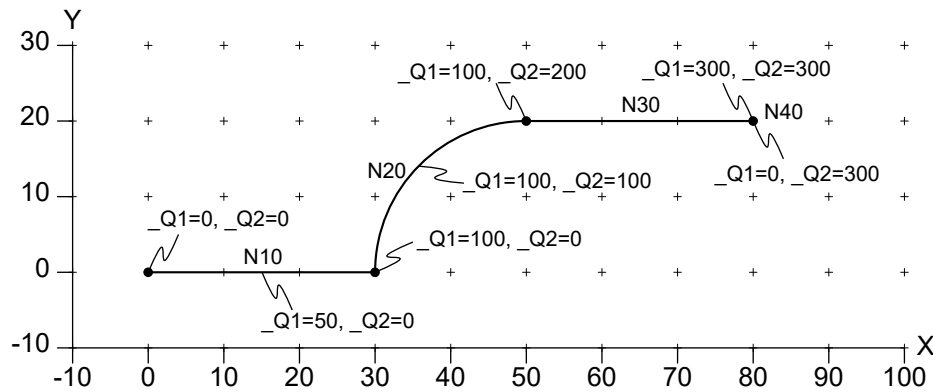


Figure "ExampleQ".

X

X<v>

Sets the X-coordinate of the next point to v. The current length unit is used for v.

Y

Y<v>

Sets the Y-coordinate of the next point to v. The current length unit is used for v.

Z

Z<v>

Sets the Z-coordinate of the next point to v. The current length unit is used for v.

A

A<v>

Sets the A-angle of the next orientation to v. The current angle unit is used for v.

B

B<v>

Sets the B-angle of the next orientation to v. For v the current angle unit is used.

C

C<v>

Sets the C-angle of the next orientation to v. For v the current angle unit is used.

5.5 ST - Structured Text (IEC 61131-3)

5.5.1 Comments

Line Comment

<st-code> // <comment>

Text between '//' and the end of line is treated as comment in ST-Code.

Example:

```
{
VAR
  i : INT; // this variable is primarily used in FOR-loops for counting
END_VAR
}
```

/* */ Comment

```
<st-code> /* <comment>
<comment> */ <st-code>
```

Text between ‘/*’ and ‘*/’ is treated as comment in ST. This type of comment may be nested up to a depth of 3. The ‘/*...*/’-style comment may appear anywhere between literals, keywords, identifiers and special symbols. It may also contain G-Code lines.

Example:

The following example demonstrates the notation of comments in ST-Code. The first comment is placed within a variable declaration. The second comment encloses an entire ST-loop. The comment contains further comments and a G-Code line, which itself contains a G-Code comment.

```
{
VAR i /* used for counting */ : INT;  END_VAR

/* The following loop is commented out.
FOR i := 0 TO 10 DO
  /* zigzag pattern */
  ! G01 (linear interpolation) X=i Y{i MOD 2} F6000
  // end of loop
END_FOR;
*/
}
```

(* *) Comment

```
<st-code> (* <comment>
<comment> *) <st-code>
```

Text between ‘(*)’ and ‘(*)’ is treated as comment in ST. This type of comment may be nested up to a depth of 3. It is similar to the /*...*/-style comment.

5.5.2 Literals

Integer Literals

Decimal	18
Binary	2#10010
Octal	8#22
Hexadecimal	16#12

The same integer value in decimal, binary, octal and hexadecimal notation.

Real Literals

Notation of real values

1.0

1.602E-19

Boolean Literals

Notation of Boolean values

0

1

TRUE

FALSE

Typed Literals

<typename>#<literal>

Typed literals where typename is a native type (e.g. `Word` or `LReal`) or an enumeration type (to avoid ambiguities).

Typing of literals is typically not necessary in GST, since the interpreter implements a decent typesystem that handles untyped literals properly. There are a few exceptions where the type of a literal is significant for semantics, like in the following example.

Example:

The first assignment assigns the value 16#80 to `w`, whereas the second one assigns the value 16#8000 to `w`.

```
{
VAR  w: word;  END_VAR
w :=  ror(BYTE#1,1);
w :=  ror(WORD#1,1);
}
```

String Literals

"abc"

'abc'

Notation of a 2-byte and a 1-byte string, respectively. Note that there is no implicit conversion between both types. The following escape-sequences can be used within both types of literals:

\$L	line feed
\$N	newline
\$P	form feed
\$R	carriage return
\$t	tab
\$' or \$"	quotes
\$<2 or 4 hexadecimal digits>	character of given code

.

Duration Literals

T# [+/-] <value><unit> [...] <value><unit>

TIME# [+/-] <value><unit> [...] <value><unit>

LT# [+/-] <value><unit> [...] <value><unit>

LTIME# [+/-] <value><unit> [...] <value><unit>

Time literals of type `TIME` or `LTIME`. The literal consists of an optional sign (+/-) and a sequence of `value/unit` pairs. `Value` must be an integer, except for the last one that may also be a floating point number. `Values` must not be negative and may be arbitrarily large. `Units` must appear in the following order.

d	day
h	hour
m	minute
s	second
ms	millisecond
us	microsecond
ns	nanosecond

An arbitrary subset of `units` may be used in a literal. For instance, the literal `T#1d15ms1500.01us` is valid.

Date Literals

DATE# <yyyy>-<mm>-<dd>

D# <yyyy>-<mm>-<dd>

LDATE# <yyyy>-<mm>-<dd>

LD# <yyyy>-<mm>-<dd>

Date literal of type `DATE` or `LDATE`. The literal is interpreted as UTC, i.e. timezone, daylight saving time and leap seconds are not considered. The year must not be smaller than 1970. The values `yyyy`, `mm` and `dd` have to be integer values, i.e. `D#1980-20-10` is a valid date literal, for example.

Time-of-Day Literals

TIME_OF_DAY# <hh>:<mm>:<ss>

TOD# <hh>:<mm>:<ss>

LTIME_OF_DAY# <hh>:<mm>:<ss>

LTOD# <hh>:<mm>:<ss>

Time-of-day literal of type `TOD` or `LTOD`. The literal is interpreted as UTC, i.e. timezone, daylight saving time and leap seconds are not considered. `hh` and `mm` must be integer values. `ss` may be an integer or a floatingpoint number, i.e. `TOD#7:30:3.1415` is a valid literal, for example.

Date-and-Time Literals

DATE_AND_TIME#<yyyy>-<mm>-<dd>-<hh>:<mm>:<ss>

DT#<yyyy>-<mm>-<dd>-<hh>:<mm>:<ss>

LDATE_AND_TIME#<yyyy>-<mm>-<dd>-<hh>:<mm>:<ss>

LDT#<yyyy>-<mm>-<dd>-<hh>:<mm>:<ss>

Date-and-time literal of type DT or LDT. The literal is interpreted as UTC, i.e. timezone, daylight saving time and leap seconds are not considered. This literal is a combination of the date literal and the time-of-day literal. Analogously, the corresponding rules for these two parts apply.

5.5.3 Native Data Types**Bitstring Types**

BOOL, BYTE, WORD, DWORD, LWORD

Bitstring types of 1, 8, 16, 32 and 64 bit. Implicit conversion from left to right using zero extension.

Unsigned Integer Types

USINT, UINT, UDINT, ULINT

Unsigned integer types of 8, 16, 32 and 64 bit. Implicit conversion from left to right preserving the value.

Signed Integer Types

SINT, INT, DINT, LINT

Signed integer types of 8, 16, 32 and 64 bit. Implicit conversion from left to right preserving the value. An unsigned type of n bit is also implicitly converted to a signed type of m bit where the relation $m > n$ must hold. There is no implicit conversion between bitstring types and integer types.

Floating Point Types

REAL, LREAL

Floating point data types of 32 and 64 bit. Implicit conversion from left to right preserving the value.

String Types

string[<length>]

wstring[<length>]

1-byte and 2-byte strings of given length. If length is omitted, it has 255 as default value.

Character Types

char

wchar

Single 1-byte and 2-byte character of a string. It can be implicitly converted to a string.

Time-Related Types

TIME, LTIME

DATE, LDATE

TIME_OF_DAY, TOD, LTIME_OF_DAY, LTOD

DATE_AND_TIME, DT, LDATE_AND_TIME, LDT

Datatypes for duration, date and time. Internally, all values of these types are represented with a granularity of 1 nanosecond. Values of date-related types represent the number of nanoseconds since 1.1.1970 (UTC). Leapseconds are ignored. Implicit conversion is allowed from a non-L type to an L type, e.g. from TIME to LTIME.

5.5.4 Userdefined Types

Derived Types

TYPE

```
<typeName>: <typeName> := <defaultValue>;
```

END_TYPE

Definition of a new type as an alias to an existing type. The default value is optional.

Enumeration Types

TYPE

```
<typeName> : (<enumValue>, ..., <enumValue>) := <defaultValue>;
```

END_TYPE

Definition of an enumeration type. The default value is optional.

Enumeration Types with Defined Values

TYPE

```
<typeName> : (<enumValue>:=<integer value>, ...,  
<enumValue>:=<integer value>) := <defaultValue>;
```

END_TYPE

Definition of an enumeration type with user-defined values for each element. The default value is optional.

Array Types

TYPE

```
<typeName>: ARRAY [<from>..<to>,<from>..<to>] OF <typeName> :=  
[<defaultValue>, <repetition>(<defaultValue>), ...];
```

END_TYPE

Definition of an array type. The array may be multi-dimensional. The index range is defined for each dimension. At runtime the boundaries of the array are checked. A boundary violation leads to a runtime-error. The default values are defined in ascending order starting with the last dimension. A value can be repeated by placing it into parentheses prefixed with the number of repetitions. If the number of defined default values does not match the array size, initialization is truncated or padded with the default value of the element type. In either cases a compile-time warning is issued.

Structure Types

TYPE

```
<typeName>: STRUCT  
    <memberName>: memberType;
```

...

```
END_STRUCT := (<memberName> := <defaultValue>, ...);
```

```
END_TYPE
```

Defines a structure type of the given members. Currently, the default value is placed after the type definition. This positional style is a difference to the ST-standard.

Pointer Types

```
TYPE
```

```
    <typeName>: REF_TO <basetypeName>;
```

```
END_TYPE
```

Defines a pointer type of the given base type.

5.5.5 Control Structures

IF-THEN-ELSIF-ELSE

```
IF <condition> THEN
```

```
    <statements>
```

```
ELSIF <condition> THEN
```

```
    <statements>
```

```
ELSE
```

```
    <statements>
```

```
END_IF;
```

Conditional statement. The ELSIF-branch and ELSE-branch are optional. ELSIF can be repeated arbitrarily.

CASE OF

```
CASE <expression> OF
```

```
    <value>, <value>, ..., <value>: <statements>
```

```
ELSE
```

```
    <statements>
```

```
END_CASE;
```

The case-list consists of a comma-separated sequence of values or ranges. Only the first matching case is executed. The optional ELSE-branch is executed if no case matches.

FOR

```
FOR <variable> := <expression> TO <expression> BY <expression> DO
```

```
    <statements>
```

```
END_FOR;
```

Iterates over the given `variable` in the defined range (including) using the supplied step-size. If the latter is omitted, it has 1 as default value.

WHILE

```

WHILE <condition> DO
    <statements>
END_WHILE;

```

Pre-checked loop.

REPEAT

```

REPEAT
    <statement>
UNTIL <condition>
END_REPEAT;

```

Post-checked loop. The break condition is evaluated after performing the <statements> the loop includes.

EXIT

```
EXIT;
```

EXIT can be used within loops to leave the loop. If loops are nested, only the innermost loop is left. If there is no loop surrounding the EXIT keyword, a compile-time error is issued.

5.5.6 Jump statement

```

LABEL <label_name>;

<statements>

GOTO <label_name>;

```

The LABEL- and GOTO statements allow jumps in the G-code.

```
LABEL <label_name>;
```

A jump destination with the specified name is included at the specified position using LABEL.

<label_name> must be a valid identifier, like the name of a variable or a function.

A LABEL statement can be used where a statement is expected, except in the context of a CASE statement.

If a LABEL statement is defined in a function, its scope is limited to the function.

If the label statement is in the global code, it is valid only in the global scope.

It is an error if two LABEL statements with the same name are defined in the same scope.

```
GOTO <label_name>;
```

Causes the execution of the g-code to continue at the point where the specified LABEL is included.

It is an error if the specified <label_name> is not defined in the scope of the GOTO statement.

In addition, it is not allowed to use GOTO statements within a CASE statement.

Sample

```

N10 G00 X0 Y0 Z0
N20 G01 X10 F1000
!R1 := 0;

!LABEL jumpPos;
!R2 := R1;
!R1 := R2 + 1;
N30 G01 Y=10*R1

!IF R1 = 1 THEN
    !GOTO jumpPos;
!END_IF

```

```

N40 G01 Z =10*r1
!IF R1 = 2 THEN
!goto jumpPos;
!END_IF
M30

```

Requirements

TwinCAT	GST Interpreter
TwinCAT 3.1.4024.47	GST 3.1.8.67

5.5.7 Userdefined Functions

Function Definition

```

FUNCTION <name> : <returntype>

VAR_INPUT
    <variable declarations>
END_VAR

VAR_OUTPUT
    <variable declarations>
END_VAR

VAR_IN_OUT
    <variable declarations>
END_VAR

VAR
    <variable declarations>
END_VAR

VAR_EXTERNAL
    <variable declarations>
END_VAR

    <statements>

END_FUNCTION

```

Declares a function. Thereafter, it is callable by its name. The declaration of the return type is optional. If it is supplied, the function returns a value of the given type. The return value is defined within the function body by an assignment to the function name.

The function may have input, output and in-out parameters. The order of declaration is significant. It is used for nonformal calls. Declared variables are only used within the function body. External variables are imported from global scope. Variables and parameters are not persistent, i.e. they do not retain their value between two calls.

Nonformal Function Call

```
<functionname>(<expression>, ..., <expression>)
```

Nonformal function call. The order of expressions must match the number and order of declared parameters.

Formal Function Call

```
<functionname>(
    <inputParamName>  := <expression>,
    <outputParamName> => <variableName>,
    <inputParamName>  := <variableName>)
```

Formal function call. Parameters are identified by their name. If a declared parameter is not listed, it is implicitly set to its default value.



Do not Mix Formal with Nonformal

Mixing formal with nonformal function calls leads to invalid GST-syntax.

5.5.8 Standard Functions

5.5.8.1 Type Conversion

Type Conversion (*_TO_*)

```
<nativeType>_to_<nativeType>(x)
to_<nativeType>(x)
```

Explicit conversion between the given native types. The second alternative is overloaded for any applicable type.

For conversion from floatingpoint to integer x is rounded.

5.5.8.2 Arithmetic and Trigonometric

ABS

ABS (x)

Returns the absolute value of x .

The function is overloaded for any integer type and floatingpoint type. The type of x is used as return type.

SQRT

SQRT (x)

Returns the square root of x .

The function is overloaded for any floatingpoint type. The type of x is used as return type.



RESTRICTION:

Variable x must not be negative.

LN

LN (x)

Returns the natural logarithm of x , i.e. the logarithm to the base e .

The function is overloaded for any floatingpoint type. The type of x is used as return type.

**RESTRICTION:**

Variable x must be larger than 0.

LOG

LOG (x)

Returns the logarithm of x to the base 10.

The function is overloaded for any floatingpoint type. The type of x is used as return type.

**RESTRICTION:**

Variable x must be larger than 0.

EXP

EXP (x)

Returns e raised to the power of x .

The function is overloaded for any floatingpoint type. The type of x is used as return type.

SIN

SIN (x)

Returns the sine of x where x is expected to be in radians.

The function is overloaded for any floatingpoint type. The type of x is used as return type.

See also: The gSin function (chapter [Trigonometric](#) [► 87]).

COS

COS (x)

Returns the cosine of x where x is expected to be in radians.

The function is overloaded for any floatingpoint type. The type of x is used as return type.

See also: The gCos function (chapter [Trigonometric](#) [► 87]).

TAN

TAN (x)

Returns the tangent of x where x is expected to be in radians.

The function is overloaded for any floatingpoint type. The type of x is used as return type.

See also: The gTan function (chapter [Trigonometric](#) [► 87]).

ASIN

ASIN (x)

Returns the arc sine of x within the interval $[-\pi/2, \pi/2]$ radians.

The function is overloaded for any floatingpoint type. The type of x is used as return type.

See also: The gASin function (chapter [Trigonometric \[► 87\]](#)).

**RESTRICTION:**

Variable x must lie within the interval $[-1, 1]$.

ACOS

ACOS (x)

Returns the arc cosine of x within the interval $[0, \pi]$ radians.

The function is overloaded for any floatingpoint type. The type of x is used as return type.

See also: The gACos function (chapter [Trigonometric \[► 87\]](#)).

**RESTRICTION:**

Variable x must lie within the interval $[-1, 1]$.

ATAN

ATAN (x)

Returns the arc tangent of x within the interval $[-\pi/2, \pi/2]$ radians.

The function is overloaded for any floatingpoint type. The type of x is used as return type.

See also: The gATan function (chapter [Trigonometric \[► 87\]](#)).

ATAN2

ATAN2 (y, x)

Returns the arc tangent of y/x within the interval $[-\pi, \pi]$ radians.

The function is overloaded for any floatingpoint type. The smallest common type of x and y is used as return type.

See also: The gATan2 function (chapter [Trigonometric \[► 87\]](#)).

ADD

ADD ($x_1, x_2, \dots$)

Returns the sum of all parameters. The ADD-function can have an arbitrary number of parameters, but has to have at least one.

The function is overloaded for any integer and floatingpoint type. The smallest common type of all parameters is used as return type.

MUL

MUL ($x_1, x_2, \dots$)

Returns the product of all parameters. The MUL-function can have an arbitrary number of parameters, but has to have at least one. The infix-operator '*' can be used as an alternative.

The function is overloaded for any integer and floatingpoint type. The smallest common type of all parameters is used as return type.

SUB

SUB (x, y)

Returns the difference $x-y$. The infix-operator '-' can be used as an alternative.

The function is overloaded for any integer and floatingpoint type. The smallest common type of x and y is used as return type.

DIV

`DIV(x, y)`

Returns the quotient x/y . The infix-operator '/' can be used as an alternative.

The function is overloaded for any integer and floatingpoint type. The smallest common type of x and y is used as return type. If the return type is an integer type, the result is truncated towards zero.



RESTRICTION:

Variable y must not be zero.

MOD

`MOD(x, y)`

Returns the remainder of the integer division x/y . The infix-operator 'MOD' can be used as an alternative.

The function is overloaded for any integer type. The smallest common type of x and y is used as return type. The result may also be negative. The equation $x = \text{MUL}(\text{DIV}(x, y), y) + \text{MOD}(x, y)$ holds.



RESTRICTION:

Variable y must not be zero.

EXPT

`EXPT(x, y)`

Returns x raised to the power of y .

The function is overloaded such that x has a floatingpoint type and y has a floatingpoint type or integer type. The type of x is used as return type, i.e. returned is a `Real` or an `LReal` floating point type. The infix-operator '**' can be used as an alternative.



RESTRICTION:

If x is negative, then y must be an integer.



RESTRICTION:

If x is zero, then y must be larger than zero.

5.5.8.3 Shift and Rotation

SHL

`SHL(x, y)`

Returns the bitstring x shifted left by y bits. Zero-bits are inserted at the right side. The least significant bit is assumed to be rightmost.

The function is overloaded for any bitstring type for x and any integer type for y . The type of x is used as return type.

**CONSTRAINT:**

Variable y must not be negative.

SHR

$\text{SHR}(x, y)$

Returns the bitstring x shifted right by y bits. Zero-bits are inserted at the left side. The least significant bit is assumed to be rightmost.

The function is overloaded for any bitstring type for x and for any integer type for y . The type of x is used as return type.

**CONSTRAINT:**

Variable y must not be negative.

ROL

$\text{ROL}(x, y)$

Returns the bitstring x rotated left by y bits. Bits that are shifted out at the left side are inserted at the right side. The least significant bit is assumed to be rightmost.

The function is overloaded for any bitstring type for x and for any integer type for y . The type of x is used as return type.

**CONSTRAINT:**

Variable y must not be negative.

ROR

$\text{ROR}(x, y)$

Returns the bitstring x rotated right by y bits. Bits that are shifted out at the right side are inserted at the left side. The least significant bit is assumed to be rightmost.

The function is overloaded for any bitstring type for x and for any integer type for y . The type of x is used as return type.

**CONSTRAINT:**

Variable y must not be negative.

5.5.8.4 Logical Operations**AND**

$\text{AND}(x1, x2, \dots)$

Returns the bitwise Logical And of all parameters. Bit i is set in the result if bit i is set in all parameters. The **AND** function can have an arbitrary number of parameters, but has to have at least one.

The function is overloaded for any bitstring type. The smallest common bitstring type is used as return type.

OR

$\text{OR}(x1, x2, \dots)$

Returns the bitwise Logical Or of all parameters. Bit *i* is set in the result if bit *i* is set in at least one of all parameters. The `OR` function can have an arbitrary number of parameters, but has to have at least one.

The function is overloaded for any bitstring type. The smallest common bitstring type is used as return type.

XOR

`XOR(x1, x2, ...)`

Returns the bitwise Logical Exclusive Or of all parameters. Bit *i* is set in the result if bit *i* is set in an uneven number of all parameters. The `XOR` function can have an arbitrary number of parameters, but has to have at least one.

The function is overloaded for any bitstring type. The smallest common bitstring type is used as return type.

NOT

`NOT(x)`

Returns the bitwise complement of *x*. Bit *i* is set in the result if bit *i* is not set in *x*.

The function is overloaded for any bitstring type. The type of *x* is used as return type.

5.5.8.5 Selection (Conditional Expressions)

SEL

`SEL(cond, x1, x2)`

Returns *x1* if *cond* is false, and *x2* otherwise.

MUX

`MUX(select, x0, x1, ..., xN)`

Returns *x*<*select*>. If *select* is 0, *x0* is returned. If *select* is 1, *x1* is returned and so forth. The `MUX` function can have an arbitrary number of parameters, but has to have at least two.

The function is overloaded for any type for *x*<*i*> and for any integer for *select*. The smallest common type of *x*<*i*> is used as return type.



RESTRICTION:

The variable *select* must lie within the interval $[0, N]$. Otherwise, an out-of-bounds error is issued at runtime.

5.5.8.6 Min, Max and Limit

MAX

`MAX(x1, x2, ...)`

Returns the maximum of all parameters.

The function is overloaded for any integer and floatingpoint type. The smallest common type of all parameters is used as return type.

MIN

`MIN(x1, x2, ...)`

Returns the minimum of all parameters.

The function is overloaded for any integer and floatingpoint type. The smallest common type of all parameters is used as return type.

LIMIT

LIMIT(*min*, *in*, *max*)

Returns *in* if it lies in the interval [*min*, *max*]. Otherwise, the violated bound (*min* or *max*) is returned.

The function is overloaded for any integer and floatingpoint type. The smallest common type of all parameters is used as return type.



CONSTRAINT:

The *min* boundary must be smaller than the *max* boundary.

5.5.8.7 Comparison

GT

GT(*x*, *y*)

Returns **TRUE** if *x* is larger than *y*. The smallest common type of *x* and *y* is used to perform the comparison.

The function is overloaded for all integer and floatingpoint types. The returntype is **BOOL**.

GE

GE(*x*, *y*)

Returns **TRUE** if *x* is not smaller than *y*. The smallest common type of *x* and *y* is used to perform the comparison.

The function is overloaded for all integer and floatingpoint types. The returntype is **BOOL**.

EQ

EQ(*x*, *y*)

Returns **TRUE** if *x* and *y* are equal. The smallest common type of *x* and *y* is used to perform the comparison.

The function is overloaded for all integer and floatingpoint types. The returntype is **BOOL**.

LE

LE(*x*, *y*)

Returns **TRUE** if *x* is not larger than *y*. The smallest common type of *x* and *y* is used to perform the comparison.

The function is overloaded for all integer and floatingpoint types. The returntype is **BOOL**.

LT

LT(*x*, *y*)

Returns **TRUE** if *x* is smaller than *y*. The smallest common type of *x* and *y* is used to perform the comparison.

The function is overloaded for all integer and floatingpoint types. The returntype is **BOOL**.

NE

NE(*x*, *y*)

Returns `TRUE` if `x` and `y` are not equal. The smallest common type of `x` and `y` is used to perform the comparison.

The function is overloaded for all integer and floatingpoint types. The returntype is `BOOL`.

5.6 CNC Functions

5.6.1 Strings and Messages

toString

`toString(<arg0>, ..., <argN>): STRING`

Converts and concatenates the given arguments to one string. This string is limited to 255 characters, which is the default string length. The `toString`-function behaves like the `print` function, except that it yields a formatted string instead of printing.



The `toString`-function is especially useful to format a string for the `msg (...)`-function.

msg

`msg(str:= String[81])`

Send the given message to the message list of TwinCAT. The message is processed by the NC-channel synchronously. It appears in the user-interface when all preceeding NC-commands are completed.

To send formatted strings this function can be combined with the `toString`-function.



The message is restricted to 81 characters. Text exceeding this restriction will be truncated.

Example:

The path of the following example is shown in Figure “ExampleMsg”. It is annotated with the emitted messages.

```
{
VAR
    x,y,z: LREAL;
    start: LDT;
END_VAR

!N10 G00 X0 Y0 F300
start := currentLdt();
!N20 G01 X30
msg('N20 completed');
!N30 X60 Y10
frameGet(x=>x,y=>y,z=>z);
msg(toString('Current position: [' ,x,',',y,',',z,']'));
!N40 X90
sync();
msg(toString('Machining time: ', currentLdt()-start));
}
M02
```

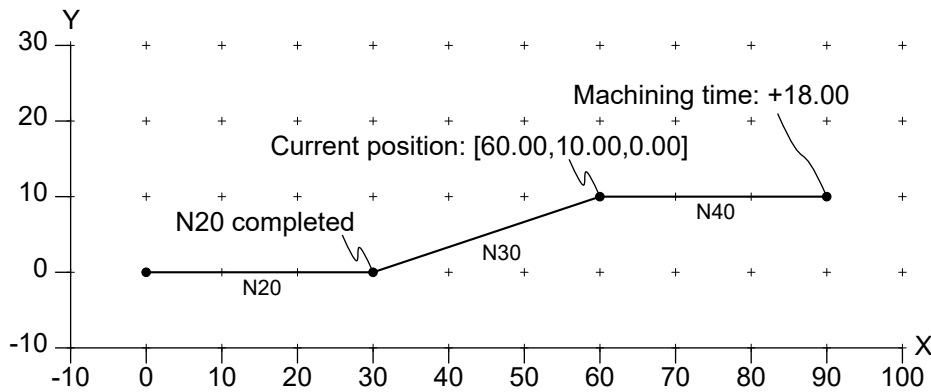


Figure "ExampleMsg".

5.6.2 Transformations

transRotX/Y/Z

```
transRotX(angle := LREAL)
```

```
transRotY(angle := LREAL)
```

```
transRotZ(angle := LREAL)
```

Rotation around the respective axis by the given angle in the user-defined angle unit. The rotation is pushed onto the stack of transformations. The angle value is interpreted using the current angle-unit. See section [Transformations](#) [► 99] for details.

Example:

The resulting path of the following example is shown in Figure "ExampleTransRotZ".

- N10 is programmed with the PCS (program coordinate system) and the MCS (machine coordinate system) being equal.
- N20 is programmed after a 45-degree rotation around the Z-axis in $[0, 0, 0]$ has been pushed onto the stack of transformations. Another rotation of 45 degrees is pushed onto the transformation stack such that the rotations add up to 90 degree.
- Therefore, the MCS (machine coordinate system) coordinate of the end of segment N30 is $[0, 30, 0]$.

```
N10 G01 X30 Y0 F6000
!transRotZ(45);
N20 G01 X30 Y0
!transRotZ(45);
N30 G01 X30 Y0
!transPop();
!transPop();
M02
```

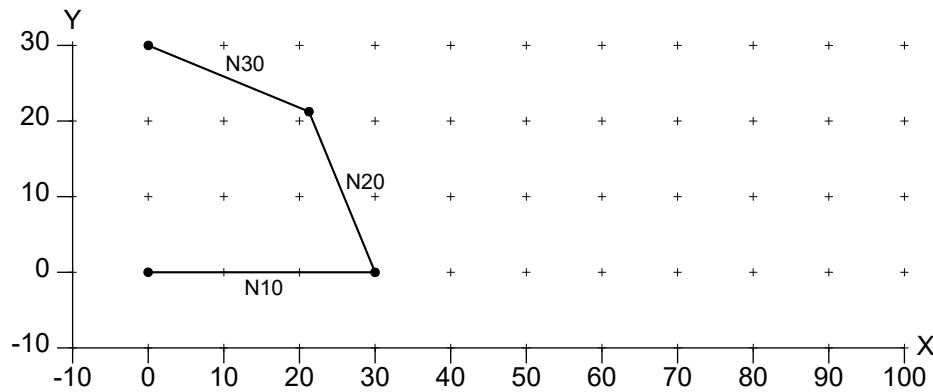



Figure "ExampleTransRotZ".

transRotA

```
transRotA(x:=LReal, y:=LReal, z:=LReal, angle:=LReal)
```

Rotate around vector $[x, y, z]$ by the given *angle*. The rotation is pushed onto the stack of transformations. The angle value is interpreted using the current angle-unit. See section [Transformations](#) [► 99] for details.



The vector $[x, y, z]$ must not be the zero vector.

Example:

The resulting path of the following example is shown in Figure "ExampleTransRotA". The first invocation of `transRotA` rotates the PCS (program coordinate system) around the positive z-axis (right-hand rule) by 45 degree. The second invocation rotates around the negative z-axis by the same angle, i.e. into the opposite direction. The combination of both rotations is the identity transformation.

```
!transRotA(0,0,1,45);
N10 G01 X30 Y0 F6000
!transRotA(0,0,-1,45);
N20 G01 X30 Y0
!transPop();
!transPop();
M02
```

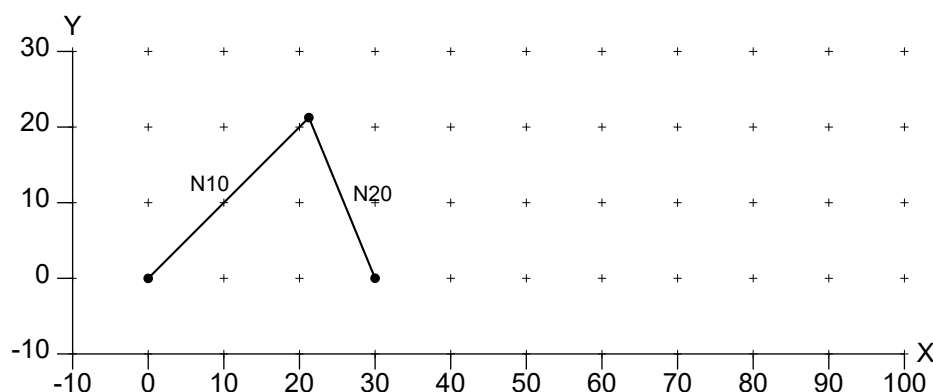


Figure "ExampleTransRotA".

transMirrorX/Y/Z

```
transMirrorX()
```

```
transMirrorY()
```

```
transMirrorZ()
```

Mirror with respect to the X-direction, Y-direction or Z-direction relative to the origin of the current PCS (program coordinate system). The transformation is pushed onto the stack of transformations.

i The invocation of a mirror function switches the orientation of the coordinate system from right-handed to left-handed or vice versa. Most notably, this behavior switches the rotation direction of circles and the compensation direction of tool radius compensation. By default, the coordinate system is right-handed.

Example:

The resulting path of the following example is shown in Figure “ExampleTransMirrorX”. The PCS (program coordinate system) is mirrored along the X-dimension. Thereby, the coordinate system becomes a left-handed system, within which the rotation direction of G2 is (intentionally) swapped.

```
N10 G02 X20 Y20 U20 F6000
!transMirrorX();
N20 G02 X-40 Y0 U20
!transPop();
M02
```

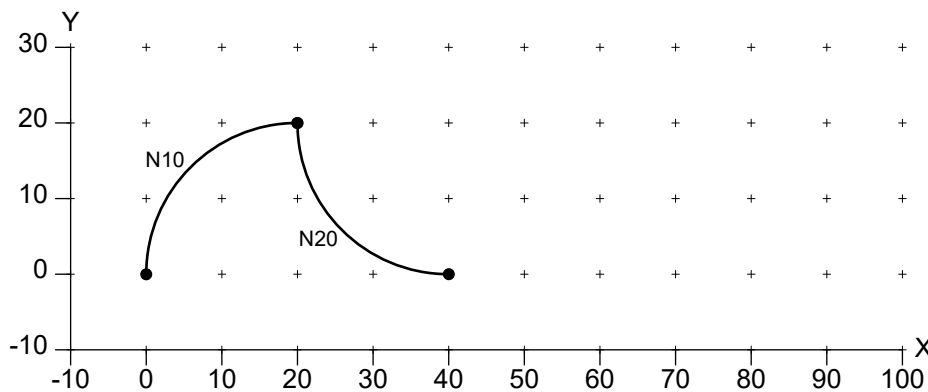


Figure “ExampleTransMirrorX”.

transScale

```
transScale(factor:= LReal)
```

Scales the coordinate system by the `factor` in the X-dimension, Y-dimension and Z-dimension. The transformation is pushed onto the stack of transformations.

i The factor must be nonzero.

i If the factor is negative, the coordinate system is effectively mirrored in the X-dimension, Y-dimension and Z-dimension. Thus, the orientation of the coordinate system is swapped.

Example:

The resulting path of the following example is shown in Figure “ExampleTransScale”. After scaling by a factor of 2, the endpoint of segment N20 is mapped to [60, 20, 0].

```
N10 G01 X30 Y10 F6000
!transScale(2);
N20 G01 X30 Y10
!transPop();
M02
```

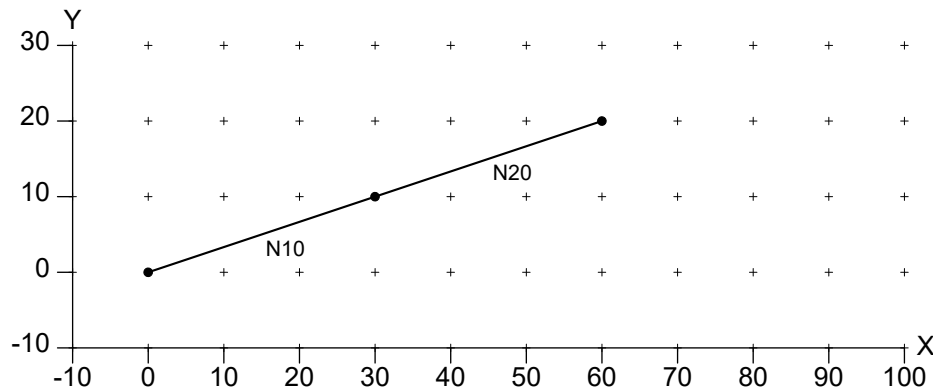


Figure "ExampleTransScale".

transScaleAxis

```
transScaleAxis(axisNo := axisIndex, factor := value);
```

Scales the selected path axis (`axisNo`) by the factor. The supported axis and indexes are:

- X: 0
- Y: 1
- Z: 2

Q-axes are not supported.



A different axes scaling is only allowed for linear movements, not for circular movements.

Example 1

```
N10 G01 X30 Y10 F6000
!transScaleAxis(axisNo:= 0, factor:=2.0);
!transScaleAxis(axisNo:= 1, factor:=2.0);
!transScaleAxis(axisNo:= 2, factor:=3.0);
N20 G01 X30 Y10
N30 G03 X40 Y10 I5 J0
M02
```

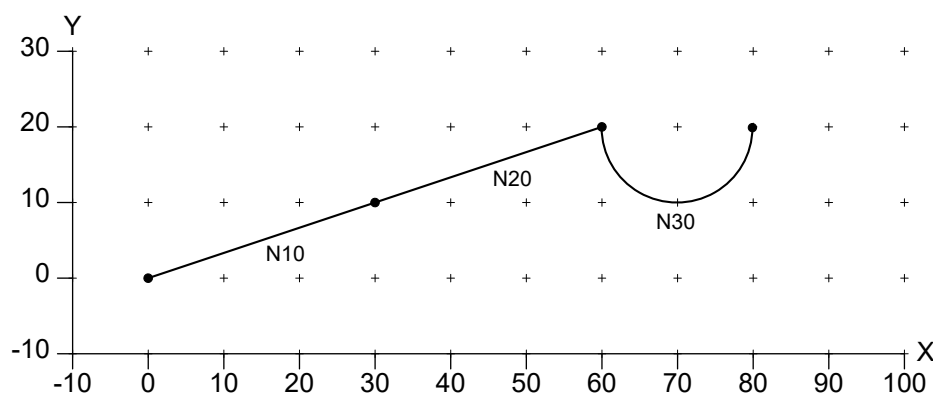


Figure "Example 1 TransScaleAxis".

Example 2

```
N10 G01 X20 Y5 F6000
!transScaleAxis(axisNo:= 0, factor:=2.0);
!transScaleAxis(axisNo:= 1, factor:=2.0);
!transScaleAxis(axisNo:= 2, factor:=3.0);
N20 G01 X20 Y5
!transScaleAxis(axisNo:= 0, factor:=2.0);
```

```
!transScaleAxis(axisNo:= 1, factor:=3.0);
N30 G01 X20 Y5
M02
```

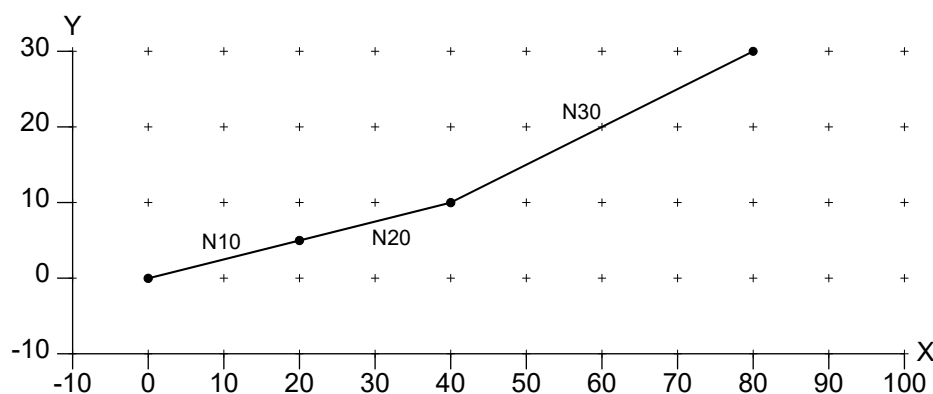


Figure "Example 2 TransScaleAxis".

Requirements

Development Environment	Target System
TwinCAT V3.1.4024.20	PC or CX (x86 or x64)

transTranslate

```
transTranslate(x:=LReal, y:=LReal, z:=LReal)
```

Translate by vector $[x, y, z]$. The translation is pushed onto the stack of transformations.

Example:

The resulting path of the following example is shown in Figure "ExampleTransTranslate". After translating by $[40, 20, 0]$ the endpoint of segment N20 is mapped to $[80, 20, 0]$.

```
N10 G01 X20 Y0 F6000
!transTranslate(40,20,0);
N20 G01 X40 Y0
!transPop();
M02
```

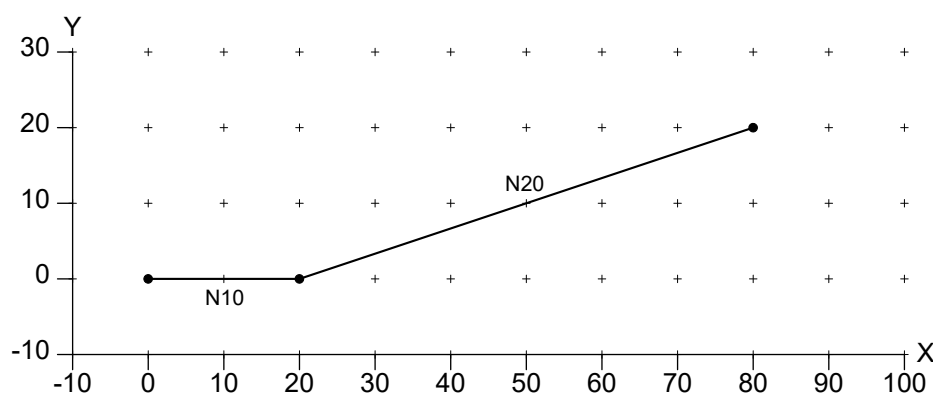


Figure "ExampleTransTranslate".

transPop

```
transPop()
```

Pops a transformation from the stack of transformations.

Example:

The resulting path of the following example is shown in Figure “ExampleTransPop”. This example pushes the translation $[0, 20, 0]$ onto the stack, followed by the translation $[0, 10, 0]$. Thereby, the effective translation for N30 is $[0, 30, 0]$. The invocation of `transPop` removes the translation $[0, 10, 0]$ from the stack. Thus, the endpoint of segment N40 is translated by $[0, 20, 0]$. After removing the last translation from the stack the endpoint of segment N50 is not translated at all.

```
N10 G01 X10 Y0 F6000
!transTranslate(0,20,0);
N20 G01 X30 Y0
!transTranslate(0,10,0);
N30 G01 X50 Y0
!transPop();
N40 G01 X70 Y0
!transPop();
N50 G01 X90 Y0
M02
```

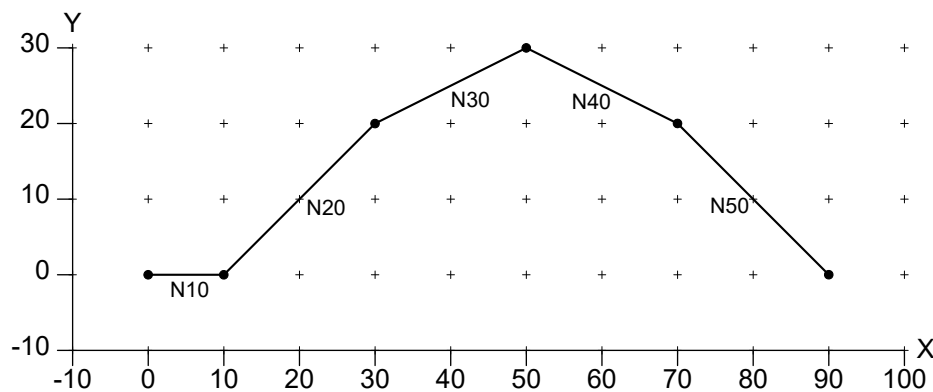


Figure “ExampleTransPop”.

transDepth

`transDepth() : UInt`

Yields the depth of the stack of transformations, i.e. the number of active transformations. See `transRestore(...)`, chapter [transformations](#) [► 99], for more details.

transRestore

`transRestore(depth:= UInt)`

Reduces the stack of transformations to the given depth. This command is typically used in conjunction with `transDepth()` to restore an earlier state of the stack.



The current depth of the stack must not be smaller than the given depth.

Example:

The resulting path of the following example is shown in Figure “ExampleTransDepthTransRestore”. A translation to $[40, 10, 0]$ is initially pushed onto the transformation stack. The resulting depth is stored in variable `savedDepth`. The following code repeatedly performs a linear move to X20 Y0 and a rotation by 45 degree. This resulting path is one half of an octagon, composed of segments N10 to N50. When N50 is processed, the transformation stack contains the initial translation and 4 rotations by 45 degree. The invocation of `transRestore(savedDepth)` restores the stack depth of 1 by removing all rotations. Hence, only the translation is applied to N60.

```
!VAR savedDepth : UInt; END_VAR
!transTranslate(40,10,0);
!savedDepth := transDepth();

N10 G01 X20 Y0 F6000
```

```
!transRotZ(45);
N20 G01 X20 Y0
!transRotZ(45);
N30 G01 X20 Y0
!transRotZ(45);
N40 G01 X20 Y0
!transRotZ(45);
N50 G01 X20 Y0
!transRestore(savedDepth);
N60 G01 X10 Y0
M02
```

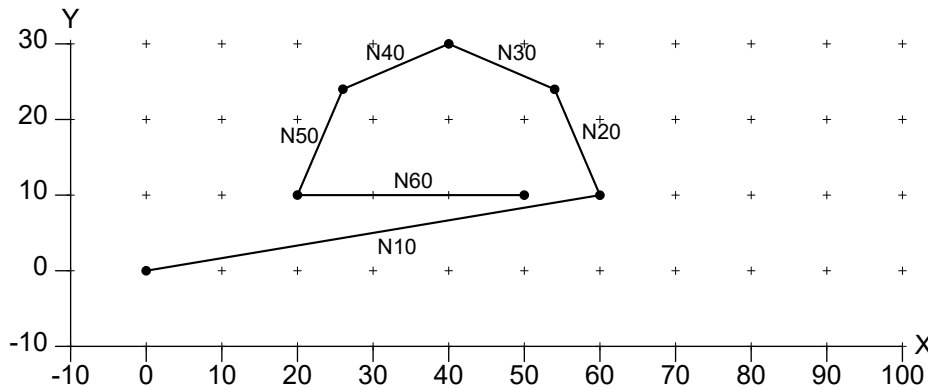


Figure "ExampleTransDepthTransRestore".

5.6.3 Circular Movement

moveCircle3d

```
moveCircle3d(cx:=LREAL, cy:=LREAL, cz:=LREAL, nx:=LREAL, ny:=LREAL, nz:=LREAL, a
nple:=LREAL, height:=LREAL)
```

Move circular by rotating around the center cx, cy, cz and the normal vector nx, ny, nz by the given angle. If height is nonzero, a helix is described. If angle is greater than a full circle, a multiturn circle or a multiturn helix is described. The rotation is performed according to the right hand rule. Using a negative angle or flipping the normal will reverse the direction of rotation. The angle value is interpreted using the current angle unit. The parameters x, y, z, cx, cy, cz are interpreted using the current length unit.



The radius must be nonzero.

Example:

The resulting path of the following example is shown in Figure "ExampleMoveCircle3D". The invocation of moveCircle3D describes a helical movement. It starts at the current point that is $[40, 10, 0]$. The center axis of the helix is defined by the point $[30, 10, 0]$ and direction $[gSin(22.5), 0, gCos(22.5)]$. Compared to the workingplane normal $[0, 0, 1]$ the axis is tilted by 22.5 degree in x-direction. The angle of $720+90$ degree describes a multiturn helix. It exhibits a height of 30 with respect to the center axis. The endpoint of the helix is not explicitly programmed to avoid redundancy. If the user requires these coordinates, they can be retrieved by the frameGet(...) function, as demonstrated. The approximate coordinates are shown in Figure "ExampleMoveCircle3D".

```
{
VAR
  x,y,z: LREAL;
END_VAR

!N10 G01 X40 Y10 F6000
moveCircle3D(cx:=30, cy:=10, cz:=0, nx:=gSin(22.5), ny:=0, nz:=gCos(22.5), angle:=720+90, height:=30
);
frameGet(x=>x, y=>y, z=>z);
```

```
}
M02
```

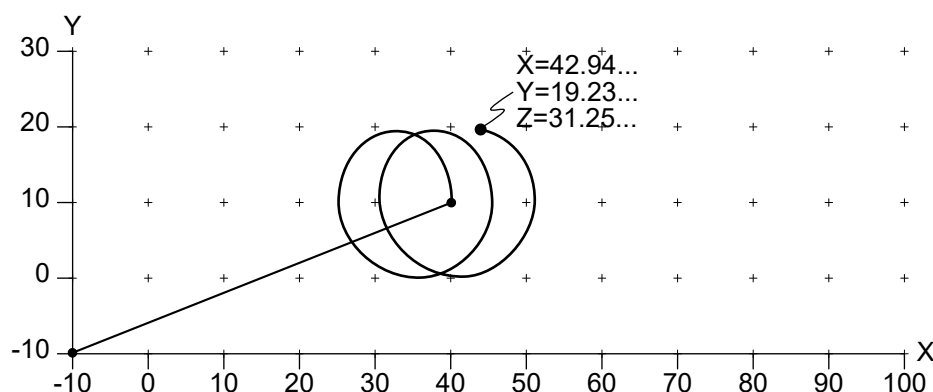


Figure "ExampleMoveCircle3D".

5.6.4 Centerpoint Correction

centerpointCorrectionSet

```
centerpointCorrectionSet(on:= bool)
```

Activates the centerpoint correction for circles. The centerpoint correction will be used for circles that are defined using centerpoint programming, see [G2 and G3 \[► 40\]](#). Due to inaccuracies (e.g. rounding errors by the CAD program), the radius of the starting-point and endpoint with respect to the centerpoint may differ. If centerpoint correction is active, the center will be moved in such a way that the starting-radius and endradius are equal to their former average.

A limit for centerpoint correction can be configured with `centerpointCorrectionLimitSet(...)`. If this limit is exceeded, a runtime error will be reported.

centerpointCorrectionLimitSet

```
centerpointCorrectionLimitSet(limit:= LREAL)
```

Sets the precision limit for the centerpoint of circles. If the given limit is exceeded, a runtime error is reported. The default limit value is 0.1 mm.

5.6.5 Tools



Using tool displacement and rotation

If the Cartesian tool displacement is used in combination with [rotation \[► 72\]](#), then the compensation will only be correct, if the aggregate (the tool carrier) is also rotated through the same angle.

toolParamSet

```
toolParamSet(tidx:= USINT, col:= USINT, val:= LREAL)
```

Set a parameter of the tool `tidx` (1..255) to `val`. The parameter is identified by `col` (0..15).

COL	DESCRIPTION
0	tool number For giving the tool a number. Written to the T-parameter in the cyclic channel interface.

1	tool type (10: drill, 20: miller) The drill is type 10. The miller is type 20.
2	length Describes the length of e.g. the drill.
3	-
4	radius
5	length (added to the length value of column 2) Describes the wear on e.g. the drill. The wear has to be given as a negative value as it is added to the length.
6	-
7	radius (added to the radius value of column 4)
8	x-shift Cartesian tool displacement in x-direction.
9	y-shift Cartesian tool displacement in y-direction.
10	z-shift Cartesian tool displacement in z-direction.
11	-
12	-
13	Tool type 20 (miller): for free use by the user
14	Tool type 20 (miller): for free use by the user
15	Tool type 20 (miller): for free use by the user

toolParam

```
toolParam(tidX:= USINT, col:= USINT): LREAL
```

Yields the given tool parameter.

toolSet

```
toolSet(index:= USINT, nr:= INT, tooltype:= ToolType, length:= LREAL, radius:= LREAL, lengthAdd:= LREAL, radiusAdd:= LREAL, offsetX:= LREAL, offsetY:= LREAL, offsetZ:= LREAL)
```

Set all parameters of a tool. The index is used in [D-words \[► 43\]](#) to refer to the tool. It must lie in the range 1 to 255. The parameter `nr` has only informational purpose. Typically, it is a company internal number to identify a certain tool. The parameter `tooltype` identifies the kind of tool, like a drill for instance. The remaining parameters are dimensions, which are visualized in Figure “ToolSetDimensions”. If the tool orientation is changed towards the negative (see [P-word \[► 47\]](#)), the value `length+lengthAdd` is implicitly negated. The parameters `length`, `radius`, `lengthAdd`, `radiusAdd`, `offsetX`, `offsetY` and `offsetZ` are interpreted using the current length unit.

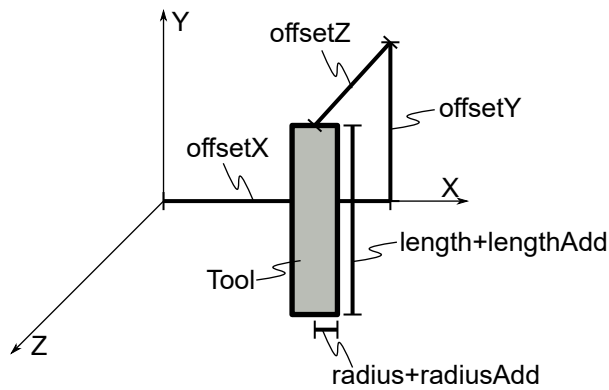


Figure "ToolSetDimensions".

Example:

The example defines tool 1 as a drill of total length 48.5 and tool 2 as a mill with a length of 30 and a diameter of 5.

```
!toolSet(index:=1, nr:=4711, tooltype:=tooltypeDrill, length:=50, lengthAdd:=-1.5);
!toolSet(index:=2, nr:=10783, tooltype:=tooltypeMill, length:=30, radius:=2.5);
```

toolType

Enumeration of tool types.

```
tooltypeDrill
tooltypeMill
```

tooltypeDrill: Selects a drill as a tool.

tooltypeMill: Selects a mill as a tool.

5.6.6 Synchronization

sync

```
sync()
```

Synchronizes the interpreter with the associated NC-channel. The `sync()`-command blocks until all pending NC-commands are completed, i.e. until the job-queue of the NC-channel is empty. This command replaces the former `@714`-command. Oftentimes, the `sync()`-command is combined with a preceding M-function of type handshake. Then, the `sync()`-command will block until the M-function is acknowledged by the PLC.

wait

```
wait()
```

Waits for a GoAhead-signal from the PLC. The `wait()`-command blocks until this signal is received. This command replaces the former `@717`-command. Compared to a combination of an M-function and `sync()`, this kind of synchronization does not result in an empty job queue. Notably, an empty job queue forces the machine to halt.



The GoAhead-signal may be send from the PLC before the associated `wait()`-function is called. In this case the `wait()`-function does not block.

5.6.7 Query of Axes

queryAxes

queryAxes()

Set the MCS (machine coordinate system) coordinates of the interpreter to the actual coordinates of the physical axes. The MCS (machine coordinate system) coordinates are automatically translated to PCS (path coordinate system) coordinates, which are exposed to the programmer. They may also be retrieved by `frameGet(...)`. A combination of `sync()` and `queryAxes()` replaces the former `@716`-command.

- The `queryAxes()`-command considers the path axes (X, Y, Z), as well as the auxiliary axes (Q1..Q5).



The `queryAxes()`-command should be preceded by `sync()` to avoid unexpected behavior.

Example:

The resulting path of the following example is shown in Figure “ExampleQueryAxes”. The example assumes M20 to be an M-function of type “handshake after”. The PLC is assumed to

- wait for M20,
- move the Y-axis to 20,
- wait for completion of the movement,
- acknowledge M20.

The interpreter sends the line segment N10 to the NC-channel followed by the M-function M20. Then the invocation of `sync()` blocks. The NC-channel signals the M-function to the PLC after the line segment N10 has been processed. Then the PLC moves the tool from the end of segment N10 to the beginning of segment N20 and acknowledges M20. The interpreter resumes operation and invokes `queryAxes()`, which sets the internal “current point” to the endpoint of segment N10'. Therefore, the final block sends the line segment N20 to the NC-channel.

```
N00
N10 G01 X40 M20 F6000
!sync();
!queryAxes();
N20 G01 X80
M02
```

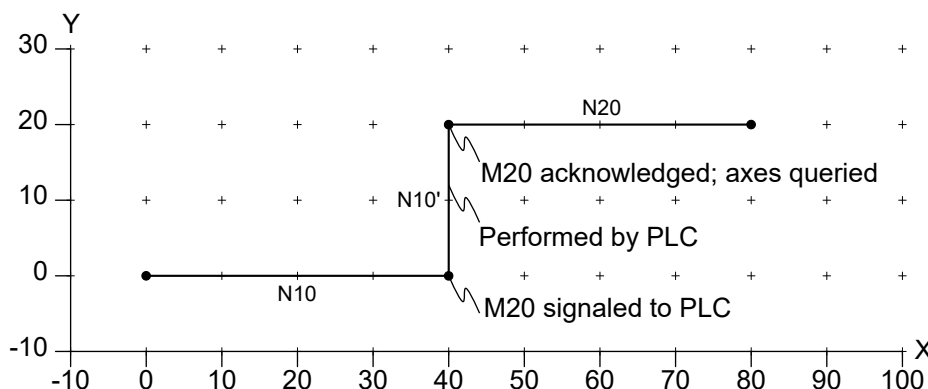


Figure “ExampleQueryAxes”.

5.6.8 Current Point

frameGet

```
frameGet(x:=LREAL, y:=LREAL, z:=LREAL, a:=LREAL, b:=LREAL, c:=LREAL)
```

Store the current frame of the PCS (program coordinate system) in x, y, z and a, b, c.

Example:

The output of the following example is shown below. The G-Code in the example performs a linear movement to the PCS (program coordinate system) point [10, 20, 30]. Then these coordinates are stored in curX, curY, curZ by frameGet(...). The translation [1, 2, 3] that is pushed onto the transformation-stack leads to an adaption of the current PCS (program coordinate system) point such that the MCS (machine coordinate system) point [10, 20, 30] remains unchanged. Therefore, the subsequent call of frameGet(...) retrieves the PCS (program coordinate system) point [9, 18, 27].

```
{
VAR
    curX, curY, curZ : LREAL;
END_VAR

!G01 X10 Y20 Z30 F65000

frameGet(x=>curX, y=>curY, z=>curZ);
MSG(toString(curX, ' ', curY, ' ', curZ, ''));

transTranslate(1,2,3);
frameGet(x=>curX, y=>curY, z=>curZ);
MSG(toString(curX, ' ', curY, ' ', curZ, ''));
}
M02
```

Output:

```
10.000000 20.000000 30.000000
9.000000 18.000000 27.000000
```

qAxisGet

```
qAxisGet(q1:=LREAL, q2:=LREAL, q3:=LREAL, q4:=LREAL, q5:=LREAL)
```

Store the current values of Q-axes in q1 to q5. The Q-axes are the auxiliary axes.

5.6.9 Tool Radius Compensation

trcApproachDepartSet

```
trcApproachDepartSet(approachRadius:= LREAL, approachAngle:= LREAL, departRadius
:= LREAL, departAngle:= LREAL)
```

Configures the approach and depart behavior to use an arc of given radius and angle. If the product of radius and angle are zero, no approach or depart segment will be inserted.

The resulting configuration is used by G41/G42.

trcOffsetSet

```
trcOffsetSet(offset:= LREAL)
```

Configures the amount of segment extension that is used to close gaps. If offset is zero, no extension will be performed.

The resulting configuration is used by G41/G42.

trcLimitSet

```
trcLimitSet(limit:= ULINT)
```

Configures the lookahead that is used for collision elimination.

The resulting configuration is used by G41/G42.

trcParam

```
trcParam(): TrcParamType
```

Returns the current configuration as a structure value.

trcParamSet

```
trcParamSet(param:= TrcParamType)
```

Configures the tool radius compensation. This function is an alternative that summarizes `trcApproachDepartSet`, `trcOffsetSet` and `trcLimitSet`. It can be used in combination with `trcParam` to load, save and restore different TRC (tool radius compensation) configurations efficiently.

TrcParamType

```
TrcParamType
```

This structure contains all configuration parameters of the tool radius compensation. It consists of the following parameters.

```
approachRadius: LREAL;
approachAngle: LREAL;
departRadius: LREAL;
departAngle: LREAL;
offset: LREAL;
limit: ULINT;
```

See `trcApproachDepartSet`, `trcOffsetSet`, `trcLimitSet` for a comprehensive description of the listed parameters.

collisionElimination

```
collisionElimination(nx:= LREAL, ny:= LREAL, nz:= LREAL, limit:= ULINT)
```

Activates collision elimination with respect to the plane of the normal vector `nx`, `ny`, `nz`. Collisions within the projection of the path onto the plane are eliminated. Supplying a zero vector deactivates collision elimination. The `limit` parameter can be used to restrict elimination to the last `n` segments. By default, elimination is unlimited.

collisionEliminationFlush

```
collisionEliminationFlush()
```

This function can be called during active collision elimination to ignore any conflicts between the path preceding the call and the path succeeding the call.

5.6.10 Suppression of G-Code Blocks

disableMask

```
disableMask(): LWORD
```

Yields the current value of the disable mask. Note that the mask may also be set by the PLC.

disableMaskSet

disableMaskSet(mask:= LWORD)

Sets the internal disable mask to the given value. The mask is used to suppress execution of G-Code blocks. The disable mask has 0 default value, i.e. no suppression is active by default. The mask consists of 64 bits.

In a binary notation like 2#1101 bits are numbered from right to left, starting with bit 0. For the value 2#1101 the bits 0, 2 and 3 are set by value one. The remaining bits are not set by exhibiting zero value.

Example:

The resulting path of the following example is shown in Figure “ExampleDisableMaskSet”. The disable mask is initially set to the binary value 2#1101, which is equal to the decimal value 13. The first G-Code, which is N10 in the given example, is always executed, independently of the current disable mask because there is no ‘/’-operator in the N10-line. N20 is only executed if bit 0 is not set. In the case bit 0 is set N20 is suppressed, which is true in the given example. The same holds for N30, since ‘/’ is only a shorthand for ‘/0’. N40 is not suppressed, since bit 1 is not set. The G-Codes N50 and N60 after disableMaskSet(0) are executed, since no bit in the disable mask is set. In contrast, the call disableMaskSet(-1) sets all bits of the mask. Consequently, the succeeding G-Codes that are prefixed with a ‘/’, N80 and N90, are disabled.

```
!disableMaskSet(2#1101);
N10 G01 X10 Y10 F6000
/0 N20 G01 X20 Y0
/ N30 G01 X30 Y0
/1 N40 G01 X40 Y10
!disableMaskSet(0);
/ N50 G01 X50 Y0
/1 N60 G01 X60 Y10
!disableMaskSet(-1);
N70 G01 X70 Y0
/1 N80 G01 X80 Y10
/2 N90 G01 X90 Y20
M02
```

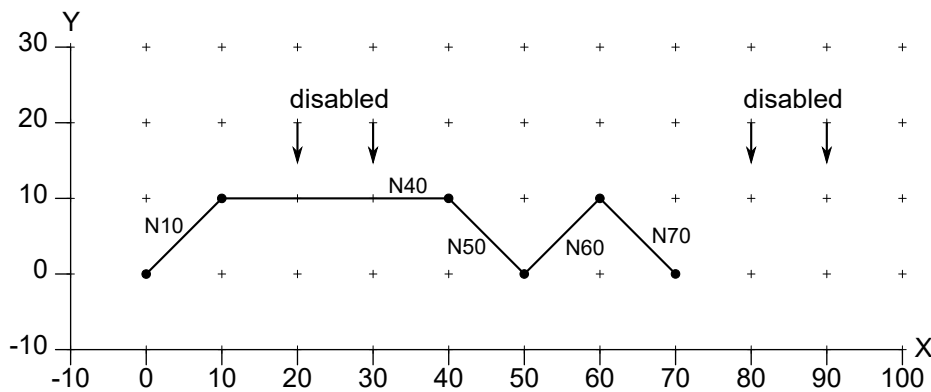


Figure “ExampleDisableMaskSet”.

5.6.11 Zero Offset Shift

zeroOffsetShiftSet

zeroOffsetShiftSet(g:= USINT, x:= LREAL, y:= LREAL, z:= LREAL)

Sets the translation for G-Code g where g must be one of the numbers 54, 55, 56 or 57. Alternatively, the Zero Offset Shift can be set with the PLC Function Block [ltpWriteZeroShiftEx](#) [► 260].

Example:

The resulting path of the following example is shown in Figure “ExampleZeroOffsetShiftSet”. The zero offset shift of G54 is first set to the translation [0, 10, 0]. It gets active for N20 and any later segment endpoints until a novel translation is applied. The second invocation of `zeroOffsetShiftSet` has an immediate effect. It applies to N30 and any later segment endpoints until a novel translation is applied. The same holds for the last invocation. However, the block N40 does not program the Y-coordinate. Therefore, the change does not become apparent for N40. (See section [Transformations \[► 99\]](#) for details.) Because the block N50 programs the Y-coordinate, it applies the recent [0, 30, 0]-translation.

```
!zeroOffsetShiftSet(g:=54, x:=0, y:=10, z:=0);
N10 G01 X20 Y0 F6000
N20 G01 G54 X40 Y0
!zeroOffsetShiftSet(g:=54, x:=0, y:=20, z:=0);
N30 G01 X60 Y0
!zeroOffsetShiftSet(g:=54, x:=0, y:=30, z:=0);
N40 G01 X80
N50 G01 X100 Y0
M02
```

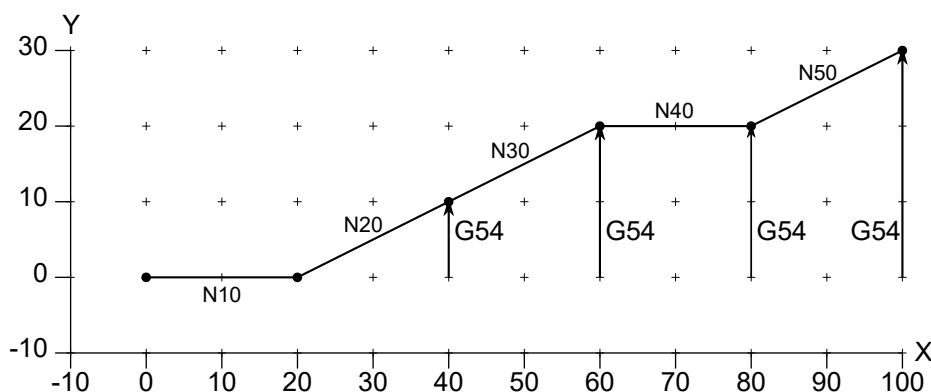


Figure “ExampleZeroOffsetShiftSet”.

5.6.12 Units

unitAngleSet

```
unitAngleSet(unitAngle:= UnitAngle)
```

Set the unit for angles to `unitAngle`. The default is `unitAngleDegree`. The unit for angles applies to all NC-related functions like `transRotX`. It does not apply to ST-standard functions like `sin`. For this reason the interpreter offers a set of NC-specific counterparts like `gSin` that consider the angle unit.

UnitAngle

Enumeration of the following values:

```
unitAngleRadian: 0...2pi
unitAngleDegree: 0...360
unitAngleGon: 0...400
unitAngleTurn: 0...1
```

unitLengthSet

```
unitLengthSet(unitLength:= UnitLength)
```

Set the unit for lengths to `unitLength`. The default is `unitLengthMillimeter`. The unit for length applies to all NC-related functions like `G01` or `zeroOffsetShiftSet(...)`.

UnitLength

Enumeration of the following values:

```

unitLengthMeter
unitLengthCentimeter
unitLengthMillimeter
unitLengthMicrometer
unitLengthNanometer
unitLengthInch
unitLengthFoot

```

.

unitTimeSet

```
unitTimeSet(unitTime:= UnitTime)
```

Set the unit for time to `unitTime`. The default is `unitTimeSecond`. The unit for time applies to all NC-related functions like `G04`. It does not apply to ST-standard functions like `currentLdt()`.

UnitTime

Enumeration of the following values:

```

unitTimeSecond
unitTimeMillisecond
unitTimeMicrosecond
unitTimeMinute
unitTimeHour

```

.

unitVelocitySet

```
unitVelocitySet(unitLength:= UnitLength, unitTime:= UnitTime)
```

Set the unit for velocity to `unitLength/unitTime`. The default is `unitLengthMillimeter/unitTimeMinute`. The unit for velocity applies to all NC-related functions. It is used by the `F`-parameter for instance.

5.6.13 Trigonometric (Unit Aware)

gSin

```
gSin(angle:= LREAL)
```

- Returns the sine of the given `angle` where the current [angle unit \[► 86\]](#) is used to interpret the angle.
- The return type is `LREAL`. This function is not overloaded.

gCos

```
gCos(angle:= LREAL)
```

- Returns the cosine of the given `angle` where the current [angle unit \[► 86\]](#) is used to interpret the angle.
- The return type is `LREAL`. This function is not overloaded.

gTan

```
gTan(angle:= LREAL)
```

- Returns the tangent of the given `angle` where the current [angle unit \[► 86\]](#) is used to interpret the angle.

- The return type is `LREAL`. This function is not overloaded.

gASin

`gASin(val := LREAL)`

- Returns the arcsine of `val` in the current [angle unit](#) [► 86].
- The return type is `LREAL`. This function is not overloaded.
- The result lies within the interval $[-c/4, c/4]$ where `c` is the angle of a full circle in the current angle unit.



CONSTRAINT:

The variable `val` must reside within the interval $[-1, 1]$.

gACos

`gACos(val := LREAL)`

- Returns the arccosine of `val` in the current [angle unit](#) [► 86].
- The return type is `LREAL`. This function is not overloaded.
- The result lies within the interval $[0, c/2]$ where `c` is the angle of a full circle in the current angle unit.



CONSTRAINT:

The variable `val` must reside within the interval $[-1, 1]$.

gATan

`gATan(val := LREAL)`

- Returns the arctangent of `val` in the current [angle unit](#) [► 86].
- The return type is `LREAL`. This function is not overloaded.
- The result lies within the interval $[-c/4, c/4]$ where `c` is the angle of a full circle in the current angle unit.

gATan2

`gATan2(y := LREAL, x := LREAL)`

- Returns the arctangent of `y/x` in the current [angle unit](#) [► 86].
- The return type is `LREAL`. This function is not overloaded.
- The result lies within the interval $[-c/2, c/2]$ where `c` is the angle of a full circle in the current angle unit.

5.6.14 Feed Mode

feedModeSet

`feedModeSet(feedMode := FeedModeType)`

FeedModeType

Enumeration of the following values:

```
fmContour
fmInternalRadius
fmToolCenterPoint
```


fmContour: Holds the feedrate at the contour constant.

fmInternalRadius: Reduces the feedrate at internal radii. This results in a constant velocity at the contour. The velocity at external radii is not increased.

fmToolCenterPoint: Keeps the feedrate of the tool's center point constant. This means that at internal radii the velocity at the contour is increased, and that it is correspondingly reduced at external radii.

5.6.15 Feed Interpolation

feedInterpolationSet

```
feedInterpolationSet(feedInterpolation:= FeedInterpolationType)
```

FeedInterpolationType

FeedInterpolationType

Enumeration of the following values:

```
fiConstant
fiLinear
```

fiConstant: The programmed velocity is applied as fast as possible with the constant feed interpolation (default).

fiLinear: The linear feed interpolation transfers the velocity linearly over the path from v_start to v_end.

5.6.16 Streaming of Large G-Code Files

runFile

```
runFile(path:= string)
```

The size of files that can be executed employing the GST-interpreter is limited. However, sometimes it is required to execute large files that may have been created e.g. by a CAD-program. Therefore, the user has the possibility to execute filestreams of native G-Code.

Executes the plain G-Code that is contained in the G-Code file given by `path`. The function call returns after all lines in the supplied file have been processed. The function is intended for streaming large G-Code files to the NC-kernel efficiently.



Native G-Code: No Structured Text Allowed

Note that the supplied G-Code file must not contain any ST-elements, but only plain G-Code.

A G-Code filestream from file 'myNativeGCodeFile.nc' can be called from a GST-program with the following syntax if the file is in the default directory of the GST interpreter:

```
!runfile('myNativeGCodeFile.nc');
```

If the file 'myNativeGCodeFile.nc' is located elsewhere, the file path must also be specified, e.g:

```
!runfile('C:\myGcodeFolder\machine1\myNativeGCodeFile.nc');
```

runFile with R parameters and simple arithmetic expressions

From the TwinCAT V3.1.4024.40 R parameters and simple arithmetic expressions are allowed with `runfile`.

`callRunfileWithRParamsAndExpressions.nc`

```
N0 G0 X0 Y0 Z0
N1 G1 X10 F5000
!R3:=3;
!R5:=5;
!R10:=15;
```

```
!r100:=-1.234;
!R888:=98.123;
N2 G1 y={r100}
!runfile(RunfileWithRParamsAndExpressions.nc');
M30
```

RunfileWithRParamsAndExpressions.nc

```
G1 X200
G1 Y150
G1 Z234
M123
G1 z = R888 - r100 - r100 / R10
G1 y=100-r888
G1 x=-R10/r5-r3 q1=20-r3*R5
```

5.6.17 Vertex Smoothing

smoothingSet

`smoothingSet(mainType:= SmoothingMainType, subType:= SmoothingSubType, value:= L Real)`

Sets the vertex smoothing behavior according to the given parameters.

SmoothingMainType

Enumeration of the following values:

```
smoothingNone
smoothingParabola
smoothingBiquadratic
smoothingBezier3
smoothingBezier5
smoothingTwinBezier
```

smoothingNone: No smoothing.

smoothingParabola: For parabola smoothing a parabola is inserted geometrically into the segment transition. This ensures a steady velocity transition within the tolerance radius.

smoothingBiquadratic: With biquadratic smoothing there is no step change in acceleration in the axis components. With the same radius, a smaller input velocity may therefore be required than for parabolic smoothing.

smoothingBezier3: In case of the 3rd order Bezier curve a step change in acceleration appears in the axis components when the tolerance sphere is entered. The max. size is limited by the acceleration of the axis components and the C1 factor.

smoothingBezier5: With 5th order Bezier blending, no step change in acceleration occurs in the axis components on entry into the tolerance sphere. In other words, the path axis acceleration is always constant if blending is selected.

smoothingTwinBezier: With the aid of smoothing, it is possible to insert a Bezier spline automatically between two geometrical entries. It is only necessary to program the radius of the tolerance sphere. This describes the maximum permissible deviation from the programmed contour in the segment transition. The advantage of this type of smoothing as opposed to rounding with an arc is that there are no step changes in acceleration at the segment transitions.

● Acute angles at the segment transition

I

The Bezier splines are generated by default, even at very acute angles. In order to avoid the dynamic values being exceeded, a considerable reduction velocity is required in this case. However, since the dynamics are held constant in the spline, the movement across the spline can be quite slow. In this case it is often practical to start the segment transition with an accurate stop. The command `AutoAccurateStop` [► 159] can be used to avoid having to calculate the angles manually.

SmoothingSubType

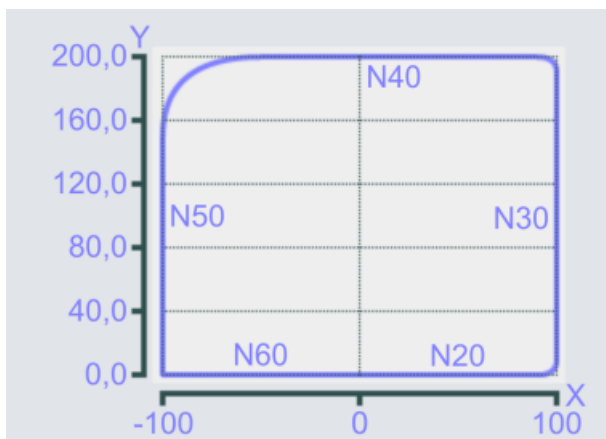
Enumeration of the following values:

```
smoothingRadius
smoothingDistance
smoothingAdaptive
```

Example

The example visualizes the effect of using a smoothing parabola. In the first two corners smoothing value 10 and in the third corner smoothing value 50 have been used. Finally, the fourth corner exhibits smoothing value 0.

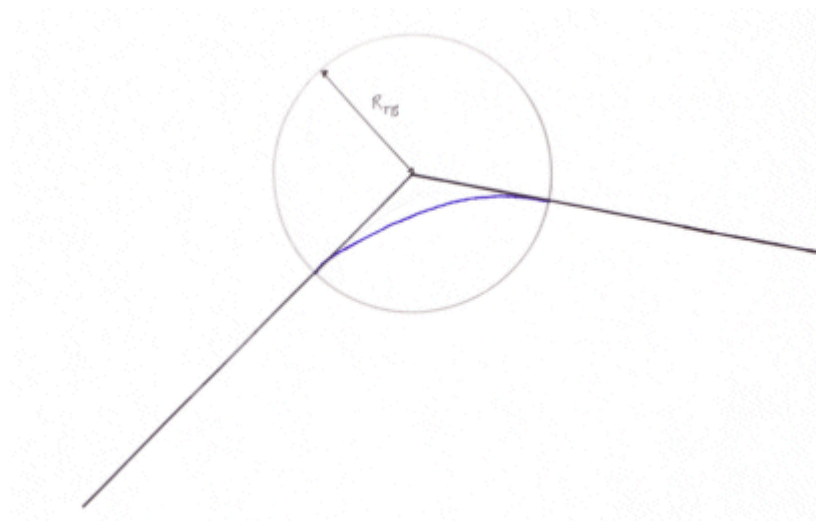
```
N10 G01 X0 Y0 F60000
!smoothingSet(mainType:=smoothingParabola, subType:=smoothingRadius, value:=10);
N20 G01 X100
N30 Y200
!smoothingSet(mainType:=smoothingParabola, subType:=smoothingRadius, value:=50);
N40 X-100
!smoothingSet(mainType:=smoothingParabola, subType:=smoothingRadius, value:=0);
N50 Y0
N60 X0
M02
```



5.6.17.1 Subtypes

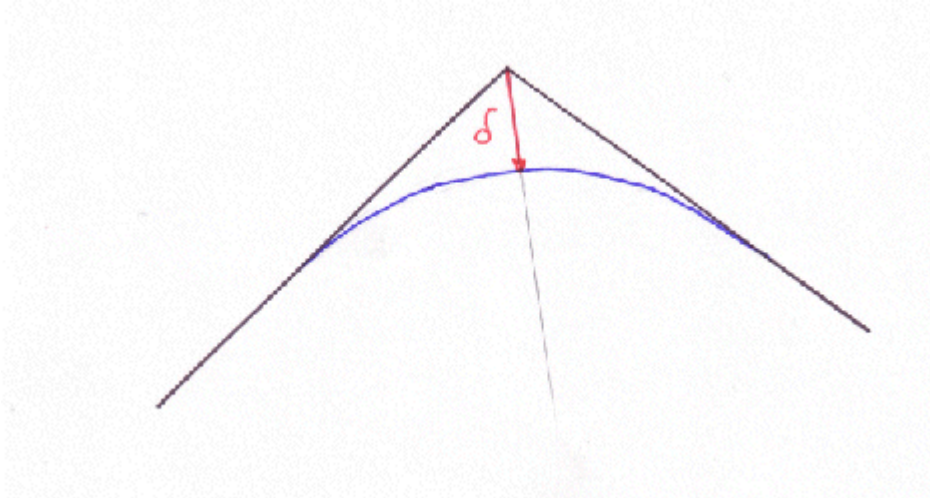
SmoothingRadius (subtype 1)

If subtype 1 is selected, the maximum tolerance radius (R_{TB}) is used for blending. R_{TB} is reduced if and only if the input or output segment is less than $3 \cdot R_{TB}$.



SmoothingDistance (subtype 2)

The distance between the programmed segment transition and the vertex of the parabola is specified with the subtype 2. The tolerance radius (R_{TB}) results from this. If a segment is too short, then the distance is shortened so that the tolerance radius is a max. of 1/3.



SmoothingAdaptive (subtype 3)

Within the tolerance radius (including constant tolerance radius) the system ensures that the maximum permissible acceleration is not exceeded. Depending on the deflection angle and the velocity, the maximum axis acceleration within the smoothing segment may be different. The aim of an adaptive tolerance radius is maximum acceleration during smoothing. In order to achieve this, the smoothing radius is reduced based on the programmed velocity and dynamics. In other words, if the programmed velocity is changed, the tolerance radius can also change. The override has no influence on the radius.

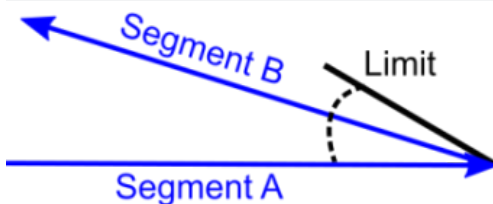
5.6.18 Automatic Accurate Stop

autoAccurateStopSet

```
autoAccurateStopSet (angle:= LREAL);
```

The command `autoAccurateStopSet` is used in conjunction with blending (see [smoothingSet](#)) and allows driving to acute angles with active blending. A limit angle, up to which an accurate stop between 2 segments must take place, is defined for this in the command `autoAccurateStopSet`.

```
!autoAccurateStopSet (angle:= 30.0);
```



For circle segments, the angle is calculated from the tangents at the points of entry and leaving.

Sample

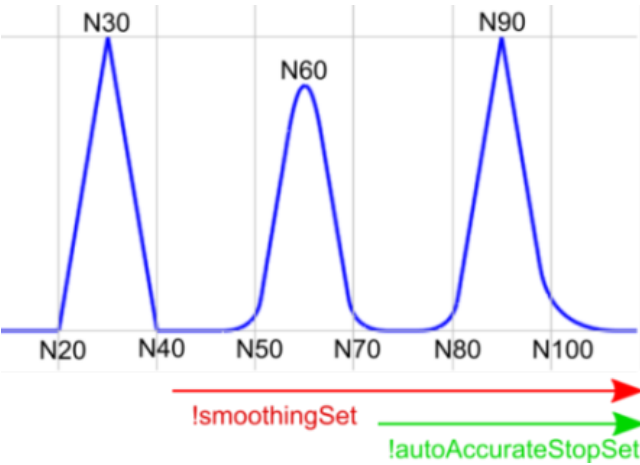
```
N10 G0 X0 Y0 Z0

N20 G01 X10 F20000
N30 G01 X15 Y30
N40 G01 X20 Y0

!smoothingSet (mainType:=smoothingParabola,
subType:=smoothingRadius, value:=50);
N50 G01 X30
N60 G01 X35 Y30
N70 G01 X40 Y0
```

```
!autoAccurateStopSet (angle:= 46.0);
N80 G01 X50
N90 G01 X55 Y30
N100 G01 X60 Y0

N110 G01 X80
N110 M30
```



Requirements

Development environment	Target system
TwinCAT V3.1.4024.15	PC or CX (x86 or x64)

5.6.19 Spline Interpolation

transBSpline

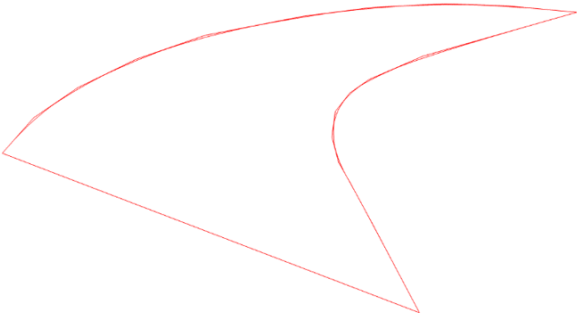
```
transBSpline(BreakAngle:=LREAL, BreakLength:=LREAL, MergeDiff:=LREAL,
LineBreakAngle:=LREAL, LineBreakLength:=LREAL, LineMergeDiff:=LREAL)
```

transBSpline generates a continuous curve from a piecewise linear polyline. The curve is bounded by the input polyline, the start and end points are interpolated, interior points are the control points (DeBoor points) of the curve. At least three points are required. A BSpline curve exhibits local control and is thereby amenable to control point manipulation.

```
//Enable
transBSpline(BreakAngle := 70, BreakLength := 1000);

//Disable
transBSpline();
```

Example:



```
!//BSpline
N10 G00 X18.498 Y0
!transBSpline(BreakAngle:=70.0, BreakLength:=1000.0);
N20 G01 X18.498 Y0 Z0 F6000
N30 X16.572 Y6.543 Z1
N40 X15.616 Y9.715 Z2
N50 X15.121 Y11.275 Z3
```

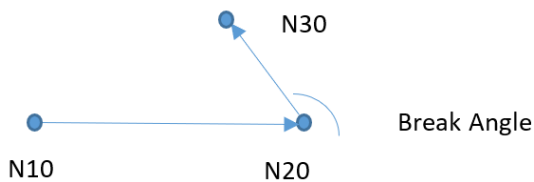
```

N60 X14.838 Y13.196 Z4
N70 X14.982 Y15.085 Z5
N80 X15.595 Y16.485 Z6
N90 X16.396 Y17.490 Z7
N100 X18.653 Y19.243 Z8
N110 X25.07 Y22.526 Z9
N120 X22.228 Y22.997 Z8
N130 X19.569 Y23.174 Z7
N140 X16.488 Y22.884 Z6
N150 X13.634 Y22.228 Z5
N160 X9.533 Y20.793 Z4
N170 X6.668 Y19.009 Z3
N180 X4.224 Y16.877 Z2
N190 X2.376 Y14.61 Z1
N200 X1.068 Y11.959 Z0
! transBSpline();
M02

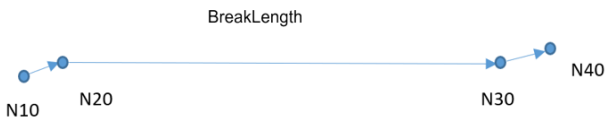
```

Parameters

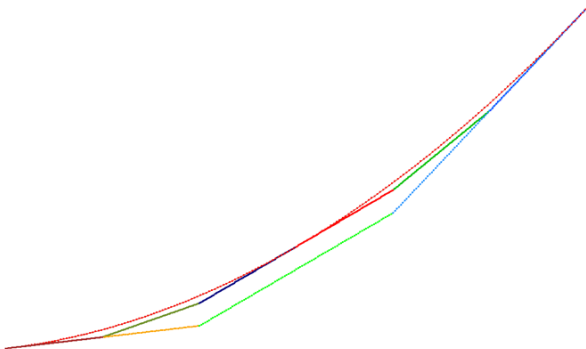
BreakAngle (mandatory): Allows preservation of sharp angle features in the path. The spline will break when the path deviates more than BreakAngle. The spline will terminate and interpolate the point.



BreakLength (mandatory): Allows preservation of long features in the path. The spline will break for segments longer than BreakLength. The spline will terminate and interpolate the start and end points of the long segment.



MergeDiff (optional): The BSpline is comprised of Bezier segments. To potentially improve processing speed the spline may be compressed by merging. Adjacent segments will be merged together when the difference in control points is less than MergeDiff. Below adjacent segments are merged into one.



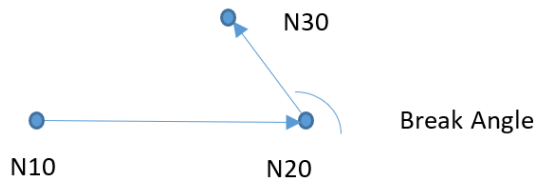
Excessive curvature

Overly aggressive merging can result in excessive contortion and a segment of excessive curvature will be rejected with a run time error.

Acceptable curvature is derived from path velocity and acceleration.

The BSpline is constructed from a control point polyline formed by G01 segments, eg: CAD/CAM. To improve processing speed the control point polyline may be compressed or simplified by merging adjacent segments.

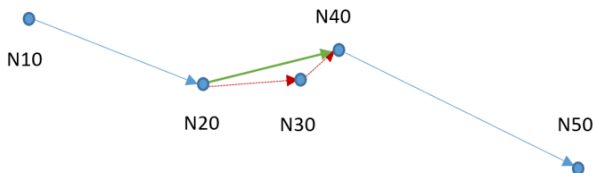
LineBreakAngle (optional): Merging of adjacent control points will break if the deviation angle exceeds LineBreakAngle.



LineBreakLength (optional): Merging of adjacent control points will break if the length exceeds LineBreakLength.



LineMergeDiff (optional): Adjacent control points will be merged if the difference (perpendicular distance) is less than LineMergeDiff. In the example N30 may be eliminated, simplifying the control polygon.



If the optional parameters aren't parameterized or if they are 0, no merging will take place.



Excessive curvature

Overly aggressive merging can result in excessive contortion and a segment of excessive curvature will be rejected with a run time error.

Acceptable curvature is derived from path velocity and acceleration.

Processing order:

If the BreakAngle or BreakLength are 0. No further processing will take place. LineBreakAngle, LineBreakLength and LineMergeDiff are processed firstly to simplify the control point polyline. BreakAngle BreakLength and MergeDiff are processed finally to generate the BSpline curve.

Decoder Stops and Handshake M functions:

The BSpline should be terminated with `!transBSpline()` ; prior to either a decoder stop or a M-function type handshake.

```
!//BSpline
N10 G00 X18.498 Y0
!transBSpline(BreakAngle:=70.0, BreakLength:=1000.0);
N20 G01 X18.498 Y0 Z0 F6000
N30 X16.572 Y6.543 Z1
N40 X15.616 Y9.715 Z2
N50 X15.121 Y11.275 Z3
N60 X14.838 Y13.196 Z4
N70 X14.982 Y15.085 Z5
N80 X15.595 Y16.485 Z6
N90 X16.396 Y17.490 Z7
N100 X18.653 Y19.243 Z8
```

```

N110 X25.07 Y22.526 Z9
!transBSpline();
!sync();
!transBSpline(BreakAngle:=70.0, BreakLength:=1000.0);
N120 X22.228 Y22.997 Z8
N130 X19.569 Y23.174 Z7
N140 X16.488 Y22.884 Z6
N150 X13.634 Y22.228 Z5
N160 X9.533 Y20.793 Z4
N170 X6.668 Y19.009 Z3
N180 X4.224 Y16.877 Z2
N190 X2.376 Y14.61 Z1
N200 X1.068 Y11.959 Z0
! transBSpline();
M02

```

Compatible G-Codes and functions

G-Codes other than G01 are supported.

G00

G02, G03 (Circle and Helix): The BSpline will terminate before and continue afterwards.

G04

G09, G60

G54 and other transformations

```

disableMask()
runFile(path:= )
smoothingSet(mainType:=smoothingTwinBezier, subType:=smoothingRadius, value:= )

```

ToolRadiusCompensation is not supported.

Requirements

Development Environment	Target System
TwinCAT V3.1.4024.4	PC or CX (x86 or x64)

5.6.20 Dynamic Override

dynOverrideSet

```
dynOverrideSet(value:= LREAL)
```

Set the dynamic override of axes to the given value.

The dynamic override function can be used to implement and evoke percentage changes to the dynamic axis parameters in the axis group while the NC program is running. Thus, these changes result in new values for motion dynamics. Without any stop the new dynamic values become valid when the line is executed.

Range of Values

The factor value for dynOverrideSet has to reside within the range $0 < \text{value} \leq 1.0$.

Example

Within the example the new dynamic values become valid without any stop. In block N010 the previously set values are used for deceleration, while the changed values are used for acceleration in block N020.

```

N010 G01 X100 Y200 F6000
!dynOverrideSet(value:= 0.4);
N020 G01 X500
M02

```

Example

The command dynOverrideSet can be used to reduce acceleration and jerk e.g. only for one movement. In the example acceleration and jerk are reduced by 50 percent merely in block N020.


```

N010 G01 X100 Y100 F6000
!dynOverrideSet(value:= 0.5);
N020 X0
!dynOverrideSet(value:= 1);
N030 X100
M02

```

5.6.21 Programming reference

programmingReferenceSet

```
programmingReferenceSet(value:= ReferenceType)
```

As an alternative to [G90/G91 \[► 50\]](#), `programmingReferenceSet` can be used to set the dimensions of the subsequent movement commands to absolute or relative.

programmingReferenceGet

```
ReferenceType := programmingReferenceGet()
```

The currently active dimension for the movement commands can be read out with `programmingReferenceGet`.

ReferenceType

Enumeration of the following values:

```

referenceAbsolute
referenceRelative

```

Example

`programmingRefGet/Set` is particularly recommended for functions. At the start of a function, the currently set dimension can be read out with `programmingRefGet` before it is set to the dimension of the function with `G90/G91` or `programmingRefSet`. At the end of the function, `programmingRefSet` is used to ensure that the dimension is reset.

```

{
FUNCTION TestFunction
VAR
    programmingRef : ReferenceType;
END_VAR

    programmingRef := programmingReferenceGet();
    programmingReferenceSet(value:= referenceRelative);

    !N21 G01 X10 Y-10
    !N22 G01 X10 Y-10

    programmingReferenceSet(value:= programmingRef);

END_FUNCTION
}

N10 G00 X0 Y0 Z0
N20 G01 G90 X100 Y20 F6000

!TestFunction();

N30 G01 X100 Y30
M30

```

Requirement

TwinCAT
TwinCAT V3.1.4024.54

5.6.22 Center Point Reference of Circles

circleCenterReferenceSet

```
circleCenterReferenceSet (value:= ReferenceType)
```

- Sets the center reference type for circles that are programmed by G02/G03 using a center point, whose definition involves the i,j,k-parameters.
- For `referenceAbsolute` the center point of the circle is defined by the supplied i,j,k-vector.
- For `referenceRelative` the center point is defined by the sum of the circle starting-point and the supplied i,j,k-vector. This is the default and usual behavior of G-Code.

circleCenterReferenceGet

```
ReferenceType := circleCenterReferenceGet()
```

Returns the currently active center point reference for circles.

circleCenterReferenceGet prerequisite

TwinCAT
TwinCAT V3.1.4024.54

ReferenceType

Enumeration of the following values:

```
referenceAbsolute
referenceRelative
```

5.6.23 Change in axis dynamics

axisDynamicsSet

```
axisDynamicsSet (axisNo:= UDINT, acc:= LREAL, dec:= LREAL, jerk:= LREAL);
```

`axisDynamicsSet` can be used to change the axis dynamics at runtime.

Function	axisDynamicsSet
Parameter <axisNo>	Axis in the interpolation group: X: 0 Y: 1 Z: 2 Q1: 3 ... Q5: 7
Parameter <acc>	Value of the maximum permitted acceleration in mm/s ² .
Parameter <dec>	Value of the maximum permitted deceleration in mm/s ² .
Parameter <jerk>	Value of the maximum permitted jerk in mm/s ³ .

Example:

```
N10 G01 X100 Y200 F6000
!R4:=10000;
!axisDynamicsSet (axisNo:= 0, acc:= 2250, dec:= 2250, jerk:= R4);
N30 G01 X500
N40 M02
```

Requirements

Development Environment	Target System
TwinCAT V3.1.4024.4	PC or CX (x86 or x64)

5.6.24 Change in path dynamics

pathDynamicsSet

```
pathDynamicsSet(acc:= LREAL, dec:= LREAL, jerk:= LREAL);
```

pathDynamicsSet can be used to change the path dynamics at runtime.

Function	pathDynamicsSet
Parameter <acc>	Value of the maximum permitted acceleration in mm/s ² . Must be set >= 1. If set to 0, the default value is used.
Parameter <dec>	Value of the maximum permitted deceleration in mm/s ² . Must be set >= 1. If set to 0, the default value is used.
Parameter <jerk>	Value of the maximum permitted jerk in mm/s ³ . Must be set >= 1. If set to 0, the default value is used.

Example:

```
N10 G01 X100 Y200 F60000
!R4:=10000;
//Set path dynamics
!pathDynamicsSet(acc:=200, dec := 200, jerk := R4);
N30 G01 X500 Y0
//Set path dynamics back to default values and jerk to 12000
!pathDynamicsSet(acc:=0, dec := 0, jerk := 12000);
N50 G01 X100 Y200
//Set path dynamics to default values
!pathDynamicsSet(acc:=0, dec := 0, jerk := 0);
N70 G01 X500 Y0
N80 M02
```

Requirements

Development Environment	Target System
TwinCAT V3.1.4024.12	PC or CX (x86 or x64)

5.7 Transformations

Speaking of GST-Transformations we refer e.g. to rotations or to zero-point-shifts.

The relation between the MCS (machine coordinate system) and the PCS (program coordinate system) is defined by the effective transformation T. T is the concatenation of the transformations T_z , T_u and T_T ($T = T_z * T_u * T_T$). Note that the order of concatenation is significant for the transformations do not commute in general. The transformation T_z represents a (historical) zero offset shift, the transformation T_u represents a user defined transformation and the transformation T_T represents a tool transformation. They are described in detail later.

Figure "TransformationsTzTuTt" visualizes the relation between the MCS (machine coordinate system) and the PCS (program coordinate system):

- T_z is defined to be a translation by $[20, 20, 0]$,
- T_u is a combination of the translation $[30, -10, 0]$, followed by a rotation by 45 degree around the z-axis,
- T_T is a translation by $[0, -10, 0]$.

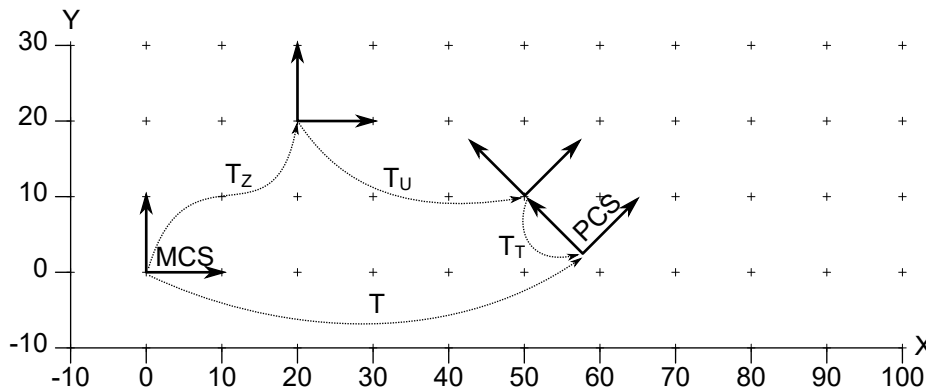


Figure "TransformationsTzTuTt".

5.7.1 Modification of the Effective Transformation T and its Effect

Most G-Codes define only the destination point of a movement. Therefore, the interpreter maintains the current position of the tool. This point can be represented in MCS (machine coordinate system) coordinates and PCS (program coordinate system) coordinates while the equation

$\text{CurrentPointMCS} = T * \text{CurrentPointPCS}$ holds. In contrast to the previous implementation, this transformation equation also holds after a modification of T. This behavior is accomplished by adapting the CurrentPointPCS . The MCS (machine coordinate system) point is not adapted, as this would affect the machine. This behavior may be summarized roughly as: When the active transformation is changed, the current PCS (program coordinate system) point is adapted in a way that the modification shows no effect.

Example:

After N10 the coordinates of the current PCS (program coordinate system) and MCS (machine coordinate system) point are $[20, 10, 80]$, since no transformation is active. The translation changes the current PCS (program coordinate system) point to $[28, 7, 84]$. Applying the translation on this point yields the unchanged MCS (machine coordinate system) point $[20, 10, 80]$. Hence, the translation shows no effect, although it is active. The block N20 programs a movement to the PCS (program coordinate system) point $[25, 7, 10]$, which is mapped to the MCS (machine coordinate system) coordinate $[17, 10, 6]$. After the invocation of `transPop()` the current PCS (program coordinate system) point is set to the current MCS (machine coordinate system) point.

```
N10 G01 X20 Y10 Z80 F6000
!transTranslate(-8,3,-4);
N20 G01 X25 Z10
!transPop();
M02
```

Example:

If the user wants the PCS (program coordinate system) point to remain unchanged, he has to retrieve and program it, as shown in the following code. However, the desire for an unchanged PCS (program coordinate system) point typically indicates a bad programming style. Actually, there should be no need for the following code.

```
{
VAR
    pcsX, pcsY, pcsZ : LREAL;
END_VAR

// ... G-Code ...

frameGet(x=>pcsX,y=>pcsY,z=>pcsZ);
// ... modify transformations ...
!G01 x=pcsX y=pcsY z=pcsZ F6000
}
```

5.7.2 Components of the Effective Transformation T

Zero Offset Shift T_z

The T_z -transformation is affected by certain G-Codes. It has no effect if G53 is active. Otherwise, T_z is the combination of the three translations T_{z58} , T_{z59} and one of $\{T_{z54}, \dots, T_{z57}\}$. The former two translations are set via the G-Codes G58 and G59. The latter translation is selected by the G-Codes G54 to G57. One translation is associated with each of these 4 G-Codes. It can be set by the PLC or using the ST-function `zeroOffsetShiftSet`.

Tool Transformation T_T

T_T is defined by the currently selected tool. It has no effect if tool 0 (D0) is selected. Otherwise, it is a translation by `[offsetX, offsetY, offsetZ] + (length+lengthAdd) * D` where D is the normal of the current workingplane.

Userdefined Transformation T_U

T_U is defined by a stack of transformations. The stack of depth N contains elementary transformations $T_{U1}, T_{U2}, \dots, T_{U<N>}$ where $T_{U<N>}$ is the topmost transformation. Initially, the stack is empty. The userdefined transformation is the concatenation of these elementary transformations $T_U = T_{U1} * T_{U2} * \dots * T_{U<N>}$. Note that the order is significant for the transformations do not commute in general. If the stack is empty, T_U is the identity transformation, which has no transformation effect.

5.7.3 Applying Transformations

A transformation is pushed onto the stack by the following ST-functions. The transformation pushed recently will be the topmost transformation on the transformation stack. When a transformation is pushed onto the transformation stack, the stack depth is increased by one and T_U is adapted accordingly.

```
transTranslate(x:= LREAL, y:= LREAL, z:= LREAL);
(* A rotation pushed onto the stack of transformations is interpreted around the respective
axis using the current angle-unit, e.g. degree or radian. *)
transRotX(angle:= LREAL);
transRotY(angle:= LREAL);
transRotZ(angle:= LREAL);
transMirrorX();
transMirrorY();
transMirrorZ();
transScale(factor:= LREAL);
```

5.7.4 Revoking Transformations

The function `transPop()` removes the topmost transformation from the transformation stack. When `transPop()` removes a transformation from the transformation stack, the stack depth is reduced by one and T_U is adapted accordingly. Commonly, the `transPop()`-function is used to revoke a temporary transformation.

Example:

In the following example the translation is applied to N10, N20 and N30. The rotation is only applied to N20 as it is revoked by `transPop()`. Figure "ExampleRevokingTransformations" shows the resulting MCS (machine coordinate system) path. Note that the rotation center is `[20, 0, 0]` in MCS (machine coordinate system), which is the origin in PCS (program coordinate system) after the preceeding translation.

```
!transTranslate(20,0,0);
N10 X10 Y0 F6000
!transRotZ(90);
N20 X20 Y0
!transPop();
N30 X30 Y0
!transPop();
M02
```

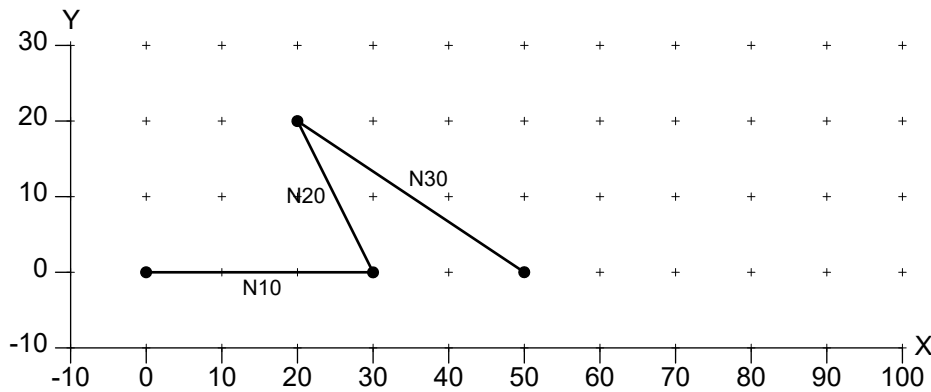


Figure "ExampleRevokingTransformations".

5.7.5 Restoration of Stack

The function `transDepth()` yields the current depth of the stack. The function `transRestore(depth)` removes transformations from the stack until the given depth is reached. Typically, the two functions are combined to save and restore the state of the transformation stack.

It is good programming style to do this saving and restoring in the context of userdefined `ST`-functions.

Example:

Initially, within the following function the depth of the stack is stored in the variable `depth`. At the end of the function the initial state is restored by `transRestore`. Note that restoration only works properly if the stack depth does not fall below `depth` within the function. Instead of using `transDepth()` and `transRestore()` the stack depth could also be restored using `transPop()`. However, it may become cumbersome to keep pushing and popping of transformations synchronous, especially if transformations are pushed conditionally.

```
{
FUNCTION draw
VAR
    depth : UINT;
END_VAR
    depth := transDepth();
    transTranslate(10,0,0);
    // ... G-Code ...
    transRotZ(45);
    // ... G-Code ...
    transMirrorX();
    // ... G-Code ...
    transRestore(depth);
END_FUNCTION
}
```

5.8 Error Reporting

Efficient development of `CNC`-programs requires decent support by development tools. This support includes proper reporting of programming errors for both, compile-time errors and runtime errors. An error message should point directly to the source code the error originates from and give a precise description of the circumstances under that the error occurred (dynamic data). Such individual error messages help a developer substantially to fix errors in short time. The `GST`-interpreter yields such error messages, as described in the following texts.

5.8.1 Error Messages

In case of an error the interpreter produces a descriptive error message. An error message consists of a source code coordinate and a description. The source code coordinate links the error to its origin in the GST-program. It defines a range of source code stretching from the first character of the code range to the last character of the code range. Both, first and last character, are defined by their file, line and column. Note that the last character actually points to the first character behind the range, which is a common technical convention.

Example:

In the following example an integer variable `i` is declared and initialized. The initialization uses a floatingpoint literal. Since an implicit conversion from floatingpoint to integer is not allowed in ST, the interpreter produces the descriptive error message given below when the program is loaded. The error message does not only report that a type-error has occurred, it also gives the precise position: File `aaa.nc`, line 3, column 14 to 17. This code range displays the literal `'1.5'`. In addition, the programmed type (`real`) and the expected type (`int`) are reported. With such a detailed error message bugs can be fixed by the developer easily.

```
{
VAR
    i : int := 1.5;
END_VAR
}
```

Error message:

```
aaa.nc: 3.14-3.17: Invalid implicit conversion from type
'<real literal>' to 'int'.
```

5.8.2 Compile-Time Errors and Runtime Errors

Errors may occur during program loading (so called compile-time errors) or during program execution (so called runtime errors). Fortunately, most errors are detected at compile-time. This detection includes missing files, syntax errors, type errors and unexpected identifiers. The developer gets feedback immediately when he tries to load the program. Thus, a part of unexpected failures during machining is avoided.

However, there are also errors that, by their nature, cannot be detected at compile-time. For instance, this circumstance includes a division by zero, since the divisor may be computed dynamically. If a runtime error occurs, the interpreter is stopped safely and an error message is produced. A runtime error message is similar to a compile-time error message. It even includes a reference to the pertinent source code.

Example:

In the following example the FOR-loop contains a division of 10 by the loop variable `i`. Since the variable `i` is iterated from -3 to 3, this program leads to an error during the 4th iteration, when `i` has the value 0. This error is detected at runtime and stops the interpreter. The error message shown below is reported. It points precisely to the code `'10/i'` in the example.

FILE `aaa.nc`:

```
{
VAR
    i, j : int;
END_VAR

FOR i := -3 TO 3 DO
    j := j + 10/i;
END_FOR;
}
```

Error message:

```
aaa.nc: 7.12-7.16: Division by zero
```

Example:

At runtime the interpreter also performs checking of array bounds. Consequently, invalid indices do not result in unpredictable and typically fatal crashes. The runtime error message precisely defines location and origin of the error at 'idx', reports the erroneously supplied index (20) and the valid index range (10..19).

FILE aaa.nc:

```
{
VAR
    idx : INT;
    a : ARRAY [10..19] OF INT;
END_VAR

FOR idx := 10 TO 20 DO
    a[idx] := i;
END_FOR;
}
M02
```

Error message:

```
aaa.nc: 8.5-8.8: Out of bounds. 20 exceeds range 10..19.
```

5.8.3 Errors in G-Code

Error reporting is also performed for G-Code. This reporting includes compile-time errors and runtime errors. Runtime error reporting includes invalid use of G-Code, e.g. like a bad definition for a circle.

Example:

In the following example the value of a string variable `str` is assigned to the address letter `X` of the G-Code block. As before the position of the error is precisely identified at '`=str`' in the code. In addition, the programmed type and the expected type are reported.

FILE aaa.nc:

```
{
VAR
    str : string := 'Hello World';
END_VAR
}

G01 X=str F6000
G01 Y100
M02
```

Error message:

```
7.5-7.9: Invalid implicit conversion from type 'string[255]'
to 'lreal'
```

Example:

In the following example a sequence of circular arcs is processed by a `FOR`-loop. The radius of the arc is 4. The distance between the starting-point and endpoint of the arc is successively increased within each iteration. During the 9th iteration the distance exceeds the circle diameter of 8. The reported error message identifies the origin `G2 X=i*10+i U4` and gives information about the diameter and distance between starting-point and endpoint.

FILE aaa.nc:

```
{
VAR
    i : INT;
END_VAR

!G00 X0 Y0 Z0
FOR i := 1 TO 10 DO
```



```

!G01 X=i*10 F6000
!G02 X=i*10+i U4
END_FOR;
}
M02

```

Error Message:

```

aaa.nc: 9.4-10.1: Invalid definition of circle. Distance
between start-point and end-point (=9.000000) is larger than
diameter (=8.000000).

```

5.8.4 Preprocessing

During preprocessing `#include`-directives are replaced by the contents of the referenced files. Care has been taken to maintain information about the origin of source code properly. Therefore, an error that is caused by code in an included file will refer to that included file and not to the result of preprocessing, as a simple implementation would do.

Example:

In the following example the file `aaa.nc` includes the file `bbb.nc`. In the latter file the variables `i` and `j` are used in G-Codes. Variable `i` is declared at the beginning of `aaa.nc`, but `j` is not. Therefore, the error message below is issued. As you can see it references the use of variable `j` in file `bbb.nc` properly.

FILE `aaa.nc`:

```

{
VAR
    i : INT;
END_VAR
}

G00 X0 Y0 Z0

#include "bbb.nc"

G00 X100

M02

```

FILE `bbb.nc`:

```

G01 X=i F6000
G01 Y=j
G01 Z100

```

Error message:

```

bbb.nc: 2.6-2.7: Undeclared variable or enumeration value
'j'

```

5.9 General Command Overview

Preprocessor

Com-mand	Description
<code>#include</code> [▶ 33]	The <code>#include</code> directive inserts the contents of another file. The included file is referenced by its path. Typically, it is used to “import” commonly used code like e.g. libraries. Its behavior is similar to the C-Preprocessor.

Interpolations

Com-mand	Description	Modal or Non-modal	Default
<u>G00</u> [▶ 39]	Interpolation mode: Linear. Applying maximum velocity ignoring programmed velocity. Reset by G01, G02, G03.	Modal.	Default.
<u>G01</u> [▶ 39]	Interpolation mode: Linear. Applying programmed velocity. Reset by G00, G02, G03.	Modal.	No.
<u>G02</u> [▶ 40]	Clockwise interpolation mode: Circular or helical. Applying current velocity. Reset by G00, G01, G03.	Modal.	No.
<u>G03</u> [▶ 40]	Counterclockwise interpolation mode: Circular or helical. Applying current velocity. Reset by G00, G01, G02.	Modal.	No.
<u>G303</u> [▶ 41]	With G303 an circular arc (CIP circle) can be programmed, that can be freely located in space.		No
<u>G04</u> [▶ 42]	Defines a dwell time, i.e. suspends machining for a given duration.	Nonmodal.	No.

Workingplane Selection

Com-mand	Description	Modal or Non-modal	Default
<u>G17</u> [▶ 47]	Selects XY-plane as workingplane.	Modal.	Default.
<u>G18</u> [▶ 47]	Selects ZX-plane as workingplane.	Modal.	No.
<u>G19</u> [▶ 47]	Selects YZ-plane as workingplane.	Modal.	No.

Delete Distance to go

Com-mand	Description	Modal or Non-modal	Default
<u>G31</u> [▶ 43]	Delete distance to go.	Nonmodal.	No.

Deactivation and Activation of Tool Radius Compensation

Com-mand	Description	Modal or Non-modal	Default
<u>G40</u> [▶ 43]	Deactivates Tool Radius Compensation (TRC). With/After a G40 command it is mandatory to program at least one geometry element.	Modal.	Default.
<u>G41</u> [▶ 43]	Activates Tool Radius Compensation (TRC). Left.	Modal.	No.
<u>G42</u> [▶ 43]	Activates Tool Radius Compensation (TRC). Right.	Modal.	No.

Set, Deactivate and Activate Zero-Offset-Shift Translations

Com-mand	Description	Modal or Non-modal	Default
G53 [▶ 45]	Deactivates any zero-offset-shift translation.	Modal.	Default.
G54..G57 [▶ 45]	Activates the zero-offset-shift associated with the given G-Code. Activates the translation G58 and G59.	Modal.	No.
G58, G59 [▶ 45]	Sets the translation associated with the given G-Code.	Modal.	No.

Command	Description
zeroOffsetShift Set(g:= USInt, [▶ 85] x:= LReal, [▶ 85] y:= LReal [▶ 85], z:= LReal) [▶ 85]	Sets the translation for G-Code g where g must be one of the numbers 54, 55, 56 or 57.

Accurate Stop

Com-mand	Description	Modal or Non-modal	Default
G09 [▶ 43]	Accurate stop.	Nonmodal.	No.
G60 [▶ 43]	Accurate stop.	Modal.	No.

Set Unit for Length and Speed

Com-mand	Description	Modal or Non-modal	Default
G70 [▶ 48]	Sets the unit for lengths to inch. Does not affect the unit for velocity.	Modal.	No.
G71 [▶ 48]	Sets the unit for lengths to millimeter. Does not affect the unit for velocity.	Modal.	Default.
G700 [▶ 48]	Sets the unit for lengths to inch. Also applies to the interpretation of velocity.	Modal.	No.
G710 [▶ 48]	Sets the unit for lengths to millimeter. Also applies to the interpretation of velocity.	Modal.	Default.

Switch to Absolute or Relative Coordinates

Com-mand	Description	Modal or Non-modal	Default
G90 [▶ 50]	Switches to absolute programming.	Modal.	Default.
G91 [▶ 50]	Switches to incremental programming.	Modal.	No.

IJK

Com-mand	Description	Modal or Non-modal	Default
I<vx> J<vy> K<vz> [▶ 40]	Center point is <code>currentPoint + [vx,vy,vz]</code> . Current length unit is used for <code>vx,vy,vz</code> . I used by G4 defines a duration.	Modal.	Default: Center point is <code>currentPoint + [0,0,0]</code> . The IJK-parameters are optional.

M-Functions

Com-mand	Description
M<v> [▶ 51]	Triggers the M-function <code>v</code> . The timing behavior depends on the definition of <code>v</code> in the development environment of TwinCAT. There must not be more than one M-function of type handshake in a block.
M2	Predefined M-function. Signals program end.
M30	Predefined M-function. Signals program end.

Tool Orientation

Com-mand	Description	Modal or Non-modal	Default
P<v> [▶ 47]	Switches tool orientation.	Modal.	No.

Set Block Number

Com-mand	Description
N<v> [▶ 54]	Block number.

Set Radius

Com-mand	Description	Modal or Non-modal	Default
U<v> [▶ 40]	Sets the radius within the context of G02 or G03 to <code> v </code> .	Modal.	No.

Set Cartesian Coordinate

Com-mand	Description
X<v> [▶ 54]	Sets the X-coordinate of the next point to <code>v</code> . Uses current length unit for <code>v</code> .
Y<v> [▶ 54]	Sets the Y-coordinate of the next point to <code>v</code> . Uses current length unit for <code>v</code> .
Z<v> [▶ 54]	Sets the Z-coordinate of the next point to <code>v</code> . Uses current length unit for <code>v</code> .

Auxiliary Axes

Com-mand	Description	Modal or Non-modal	Default
<u>Q<i>=<v></u> <u>> [► 54]</u>	Sets label for auxiliary axis.	Modal.	No.

Set Orientation Angle

Com-mand	Description	Modal or Non-modal	Default
<u>A<v></u> <u>[► 54]</u>	Sets the A-angle of the next orientation to v. Uses current length unit for v.	Nonmodal, but may influence succeeding blocks.	No.
<u>B<v></u> <u>[► 54]</u>	Sets the B-angle of the next orientation to v. Uses current length unit for v.	Nonmodal, but may influence succeeding blocks.	No.
<u>C<v></u> <u>[► 54]</u>	Sets the C-angle of the next orientation to v. Uses current length unit for v.	Nonmodal, but may influence succeeding blocks.	No.

Control Structures

Command	Description
<u>IF-THEN-ELSIF-ELSE</u> <u>[► 61]</u>	Conditional statement.
<u>CASE OF [► 61]</u>	Conditional statement.
<u>FOR [► 61]</u>	Counter-controlled loop.
<u>WHILE [► 61]</u>	Head-controlled loop.
<u>REPEAT [► 61]</u>	Foot-controlled loop.
<u>EXIT [► 61]</u>	Leaving a loop.

Jump statement

Command	Description
<u>LABEL-GOTO [► 62]</u>	Jump statement.

Trigonometric

Command	Description
<u>SIN(x) [► 64]</u>	Returns the sine of x; x in radians.
<u>COS(x) [► 64]</u>	Returns the cosine of x; x in radians.
<u>TAN(x) [► 64]</u>	Returns the tangent of x; x in radians.
<u>ASIN(x) [► 64]</u>	Returns the arc sine of x; x in radians.
<u>ACOS(x) [► 64]</u>	Returns the arc cosine of x; x in radians.
<u>ATAN(x) [► 64]</u>	Returns the arc tangent of x; x in radians.
<u>ATAN2(y, x) [► 64]</u>	Returns the arc tangent of y/x; y/x in radians.

Arithmetic

Command	Description
<u>ABS(x) [► 64]</u>	Returns the absolute value of x .
<u>SQRT(x) [► 64]</u>	Returns the square root of x .
<u>LN(x) [► 64]</u>	Returns the natural logarithm of x .
<u>LOG(x) [► 64]</u>	Returns the decimal logarithm of x .
<u>EXP(x) [► 64]</u>	Returns e raised to the power of x .
<u>ADD(x1, x2, ...) [► 64]</u>	Returns the sum of all parameters.
<u>MUL(x1, x2, ...) [► 64]</u>	Returns the product of all parameters.
<u>SUB(x, y) [► 64]</u>	Returns the difference $x - y$.
<u>DIV(x, y) [► 64]</u>	Returns the quotient x / y .
<u>MOD(x, y) [► 64]</u>	Returns the remainder of the integer division x / y .
<u>EXPT(x, y) [► 64]</u>	Returns x raised to the power of y .

Arithmetic Parameters

Command	Description
<u>rSet(index := LINT, value := LREAL) [► 52]</u>	Assigns an R-parameter value.
<u>rGet(index := LINT) [► 52]</u>	Extracts an R-parameter value.

Bit Shift and Bit Rotation

Command	Description
<u>SHL(x, y) [► 67]</u>	Returns the bitstring x shifted left by y bits.
<u>SHR(x, y) [► 67]</u>	Returns the bitstring x shifted right by y bits.
<u>ROL(x, y) [► 67]</u>	Returns the bitstring x rotated left by y bits.
<u>ROR(x, y) [► 67]</u>	Returns the bitstring x rotated right by y bits.

Logical Operations

Command	Description
<u>AND(x1, x2, ...) [► 68]</u>	Returns the bitwise Logical And of all parameters.
<u>OR(x1, y2, ...) [► 68]</u>	Returns the bitwise Logical Or of all parameters.
<u>XOR(x1, x2, ...) [► 68]</u>	Returns the bitwise Logical Exclusive Or of all parameters.
<u>NOT(x) [► 68]</u>	Returns the bitwise complement of x .

Selection (Conditional Expressions)

Command	Description
<u>SEL(cond, x1, x2) [► 69]</u>	Returns $x1$ if $cond$ is FALSE, and $x2$ otherwise.
<u>MUX(select, x0, x1, ..., xN) [► 69]</u>	Returns $x < select >$.

Min, Max and Limit

Command	Description
MAX(x1, x2, ...) [► 69]	Returns the maximum of all parameters.
MIN(x1, x2, ...) [► 69]	Returns the minimum of all parameters.
LIMIT(min, in, max) [► 69]	Returns <code>in</code> if it lies in the interval <code>[min, max]</code> . Otherwise, the violated bound (<code>min</code> or <code>max</code>) is returned.

Comparison

Command	Description
GT(x, y) [► 70]	Returns <code>TRUE</code> if <code>x</code> is larger than <code>y</code> .
GE(x, y) [► 70]	Returns <code>TRUE</code> if <code>x</code> is not smaller than <code>y</code> .
EQ(x, y) [► 70]	Returns <code>TRUE</code> if <code>x</code> and <code>y</code> are equal.
LE(x, y) [► 70]	Returns <code>TRUE</code> if <code>x</code> is not larger than <code>y</code> .
LT(x, y) [► 70]	Returns <code>TRUE</code> if <code>x</code> is smaller than <code>y</code> .
NE(x, y) [► 70]	Returns <code>TRUE</code> if <code>x</code> and <code>y</code> are not equal.

Strings and Messages

Command	Description
toString(<arg0>, ..., <argN>): STRING [► 71]	Converts and concatenates the given arguments to one string.
msg(str:= String[81]) [► 71]	Sends the given message to the message list of TwinCAT.

Transformations

Command	Description
transRotX(angle:= LReal) [► 72] transRotY(angle:= LReal) [► 72] transRotZ(angle:= LReal) [► 72]	Rotation around the respective axis by the given angle in the user-defined angle unit.
transRotA(x:= LReal [► 72], y:= LReal, [► 72] z:= LReal [► 72], angle:= LReal) [► 72]	Rotate around vector <code>[x, y, z]</code> by the given angle.
transMirrorX() [► 72] transMirrorY() [► 72] transMirrorZ() [► 72]	Mirror with respect to the x-direction, y-direction or z-direction relative to the origin of the current PCS.
transScale(factor:= LReal) [► 72]	Scales the coordinate system by the <code>factor</code> in the x-dimension, y-dimension and z-dimension.
transScaleAxis(axisNo := axisIndex, factor := value) [► 72]	Scales the selected path axis (<code>axisNo</code>) by the factor.
transTranslate(x:= LReal, [► 72] y:= LReal, [► 72] z:= LReal) [► 72]	Translate by vector <code>[x, y, z]</code> .
transPop() [► 72]	Pops a transformation from the stack of transformations.
transDepth(): UInt [► 72]	Yields the depth of the stack of transformations, i.e. the number of active transformations.
transRestore(depth:= UInt) [► 72]	Reduces the stack of transformations to the given depth.

Movement

Command	Description
<code>moveCircle3d(cx:= LReal, [► 78] cy:= LReal, [► 78] cz:= LReal, [► 78] nx:= LReal [► 78], ny:= LReal [► 78], nz:= LReal [► 78], angle:= LReal [► 78], height:= LReal) [► 78]</code>	Move circular by rotating around the center cx, cy, cz and the normal vector nx, ny, nz by the given <code>angle</code> . If <code>height</code> is nonzero, a helix is described. The rotation is performed according to the right hand rule.

Centerpoint Correction

Command	Description
<code>centerpointCorrectionSet(on:= bool) [► 79]</code>	Activates the centerpoint correction for circles. Used for circles that are defined by centerpoint programming.
<code>centerpointCorrectionLimitSet(li mit:= LReal) [► 79]</code>	Sets the precision limit for the centerpoint of circles.

Tools

Command	Description
<code>toolParamSet(tidc:= USInt, [► 79] col:= USInt [► 79], val:= LReal) [► 79]</code>	Set a parameter of the tool <code>tidc</code> (1..255) to <code>val</code> . The parameter is identified by <code>col</code> (0..15).
<code>toolParam(tidc:= USInt [► 79], col:= USInt): LReal [► 79]</code>	Yields the given tool parameter.
<code>toolSet(index:= USInt [► 79], nr:= Int [► 79], tooltype:= ToolType, [► 79] length:= LReal [► 79], radius:= LReal, [► 79] lengthAdd:= LReal, [► 79] radiusAdd:= LReal [► 79], offsetX:= LReal [► 79], offsetY:= LReal [► 79], offsetZ:= LReal) [► 79]</code>	Set all parameters of a tool.
<code>ToolType [► 79]</code>	Enumeration of tool types.

Tool Radius Compensation

Command	Description
<code>trcApproachDepartSet(approac hRadius:= LReal [► 83], approachAngle:= LReal [► 83], departRadius:= LReal, [► 83] departAngle:= LReal) [► 83]</code>	Configures the approach and depart behavior to use an arc of given radius and angle.
<code>trcOffsetSet(offset:= LReal) [► 83]</code>	Configures the amount of segment extension that is used to close gaps.
<code>trcLimitSet(offset:= LReal) [► 83]</code>	Configures the lookahead that is used for collision elimination.
<code>trcParam(): TrcParamType [► 83]</code>	Returns the current configuration as a structure value.

Command	Description
<code>trcParamSet(param:= TrcParamType) [► 83]</code>	Configures the tool radius compensation. Summarizes <code>trcApproachDepartSet</code> , <code>trcOffsetSet</code> and <code>trcLimitSet</code> .
<code>TrcParamType [► 83]</code>	Structure containing all configuration parameters of the tool radius compensation.
<code>collisionElimination(nx:= LReal [► 83], ny:= LReal [► 83], nz:= LReal [► 83], limit:= ULInt) [► 83]</code>	Activates collision elimination with respect to the plane of the normal vector <code>nx</code> , <code>ny</code> , <code>nz</code> .
<code>collisionEliminationFlush() [► 83]</code>	To ignore conflicts between the path preceding the call and the path succeeding the call.

Com- mand	Description	Modal or Non- modal	Default
<code>G40 [► 43]</code>	Deactivates Tool Radius Compensation (TRC).	Modal.	Default.
<code>G41 [► 43]</code>	Activates Tool Radius Compensation (TRC). Left.	Modal.	No.
<code>G42 [► 43]</code>	Activates Tool Radius Compensation (TRC). Right.	Modal.	No.

Synchronization

Command	Description
<code>sync() [► 81]</code>	Synchronizes the interpreter with the associated NC-channel.
<code>wait() [► 81]</code>	Waits for a <code>GoAhead</code> -signal from the PLC.

Query of Axes

Command	Description
<code>queryAxes() [► 82]</code>	Set the MCS coordinates of the interpreter to the actual coordinates of the physical axes.

Current Point

Command	Description
<code>frameGet(x:= LReal [► 83], y:= LReal [► 83], z:= LReal [► 83], a:= LReal [► 83], b:= LReal [► 83], c:= LReal [► 83])</code>	Store the current frame of the PCS in <code>x</code> , <code>y</code> , <code>z</code> and <code>a</code> , <code>b</code> , <code>c</code> .
<code>qAxisGet(q1:= LReal [► 83], q2:= LReal [► 83], q3:= LReal [► 83], q4:= LReal [► 83], q5:= LReal [► 83])</code>	Store the current values of Q-axes <code>q1</code> to <code>q5</code> .

Suppression of G-Code Blocks

Command	Description
<code>disableMask():= LWord [► 84]</code>	Yields the current value of the disable mask.

Command	Description
<code>disableMaskSet(mask:= LWord)</code> [► 84]	Sets the internal disable mask to the given value.

Units

Command	Description
<code>unitAngleSet(unitAngle:= UnitAngle)</code> [► 86]	Set the unit for angles to <code>unitAngle</code> .
<code>UnitAngle</code> [► 86]	Enumeration of unit angles.
<code>unitLengthSet(unitLength:= UnitLength)</code> [► 86]	Set the unit for lengths to <code>unitLength</code> .
<code>UnitLength</code> [► 86]	Enumeration of unit lengths.
<code>unitTimeSet(unitTime:= UnitTime)</code> [► 86]	Set the unit for time to <code>unitTime</code> .
<code>UnitTime</code> [► 86]	Enumeration of unit times.
<code>unitVelocitySet(unitLength:= UnitLength, unitTime:= UnitTime)</code> [► 86]	Set the unit for velocity to <code>unitLength/unitTime</code> .

Trigonometric (Unit Aware)

Command	Description
<code>gSin(angle:= LReal)</code> [► 87]	Returns the sine of the given <code>angle</code> where the current angle unit is used to interpret the angle.
<code>gCos(angle:= LReal)</code> [► 87]	Returns the cosine of the given <code>angle</code> where the current angle unit is used to interpret the angle.
<code>gTan(angle:= LReal)</code> [► 87]	Returns the tangent of the given <code>angle</code> where the current angle unit is used to interpret the angle.
<code>gASin(val:= LReal)</code> [► 87]	Returns the arc sine of <code>val</code> in the current angle unit.
<code>gACos(val:= LReal)</code> [► 87]	Returns the arc cosine of <code>val</code> in the current angle unit.
<code>gATan(val:= LReal)</code> [► 87]	Returns the arc tangent of <code>val</code> in the current angle unit.
<code>gATan2(y:= LReal, x:= LReal)</code> [► 87]	Returns the arc tangent of y/x in the current angle unit.

Feed Mode

Command	Description
<code>feedModeSet(feedMode:= FeedModeType)</code> [► 88]	Set the feed mode.
<code>FeedModeType</code> [► 88]	Enumeration of feed mode types.

Feed Interpolation

Command	Description
<code>feedInterpolationSet(feedInterpolation:= FeedInterpolationType)</code> [► 89]	Set feed interpolation.
<code>FeedInterpolationType</code> [► 89]	Enumeration of feed interpolation types.

Streaming of Large G-Code Files

Command	Description
<code>runFile(path:= string)</code> [► 89]	Executes the plain G-Code that is contained in the G-Code file given by <code>path</code> .

Vertex Smoothing

Command	Description
<code>smoothingSet</code> [► 90] (<code>mainType:= SmoothingMainType</code> [► 90], <code>subType:= SmoothingSubType</code> [► 90], <code>value:= LReal</code>) [► 90]	Set the vertex smoothing behavior.
<code>SmoothingMainType</code> [► 90]	Enumeration of smoothing main types.
<code>SmoothingSubType</code> [► 90]	Enumeration of smoothing sub types.
<code>autoAccurateStopSet</code> [► 92]	Automatic accurate stop.

Dynamic Override

Command	Description
<code>dynOverrideSet(value:= LReal)</code> [► 96]	Set the dynamic override of axes to the given <code>value</code> .

Programming reference

Command	Description
<code>programmingReferenceSet</code> [► 97]	As an alternative to G90/G91, <code>programmingReferenceSet</code> can be used to set the dimensions of the subsequent movement commands to absolute or relative.
<code>programmingReferenceGet</code> [► 97]	The currently active dimension for the movement commands can be read out with <code>programmingReferenceGet</code> .
<code>ReferenceType</code> [► 97]	Enumeration of reference types.

Center Point Reference of Circles

Command	Description
<code>circleCenterReferenceSet(value:= ReferenceType)</code> [► 98]	Sets the center reference type for circles that are programmed by G02/G03.
<code>ReferenceType</code> [► 98]	Enumeration of reference types.

Dynamics Set

Command	Description
<code>axisDynamicsSet</code> [► 98]	Change in axis dynamics.
<code>pathDynamicsSet</code> [► 99]	Change in path dynamics.

Spline Interpolation

Command	Description
<code>transBSpline</code> [► 93]	Spline interpolation.

5.10 Comparative Command Overview

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
ANG [► 148]		Nonmodal.	Contour line programming (angle).

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
CalcInvRot [► 149]		Nonmodal.	Calculates the inverse rotation of a vector.
CalcRot [► 149]		Nonmodal.	Calculates the rotation of a vector.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
CDOF [► 193]	collisionElimination [► 83] Supplying a zero vector.	Modal.	Bottleneck detection off.
CDON [► 193]	collisionElimination [► 83] Supplying a nonzero vector.	Modal.	Bottleneck detection on.
	collisionEliminationFlush [► 83]		This function can be called during active collision elimination to ignore any conflicts between the path preceding the call and the path succeeding the call.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
CFC [► 192]	feedModeSet(feedMode:= FeedModeType) [► 88]	Modal.	Constant velocity at the contour.
CFIN [► 192]	feedModeSet(feedMode:= FeedModeType) [► 88]	Modal.	Constant velocity in the interior circle.
CFTCP [► 192]	feedModeSet(feedMode:= FeedModeType) [► 88]	Modal.	Constant velocity of the tool center point.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
CIP [► 139]	G303 [► 41]		An circular arc (CIP circle) can be programmed, that can be freely located in space.
	moveCircle3D [► 78]	Nonmodal.	Circular interpolation. Move circular by rotating around the center c_x, c_y, c_z and the normal vector n_x, n_y, n_z by the given angle.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
CPCOF [► 139]	centerpointCorrectionSet [► 78]	Modal.	Center point correction off.
CPCON [► 139]	centerpointCorrectionSet [► 78]	Modal.	Center point correction on.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
DelDTG [► 160]	G31 [► 43]	Nonmodal.	Delete distance to go.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
DYNOVR [► 176]	dynOverrideSet [► 96]	Modal.	Dynamic override.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
FCONST [► 142]	feedInterpolationSet(feedInterpolation:= fiConstant) [► 89]	Modal.	Constant feed programming.
FLIN [► 142]	feedInterpolationSet(feedInterpolation:= fiLinear) [► 89]	Modal.	Linear feed programming.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
G00 [► 137]	G00 [► 39]	Modal.	Rapid traverse.
G01 [► 138]	G01 [► 39]	Modal.	Straight line interpolation.
G02 [► 139]	G02 [► 40]	Modal.	Clockwise circular interpolation.
G03 [► 139]	G03 [► 40]	Modal.	Counterclockwise circular interpolation.
G04 [► 142]	G04 [► 42]	Nonmodal.	Dwell time.
G09 [► 142]	G09 [► 43]	Nonmodal.	Accurate stop.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
G17 [► 131]	G17 [► 47]	Modal.	Plane selection XY.
G18 [► 131]	G18 [► 47]	Modal.	Plane selection ZX.
G19 [► 131]	G19 [► 47]	Modal.	Plane selection YZ.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
G40 [► 187]	G40 [► 43]	Modal.	No miller/ cutter radius compensation.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
G41 [► 187]	G41 [► 43]	Modal.	Miller/ cutter radius compensation left.
G42 [► 187]	G42 [► 43]	Modal.	Miller/ cutter radius compensation right.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
G53 [► 143]	G53 [► 45]	Modal.	Zero shift suppression.
G54 [► 143]	G54 [► 45]	Modal.	1st adjustable zero offset shift.
G55 [► 143]	G55 [► 45]	Modal.	2nd adjustable zero offset shift.
G56 [► 143]	G56 [► 45]	Modal.	3rd adjustable zero offset shift.
G57 [► 143]	G57 [► 45]	Modal.	4th adjustable zero offset shift.
G58 [► 143]	G58 [► 45]	Modal.	1st programmable zero offset shift.
G59 [► 143]	G59 [► 45]	Modal.	2nd programmable zero offset shift.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
G60 [► 142]	G60 [► 43]	Modal.	Accurate stop.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
G70 [► 132]	G70 [► 48]	Modal.	Dimensions in inch.
G71 [► 132]	G71 [► 48]	Modal.	Dimensions metric.
G74 [► 137]		Nonmodal.	Programmed traverse to reference point.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
G90 [► 130]	G90 [► 50]	Modal.	Reference dimension notation.
G91 [► 130]	G91 [► 50]	Modal.	Incremental dimension notation.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
G700 [► 132]	G700 [► 48]	Modal.	Dimensions in inches with calculation of the feed.
G710 [► 132]	G710 [► 48]	Modal.	Dimensions metric with calculation of the feed.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
MOD [► 160]		Nonmodal.	Modulo movement.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
MSG [► 181]	msg [► 71]	Nonmodal.	Message from the NC program.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
NORM [► 192]		Nonmodal.	Orthogonal approach off the contour and orthogonal departure from the contour.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
P+ [► 131]	P<1> [► 54]	Modal.	Feed direction positive.
P- [► 131]	P<-1> [► 54]	Modal.	Feed direction negative.
paramAutoAccurateStop	autoAccurateStopSet [► 92]	Modal.	Automatic accurate stop.
paramAxisDynamics [► 176]	axisDynamicsSet [► 98]	Modal.	Parameterization of the axis dynamics.
paramC1ReductionFactor [► 177]		Modal.	C1 reduction factor.
paramC2ReductionFactor [► 177]		Modal.	C2 reduction factor.
paramCircularSmoothing [► 158]		Modal.	Circular smoothing.
paramDevAngle [► 177]		Modal.	C0 reduction - deflection angle.
paramGroupVertex [► 158]		Modal.	Circular smoothing (old).
paramGroupDynamic [► 176]		Modal.	Path dynamics (old).
paramPathDynamics [► 176]	pathDynamicsSet [► 99]	Modal.	Path dynamics.
paramRadiusPrec [► 140]		Modal.	Circular accuracy.
paramSplineSmoothing [► 156]	smoothingSet [► 90]	Modal.	Vertex smoothing. NC: Smoothing with Bezier Splines.
paramVertexSmoothing [► 153]	smoothingSet [► 90]	Modal.	Smoothing of segment transitions.
	transBSpline [► 93]	Modal.	Spline interpolation.
paramVelocityJump [► 177]		Modal.	C0 reduction - maximum step change in velocity.
paramVelocityMin [► 179]		Modal.	Minimum velocity.
paramZeroShift [► 143]	zeroOffsetShiftSet [► 85]	Modal.	Parameterization of the configurable zero shift.
PathAxesPos [► 179]	frameGet [► 83] qAxisGet [► 83]	Nonmodal.	Reads the actual position.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
ZeroShiftIncOff [► 143]		Modal.	Zero shift is not applied under G91.
ZeroShiftIncOn [► 143]		Modal.	Zero shift is applied under G91.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
AROT [► 149]	transRotA [► 72]	Modal.	Rotation additive.
ROT [► 149]	transRotX , transRotY , transRotZ [► 72]	Modal.	Absolute rotation.
RotExOff [► 149]		Modal.	Extended rotation function off.
RotExOn [► 149]		Modal.	Extended rotation function on.
RotVec [► 149]		Nonmodal.	Calculation routine for rotating a vector.
RToDwordGetBit [► 135]		Modal.	Converts an R-parameter to DWord and checks whether a defined bit is set.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
Mirror [► 152]	transMirrorX , transMirrorY , transMirrorZ [► 72]	Modal.	Mirroring the coordinate system.
	transScale [► 72]	Modal.	Scales the coordinate system by the factor in the X-dimension, Y-dimension and Z-dimension.
	transScaleAxis [► 72]	Modal.	Scales the selected path axis (axisNo) by the factor.
	transDepth [► 72]	Nonmodal.	Yields the depth of the stack of transformations.
	transRestore [► 72]	Modal.	Reduces the stack of transformations to the given depth.
	transPop [► 72]	Modal.	Pops a transformation from the stack of transformations.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
rParam [► 135]	rSet(index := LINT, value := LREAL) [► 52]	Nonmodal.	Assigning a Value to an R-Parameter.
rParam [► 135]	rGet(index := LINT) [► 52]	Nonmodal.	Reading an R-Parameter Value.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
SEG [► 148]		Nonmodal.	Contour line programming (segment length).
skip VirtualMovements [► 180]		Modal.	Skip virtual movements.

Command Classic Interpreter	Command GST Interpreter	Modal or Non-modal	Description
ToolOffsetIncOff [► 184]		Modal.	Cartesian tool displacement and length compensation is not applied under G91.
ToolOffsetIncOn [► 184]		Modal.	Cartesian tool displacement and length compensation is applied under G91.
ToolParam [► 181]	toolParamSet [► 79]	Modal.	Set a tool parameter. NC: Writing and reading of tool parameters.
ToolParam [► 181]	toolParam [► 79]	Modal.	Yields the given tool parameter. NC: Writing and reading of tool parameters.
ToolParam [► 181]	toolSet [► 79]	Modal.	Set all parameters of a tool. NC: Writing and reading of tool parameters.
TPM [► 146]		Nonmodal.	Target position monitoring.

Command Classic Interpreter	Command GST Interpreter	Description
	trcApproachDepartSet [► 83]	Configures the approach and depart behavior to use an arc of given radius and angle.
	trcOffsetSet [► 83]	Configures the amount of segment extension that is used to close gaps.
	trcLimitSet [► 83]	Configures the lookahead that is used for collision avoidance.
	trcParam [► 83]	Returns the current configuration as a structure value.
	trcParamSet [► 83]	Configures the tool radius compensation.
	trcParamType [► 83]	This structure contains all configuration parameters of the tool radius compensation.

Command Classic Interpreter	Command GST Interpreter	Description
	queryAxes [► 82]	Set the MCS (machine coordinate system) coordinates of the interpreter to the actual coordinates of the physical axes.

Command Classic Interpreter	Command GST Interpreter	Description
	disableMask [► 84]	Yields the current value of the disable mask.
Block Skipping [► 128] /	disableMaskSet [► 84]	Sets the internal disable mask to the given value.

Command Classic Interpreter	Command GST Interpreter	Description
L [► 174]	Userdefined Functions [► 63]	Call of a subroutine.
	#include [► 33]	Directive inserts the contents of another file. Typically, it is used to "import" commonly used code like e.g. libraries.

Command Classic Interpreter	Command GST Interpreter	Description
	runFile [▶ 89]	Streaming of large G-Code files.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@40 [▶ 135]	@40 Kn Rn Rm ...		Save register on the stack.
@41 [▶ 135]	@41 Rn Rm		Save register on the stack.
@42 [▶ 135]	@42 Kn ... Rm Rn		Restore register from stack.
@43 [▶ 135]	@43 Rm Rn		Restore register from stack.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@100 [▶ 171]	@100 K±n @100 Rm	Jump statement [▶ 62]	Unconditional jump.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@111 [▶ 171]	@111 Rn K/Rn Km ...	CASE OF	Case block.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@121 [▶ 171]	@121 Rn K/Rn Kn	IF-THEN-ELSIF-ELSE;CASE OF [▶ 61]; GOTO [▶ 62]	Jump if unequal.
@122 [▶ 171]	@122 Rn K/Rn Kn	IF-THEN-ELSIF-ELSE;CASE OF [▶ 61]; GOTO [▶ 62]	Jump if equal.
@123 [▶ 171]	@123 Rn K/Rn Kn	IF-THEN-ELSIF-ELSE;CASE OF [▶ 61]; GOTO [▶ 62]	Jump if less or equal.
@124 [▶ 171]	@124 Rn K/Rn Kn	IF-THEN-ELSIF-ELSE;CASE OF [▶ 61]; GOTO [▶ 62]	Jump if less.
@125 [▶ 171]	@125 Rn K/Rn Kn	IF-THEN-ELSIF-ELSE;CASE OF [▶ 61]; GOTO [▶ 62]	Jump if greater or equal.
@126 [▶ 171]	@126 Rn K/Rn Kn	IF-THEN-ELSIF-ELSE;CASE OF [▶ 61]; GOTO [▶ 62]	Jump if greater.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@131 [▶ 173]	@131 Rn K/Rn Kn	WHILE [▶ 61]	Loop while equal.
@132 [▶ 173]	@132 Rn K/Rn Kn	WHILE [▶ 61]	Loop while unequal.
@133 [▶ 173]	@133 Rn K/Rn Kn	WHILE [▶ 61]	Loop while greater.
@134 [▶ 173]	@134 Rn K/Rn Kn	WHILE [▶ 61]	Loop while greater or equal.
@135 [▶ 173]	@135 Rn K/Rn Kn	WHILE [▶ 61]	Loop while less.
@136 [▶ 173]	@136 Rn K/Rn Kn	WHILE [▶ 61]	Loop while less or equal.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@141 [► 173]	@141 Rn K/Rn Kn	REPEAT [► 61]	Repeat until equal.
@142 [► 173]	@142 Rn K/Rn Kn	REPEAT [► 61]	Repeat until unequal.
@143 [► 173]	@143 Rn K/Rn Kn	REPEAT [► 61]	Repeat until greater.
@144 [► 173]	@144 Rn K/Rn Kn	REPEAT [► 61]	Repeat until greater or equal.
@145 [► 173]	@145 Rn K/Rn Kn	REPEAT [► 61]	Repeat until less.
@146 [► 173]	@146 Rn K/Rn Kn	REPEAT [► 61]	Repeat until less or equal.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@151 [► 173]	@151 Rn K/Rn Kn	FOR [► 61]	FOR_TO loop.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@161 [► 173]	@161 Rn K/Rn Kn	FOR [► 61]	FOR_DOWNTTO loop.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@200	@200 Rn		Delete a variable.
@202	@202 Rn Rm		Swap two variables.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@302	@302 K/R/Pn K/R/Pn R/Pn		Read machine data bit.
@361 [► 179]	@361 Rn Km		Read machine-related actual axis value.
@372	@372 Rn		Extract the NC-Channel-ID and store it in a variable.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@402 [► 139]	@402 K/R/Pn K/R/Pn K/R/Pn	circleCenterReferenceSet [► 98]	Write machine data bit.
		circleCenterReferenceGet [► 98]	Returns the current center point reference for circles.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@610	@610 Rn Rn	ABS [► 64]	Find the absolute value of a variable.
@613	@613 Rn Rn	SQRT [► 64]	Find the square root of a variable.
@614	@614 Rn Rm Rm	SQRT (a^2 + b^2)	Find the square root of the sum of the squares of two variables ! x := sqrt (a^2 + b^2);.

Command Classic Interpreter	Versions	Command GST Interpreter	Description
@620 [► 173]	@620 Rn	!var := var+1;	Increment variable.
@621	@621 Rn	!var := var-1;	Decrement variable.
@622	@622 Rn		Find integer part of a variable.

Command Class- sic Interpreter	Versions	Command GST In- terpreter	Description
@630 [► 135]	@630 Rn Rm	SIN [► 64]	Find the sine of a variable.
@630 [► 135]	@630 Rn Rm	gSin [► 87]	Find the sine of a variable.
@631 [► 135]	@631 Rn Rm	COS [► 64]	Find the cosine of a variable.
@631 [► 135]	@631 Rn Rm	gCos [► 87]	Find the cosine of a variable.
@632 [► 135]	@632 Rn Rm	TAN [► 64]	Find the tangent of a variable.
@632 [► 135]	@632 Rn Rm	gTan [► 87]	Find the tangent of a variable.
@633 [► 135]	@633 Rn Rm		Find the cotangent of a variable.
@634 [► 135]	@634 Rn Rm	ASIN [► 64]	Find the arc sine of a variable.
@634 [► 135]	@634 Rn Rm	gASin [► 87]	Find the arc sine of a variable.
@635 [► 135]	@635 Rn Rm	ACOS [► 64]	Find the arc cosine of a variable.
@635 [► 135]	@635 Rn Rm	gACos [► 87]	Find the arc cosine of a variable.
@636 [► 135]	@636 Rn Rm	gATan [► 87]	Find the arc tangent of a variable.
		gATan2 [► 87]	Returns the arc tangent of y/x .

Command Class- sic Interpreter	Versions	Command GST In- terpreter	Description
@714 [► 170]	@714	sync() [► 81]	Decoder stop.
@716 [► 170]	@716	A combination of sync() [► 81] and queryAxes() [► 82] replaces the former @716-command.	Decoder stop with rescan of the axis positions.
@717 [► 170]	@717	wait() [► 81]	Decoder stop with external trigger event.

Command Class- sic Interpreter	Command GST In- terpreter	Description
	LN(x) [► 64]	Returns the natural logarithm of x .
	LOG(x) [► 64]	Returns the decimal logarithm of x .
	EXP(x) [► 64]	Returns e raised to the power of x .
	ADD(x1, x2, ...) [► 64]	Returns the sum of all parameters.
	MUL(x1, x2, ...) [► 64]	Returns the product of all parameters.
	SUB(x, y) [► 64]	Returns the difference $x-y$.
	DIV(x, y) [► 64]	Returns the quotient x/y .
	MOD(x, y) [► 64]	Returns the remainder of the integer division x/y .
	EXPT(x, y) [► 64]	Returns x raised to the power of y .

Command Class- sic Interpreter	Command GST In- terpreter	Description
	GT(x, y) [► 70]	Returns TRUE if x is larger than y .
	GE(x, y) [► 70]	Returns TRUE if x is not smaller than y .
	EQ(x, y) [► 70]	Returns TRUE if x and y are equal.
	LE(x, y) [► 70]	Returns TRUE if x is not larger than y .
	LT(x, y) [► 70]	Returns TRUE if x is smaller than y .

Command Class- sic Interpreter	Command GST In- terpreter	Description
	NE(x, y) [► 70]	Returns TRUE if x and y are not equal.
Command Class- sic Interpreter	Command GST In- terpreter	Description
	<nativeType> to <n ativeType>(x), [► 64] to <nativeType>(x) [► 64]	Explicit conversion between the given native types.

Logical Operations

Command Class- sic Interpreter	Command GST In- terpreter	Description
	AND(x1, x2, ...) [► 68]	Returns the bitwise Logical And of all parameters.
	OR(x1, y2, ...) [► 68]	Returns the bitwise Logical Or of all parameters.
	XOR(x1, x2, ...) [► 68]	Returns the bitwise Logical Exclusive Or of all parameters.
	NOT(x) [► 68]	Returns the bitwise complement of x.

Min, Max and Limit

Command Class- sic Interpreter	Command GST In- terpreter	Description
	MAX(x1, x2, ...) [► 69]	Returns the maximum of all parameters.
	MIN(x1, x2, ...) [► 69]	Returns the minimum of all parameters.
	LIMIT(min, in, max [► 69])	Returns in if it lies in the interval [min, max]. Otherwise, the violated bound (min or max) is returned.

Rotation

Command Class- sic Interpreter	Command GST In- terpreter	Description
	ROL(x, y) [► 67]	Returns the bitstring x rotated left by y bits.
	ROR(x, y) [► 67]	Returns the bitstring x rotated right by y bits.

Selection (Conditional Expressions)

Command Class- sic Interpreter	Command GST In- terpreter	Description
	SEL(cond, x1, x2) [► 69]	Returns x1 if cond is FALSE, and x2 otherwise.
	MUX(select, x0, x1, ... , xN) [► 69]	Returns x<select>.

Shift

Command Class- sic Interpreter	Command GST In- terpreter	Description
	SHL(x, y) [► 67]	Returns the bitstring x shifted left by y bits.
	SHR(x, y) [► 67]	Returns the bitstring x shifted right by y bits.

Units

Command Classic Interpreter	Command GST Interpreter	Description
	unitAngleSet(unitAngle:= UnitAngle) [► 86]	Set the unit for angles to <code>unitAngle</code> .
	UnitAngle [► 86]	Enumeration of unit angles.
	unitLengthSet(unitLength:= UnitLength) [► 86]	Set the unit for lengths to <code>unitLength</code> .
	UnitLength [► 86]	Enumeration of unit lengths.
	unitTimeSet(unitTime:= UnitTime) [► 86]	Set the unit for time to <code>unitTime</code> .
	UnitTime [► 86]	Enumeration of unit times.
	unitVelocitySet(unitLength:= UnitLength, unitTime:= UnitTime) [► 86]	Set the unit for velocity to <code>unitLength/unitTime</code> .

6 Classic Dialect Reference Manual

6.1 Basic Principles of NC Programming

6.1.1 Structure of an NC Program

An NC program is a text that is normally stored as a sequence of ASCII codes in a file on the hard disk. It consists of a sequence of NC blocks separated by line breaks (Return). Usually it is executed by being interpreted and worked through, character by character and line by line.

Program structure

The NC program is thus composed of three parts

- Program start (optional)
- Number of blocks
- Program end

Program start

At the beginning of an NC program the character "%" can represent the start of the program. The name of the program is then found following this character. The block for the program start does not necessarily have to be programmed.

Sample:

```
% Test1 (program start)
N10 G0 X100 Y100 Z0
M30 (program end)
```

NC block

Each NC block consists of one or several NC words, or even of none (an empty line), separated by spaces or tab characters. It is therefore not possible to use a space within a word.

Sample:

```
N10 G0 X100 Y100 Z0
```

NC word

The first character of an NC word specifies its meaning. It is either a letter or a special character.

Upper/lower case has, in general, no significance. Uniform use of upper case is, however, recommended for the sake of better readability. The optional following characters specify the meaning more precisely, or supply parameters for the execution.

In order to manage with such a limited supply of characters, an expression is not available for every variation of every function. It is rather the case that the significance and effect of many NC words is determined partly by the context. This can be a matter of the foregoing words in the block, but it can also depend on previous NC blocks. In a few cases the effect of NC words even depends on the machine data.

Program end

The end of the program is indicated by an M-function. Either M2 or M30 is used for this.

Effective Duration of Words

Commands such as G0 [▶ 137] or G17 [▶ 131], that have effects beyond the end of the block, are known, according to DIN 66025, as **modal**. These commands are effective as long as they are neither cancelled nor altered by another command.

Comments

If either parts of an NC block, or the whole of it, is not to be interpreted, the region concerned is to be placed within curved brackets.

Sample:

```
N10 G0 X100 (comment)
```

Notice A comment ends with the closing bracket, or, at the latest, at the end of the block. This means that a comment can't continue over a number of lines. Nested comments are also not possible.

Block numbers

Each block can be identified by a block number. The block number is accompanied by "N" for subordinate blocks and ":" for main blocks.

Notice The block number is not essential. A block not identified by a block number can not, however, be used as the target of a jump command. An error message, moreover, can only approximately report the location of the error (the last block number).

6.1.2 Block Skipping

It is often useful if not all blocks of a program are always executed. This makes it possible to implement similar processes with a single program.

In such cases, the blocks that belong to one variant are given a block skipping identifier. This must be written at the start of the block, and consists of a slash "/".

If several variants are required, the slash is extended with line information (0..15), for instance "/12". The line information (where "/" is equivalent to "/0") selects a bit from a word in the channel interface from the PLC to the NC. If this bit is **set**, the block is not interpreted.

In the NC the variable '*mSkipLine*' is evaluated for this purpose, which can be found among the inputs in the cyclic channel interface. The counterpart in the PLC can be found in the outputs under '*nSkipLine*' [[► 344](#)] (previously: *nSkipBlock*) (see TwinCAT PLC library: NCI Interpreter).

If one of a number of variants is to be active, all the other suppressions must be set. Then only those blocks remain active that have either no identifier, or that have the desired identifier.

● Active time of block skipping

i The interpreter works an indeterminate number of blocks in advance of the execution. Block skipping can only operate correctly if it is set early enough (perhaps before the program starts), or if the interpreter is synchronized with the execution at a suitable location in the program ([decoder stop](#) [[► 170](#)]).

6.1.3 Look-Ahead

The actual velocity at the segment transition depends on a range of parameters. These include residual path length, dynamic parameters for the current segment, and (indirectly) the geometric angle at the segment transition.

Dynamic look-ahead (referred to as look-ahead below) ensures that the velocity can remain as high as possible at segment transitions. In the standard configuration 128 geometry entries are considered.

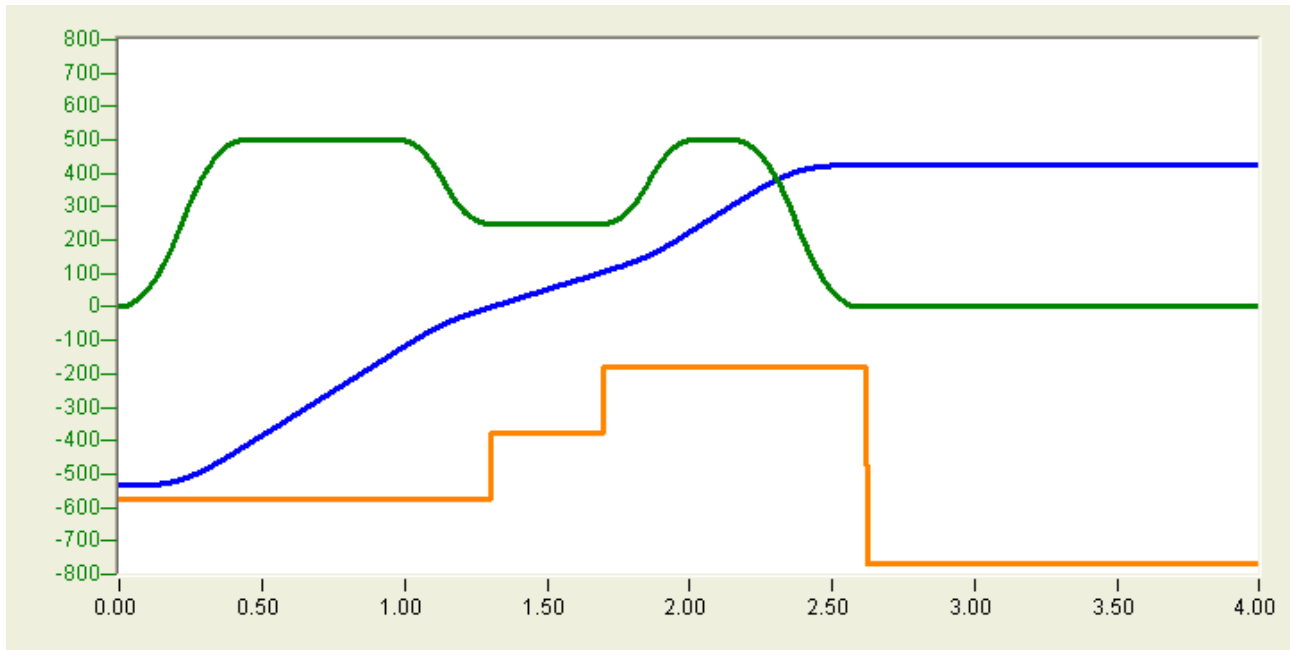
Without look-ahead the velocity is reduced to 0 at each segment transition (G60).

The number of geometry entries taken into account can be set in the [DXD parameters](#) [[► 29](#)].

Segments with different target velocity

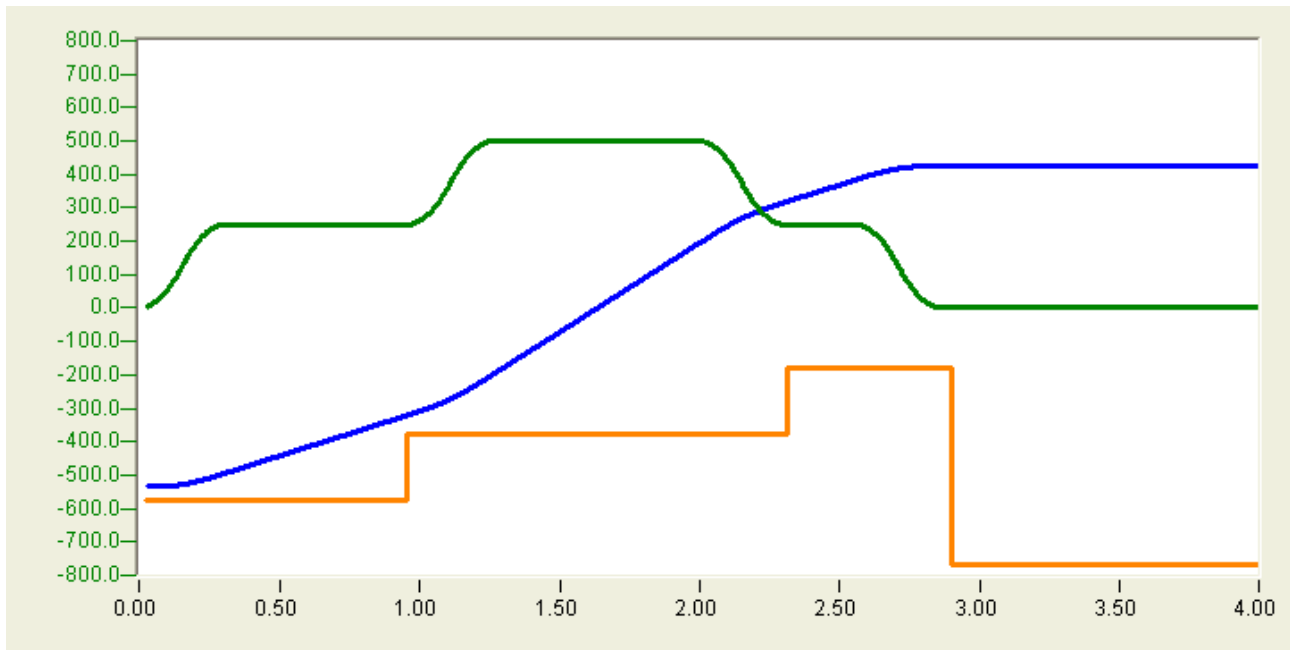
If the target velocity changes from a high velocity level to a lower level (N10 -> N20), the lower velocity will already have been reached at the start of the segment.

If the target velocity changes from a low velocity level to a higher level (N20 -> N30), the higher velocity is initiated with the segment transition. The system therefore always ensures that even at the segment boundary the current velocity does not exceed the programmed velocity.



green: Path velocity
blue: Position
orange: Block numbers

```
N10 G01 X600 F30000
N20 G01 X700 F15000
N30 G01 X900 F30000
M30
```



green: Path velocity
blue: Position
orange: Block numbers

```
N40 G01 X200 F15000
N50 G01 X800 F30000
N60 G01 X900 F15000
M30
```

6.1.4 Smoothing of Segment Transitions

Overview

Segment transitions with no continuous second differential cause instability in the dynamics unless the path velocity is reduced to 0 at those points. For dynamically stable segment transition at a finite speed it is possible to smooth segment transitions with Bezier splines which alter the local geometry and ensure that the complete path has a continuous second differential.

Tolerance spheres

A tolerance sphere is laid around every segment transition within which the path may deviate from its pre-set geometry for smoothing purposes. The radius of the tolerance sphere ([parameterization \[► 339\]](#)) is predetermined by the user and applied modally for all segment transitions that imply no exact positioning or stop in the segment transitions. The radii of the tolerance spheres are automatically reset adaptively, thus preventing tolerance spheres from overlapping in the case of small segments.

Dynamic parameters

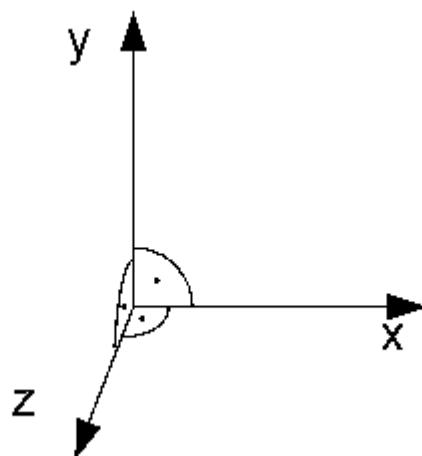
The smoothing enables faster dynamics. The system-determined maximum segment transition velocity *VeloLink* can be influenced by the user insofar as the system parameter C2 velocity reduction C2 ([parameterization \[► 339\]](#)) sets the segment transition velocity to $C2 \times \text{VeloLink}$. The factor can be changed online.

General characteristics at segment transitions

When entering the tolerance sphere, the path acceleration is 0 and the path velocity equals the segment transition velocity. This is maintained within the tolerance sphere. The override is inactive within the tolerance sphere, i.e. the change of the velocity level caused by the override is interrupted within the tolerance sphere and continues after the exit from the tolerance sphere.

6.1.5 Co-ordinate System

The names of the axes of a machine tool are specified by DIN 66217. The letters X, Y and Z are allocated to the axes. These create a right-handed right-angle (Cartesian) coordinate system. In many machines, not all three axes are present at every location. In these cases individual letters are allocated in some meaningful way, and the axes that are not present are ignored.



6.1.6 Dimensional Notation

Dimensional data can optionally be referred to an absolute origin or to the current set value.

Absolute dimensions

Command	G90 (standard setting)
Cancellation	G91

All positional data in absolute dimensions are always given with reference to the currently valid origin.

In terms of tool movement, this means that, under absolute dimensioning, it is the position to which the tool should move that is described.

Incremental Dimensions

Command	G91
Cancellation	G90

When dimensions are incremental, positional data is related to the immediately preceding point. In addition to the path axes, the auxiliary axes (Q1..Q5) are also taken into account.

For the tool movement this means that the incremental dimension describes by how much the tool is moved.

Units

The units for length, angle etc. are described in the following table:

	Unit
Positions and lengths	mm
Angle	degree
Times	sec
Feed	mm/min

6.1.7 Working Plane and Feed Direction

In order to describe circles (except [CIP \[► 139\]](#)), and for the compensation of [cutter radius \[► 187\]](#) and [tool length \[► 184\]](#), it is necessary to specify the working plane.

Working Plane XY

Command	G17 (standard setting)
Cancellation	G18 or G19

The function G17 specifies the XY plane as the working plane and the feed direction as the Z direction.

The function acts as:

- Plane for [tool radius compensation \[► 187\]](#)
- Feed direction for [tool length compensation \[► 184\]](#) (offset)
- Plane for circle interpolation

● Changing the working plane

i The working plane cannot be changed while tool compensation is active.

Working Plane ZX

Command	G18
Cancellation	G17 or G19

The function G18 specifies the ZX plane as the working plane and the feed direction as the Y direction.

Working Plane YZ

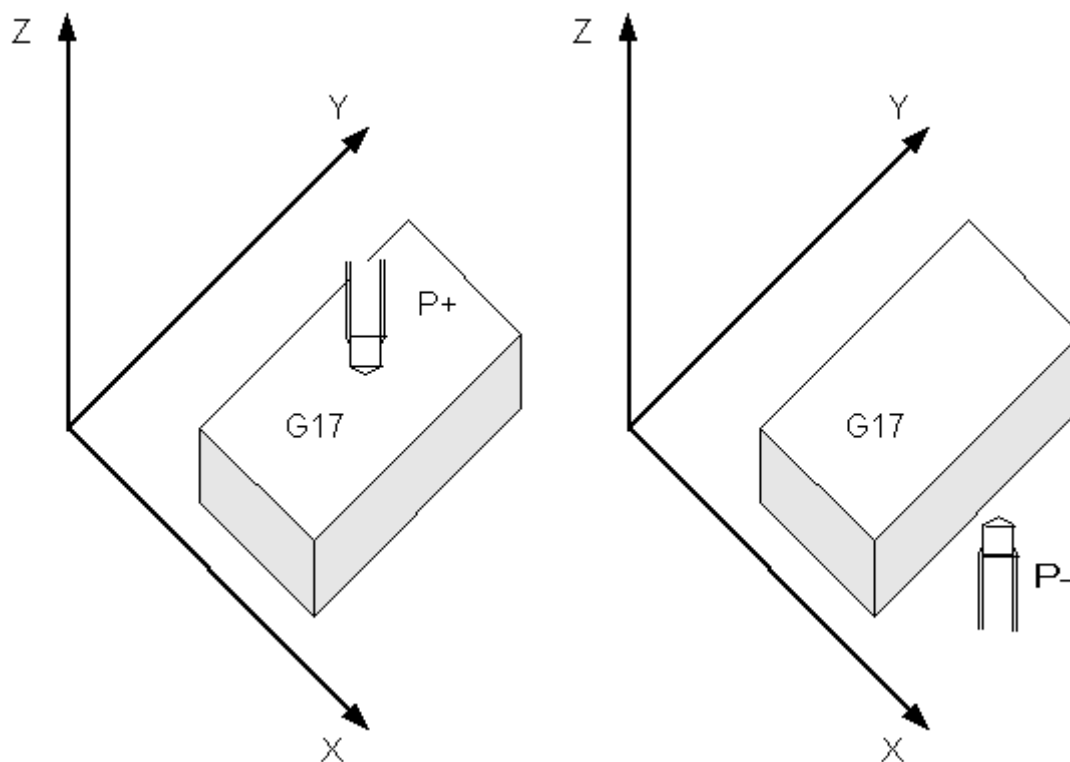
Command	G19
Cancellation	G17 or G18

The function G19 specifies the YZ plane as the working plane and the feed direction as the X direction.

Specification of the feed direction

Command	P
Parameter	+ feed direction positive (standard setting) - feed direction negative

Parameterization of the feed direction is required for tool length compensation. It is used to specify whether the tool operates above or below the workpiece.



Sample:

```
N10 G0 X0 Y0 Z0 F6000
N20 D2 P- Z
N30 G01 X100
N40 D0 Z
N50 M30
```

In this sample the length compensation operates below the workpiece.

6.1.8 Inch/metric dimensions

G70	Dimensions in inches
G71	Dimensions in millimeters (standard setting)
G700	Dimensions in inches with calculation of the feed
G710	Dimensions in millimeters with calculation of the feed

Dimensions in millimeters (G71) is active by default. Information on whether the coordinates have to be converted is stored in the machine parameters [► 16] (Interpreter tab). The basic dimension system in millimeters is also set there by default.

The effects of the changeover

If the basic dimension system is not the same as the current dimension system (set with G70 or G71), then certain parameters and co-ordinates must be converted. The conversion factor required here is stored in the machine parameters, like the basic dimension system. The changeover has effects on the following parameters:

- Path information for the path axes (X, Y & Z)
- Path information for the auxiliary axes (Q1..Q5)
- Intermediate point co-ordinates (I, J, K)
- Circle radii (B or U)
- Programmable zero shift
- Rounding radius (circle and spline smoothing)

There are also parameters that always remain in the **basic dimension system**, and are not converted. These include the

- adjustable zero shift
- Tool data
- feeds (except under G700 or G710)

Sample 1:

Basic dimension system: inch

```
...
N10 G71      (metric dimensions)
N20 G01 X100 (conversion is carried out)
N30 G70      (dimensions in inches)
N40 G01 Y100 (conversion is not necessary, because)
....        (the basic dimensions are also inches)
```

Sample 2:

Basic dimension system: millimeters

```
...
N10 G71 (metric dimensions)
N20 G01 X100 (conversion is not necessary, because)
      (the basic dimensions are also metric)
N30 G70 (dimensions in inches)
N40 G01 Y100 (conversion is carried out)
```

Zero shifts (NPV)

Adjustable zero shifts (G54-G57) always remain in the basic dimension system, and are not converted. In the case of the programmable zero shifts (G58 & G59) the effect depends on the current dimension system when the shift is selected.

Sample 3:

Basic dimension system: millimeters

```
...
N10 G71      (mm - default)
N20 G54      (activates adjustable zero offset shift)
N30 G58 X100 (programmable zero offset shift)
N40 G01 X0 F6000 (the axis travels to 100 in the machine co-ordinate system)
N50 G70      (inch)
N60 G01 X0    (zero offset shift is programmed under G71 => zero offset shift remains unchanged)
      (i.e. the axis does not move)
N70 G58 X100 (new programmable zero offset shift - now in inches)
N80 G01 X0    (axis moves out by zero offset shift - to 2540 in the machine co-ordinate system)
```

6.1.9 Single Block Operation

To test a new NC program, the NCI can be switched to single block mode with the function block [ltpSingleBlock](#) [► 253]. When single block mode is active, the NC program is stopped after each line. The user has to acknowledge execution of the next line. This can be done by pressing '**NC start (F5)**' in the XAE under the Editor tab or by setting the input 'bTriggerNext' in the PLC function block [ltpSingleBlock](#) [► 253].

A distinction is made between two modes:

- Interpreter single block mode
- NC kernel single block mode

The selection of the single block mode is not reset by an [ltpResetEx2](#) [► 241]. This means that if, for example, the NC kernel single block mode is active, it still remains active after a reset.

Interpreter single block mode

If interpreter single block mode is active, the NC program is stopped after each line in the **interpreter**. This remains true even if the line only contains calculations, and no physical movement is programmed. This enables re-writing of R-parameters, for example.

Interpreter single block mode should be activated before the NC program is started. If this is not possible, an M-function can be reserved for the activation and combined with a decoder stop.

If interpreter single block mode is activated during processing of the NC program without M-function and decoder stop, it is impossible to predict when it will be active. Theoretically it is possible that the memories in the NC kernel (SVB & SAF) are filled and contain more than 100 geometry entries. The single block can only take effect once these memories have been fully processed.

NC kernel single block mode

Like in interpreter single block mode, in NC kernel single block mode the NC blocks are executed individually. The difference is that in NC kernel single block mode all entries (e.g., geometry entries) have already passed through the interpreter. It is therefore not possible to overwrite R-parameters retrospectively, for example.

This operating mode has the advantage that single block mode can be enabled during processing of the NC program. If a geometry entry is executed (i.e. the axes are moved) during the activation, the system stops at the next possible end of segment. This is usually the current segment. For activation after program startup no M-function with decoder stop is required. However, an M-function with program end identifier (M02, M30) is required at the end of the program.

If NC kernel single block mode is used in conjunction with blending, block relaying takes place in the blending sphere. The programmed blending continues to be executed (from TwinCAT V2.10 Build 1301).

Alternatives to activation

We recommend activating single block mode with [ltpSingleBlock](#) [► 253].

For reasons of compatibility with previous TwinCAT versions, single block mode can be activated via the cyclic channel interface.

Single block mode can be selected or deselected in the cyclic channel interface of the PLC. To this end the variable 'nltpMode' has to be masked correctly in the PLC/NC channel interface.

Set bit 14 (0x4000) to switch on interpreter single block mode. Resetting the bit turns single block mode off again.

It is also possible to trigger the single block from the PLC by means of this interface. Bit 15 must be set for this. The effect is the same as activating NC start in the XAE.

6.1.10 Arithmetic Parameters

The arithmetic parameters (known as R-parameters for short) are interpreter variables that are named by an expression of the form "R<n>". Since 'n' is an integer in the range 0..999, a total of 1000 R-parameters are available. Of these, the first 900 values (R0..R899) are local variables for the NC channel. They can only be accessed by the channel's interpreter. The R-parameters R900..R999 are declared globally. They exist only once for each NC, and all channels access the same storage. This makes it possible to exchange data (e.g. for part tracing, collision avoidance etc.) over the channel boundaries.

Mathematical Calculations

The R-parameters (like the axis co-ordinates, feedrates etc.) are declared as variables of type 'double'. This makes full use of the computer's arithmetic capacity. The number of places before and after the decimal point is not restricted by a format specification. The arithmetical resolution does, nevertheless, have a limit. In practice this is only visible in particularly critical cases. Examples of this include the differences of very large numbers that are almost equal, or trigonometrical functions in particular ranges of angles.

Assignment of R-Parameters

```
N100 R5=17.5  
N110 R6=-4  
N120 R7=2.5 R8=1
```

As can be seen in the third line, it is quite possible to make more than one assignment in one block. This speeds interpretation slightly, but it can be more difficult to localize an error in the line.

Calculation formula

A calculation formula is an extension of assignment. It consists of a target parameter, an assignment sign and a series of values (R-parameters and constants) separated by arithmetical instructions.

```
N100 R1=R2+R3-17.5*R9/2.5
```

Such a formula, contrary to normal mathematical practice, is processed strictly from left to right.

The illustrated formula is calculated as follows:

1. The contents of R2 is loaded into the arithmetic unit
2. The contents of R3 is loaded into the arithmetic unit
3. The arithmetic unit carries out the + instruction
4. The value 17.5 is loaded into the arithmetic unit
5. The arithmetic unit carries out the - instruction
6. The contents of R9 is loaded into the arithmetic unit
7. The arithmetic unit carries out the * instruction
8. The value 2.5 is loaded into the arithmetic unit
9. The arithmetic unit carries out the / instruction
10. The content of the arithmetic unit is stored in R-parameter R1

Mathematical functions

The interpreter provides standard computing functions. DIN 66025 does not specify any syntax here. The computing functions are called via @6xx (see appendix - [@-command overview](#) [[▶ 197](#)]).

The trigonometrical functions are always calculated in degrees.

Sample:

```
N10 R2=0 R3=45  
N20 @630 R2 R3
```

In this sample the sine of R3 is calculated in degrees. The result is then written into R2.

R-parameter access from the PLC

You can read the R-parameters into the PLC, or write the R-parameters from the PLC. Special PLC function blocks are provided for this purpose

- [ItpReadRParams](#) [► 292]
- [ItpWriteRParams](#) [► 307]

During writing of the R-parameters, ensure that the interpreter is ahead of the block execution. In other words, writing of the R-parameters from the PLC should take place before the NC program starts or be linked to a [decoder stop](#) [► 170].

For debugging purposes, all R-parameters can be written to a file at any time. This process can be triggered via ADS (see ADS interface - channel functions IndexOffset 0x24 & 0x25).

Other functions

RToDwordGetBit

This function converts an R-parameter to a DWord and then checks whether a particular bit is set. The result is again stored in an R-parameter.

Command	RToDwordGetBit[<dest>; <src>; <bit>]
Parameter <dest>	R-parameter in which the result is entered
Parameter <src>	R-parameter containing the number that is to be converted and checked
Parameter <bit>	Bit to be checked (0..31)

Sample:

```
N10 R1=7
N20 RToDwordGetBit [R2;R1;0]
R10=31
N30 RToDwordGetBit [R3;R1;R10]
```

Enter 1 in R2 and 0 in R3.

Initialization of R-parameters

'set RParam' is used to assign a value to a contiguous block of R-parameters.

Command	#set RParam(<start index>; <count>; <value>)#
Parameter <start index>	Describes the first R-parameter to be written
Parameter <count>	Number of R-parameters to be written
Parameter <value>	Assigned value

Sample:

```
N10 G01 X100 Y200 F6000
N15 R2=3000
N20 #set RParam( 1; 2; 0.0 )# (R2 is overwritten again here)
N30 G01 X500
```

Saving R-Parameters

If the content of [R-parameters](#) [► 135] is required for subsequent use, while in the meantime the R-parameters are used for a different purpose, it can temporarily be stored in the values stack of the arithmetic unit.

Two possibilities exist for this:

- enumeration of the R-parameters
- giving the range of R-parameters

Saving the values:

Command	@40 <number> R<n> R<m>...

@41 <1st R-parameter> <last R-parameter>

Restoring the values:

Command	@42 <number> R<n> R<m> @43 <last R-parameter> <1st R-parameter>

When restoring the values, call the parameters in reverse order.

Sample 1:

```
(saving the data)
N100 @40 K4 R800 R810 R823 R4

N110 R800=4711
N120 ...

(restoring the data)
N200 @42 K4 R4 R823 R810 R800
```

Sample 2:

```
(saving the data)
N100 @41 R800 R805

N110 R800=4711
N120 ...

(restoring the data)
N200 @43 R805 R800
```

**Stack size**

The value stack of the arithmetic unit has limited capacity. If it overflows, the NC program is interrupted with an error message. That can occur as the value is saved, but can also occur in the course of subsequent formula evaluation.

6.2 Programming Movement Statements

6.2.1 Referencing

By default, axis referencing (homing) should take place before the 3D-group is formed from the PTP channel. Or it can be done from the NC program.

If axes are referenced in PTP mode, it can be done for several axes simultaneously. If axes are referenced from the NC program, it can only be done for one axis at a time.

Command	G74
Cancellation	End of block

Sample:

```
N10 G74 X
N20 G74 Y
```

**Referencing with own block**

Referencing must be carried out within its own block. G74 may only refer to one axis. This command is only applicable for the main axes (X,Y,Z).

6.2.2 Rapid Traverse

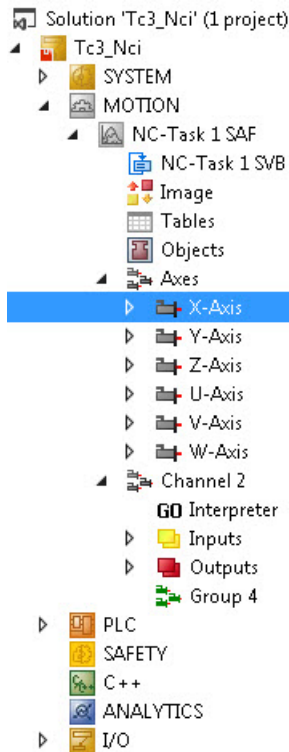
Command	G0
Cancellation	G1 [P 138], G2 [P 139] or G3 [P 139]

Rapid traverse is used to position the tool quickly, and is not to be used for machining the workpiece. With G0 the axes are moved with linear interpolation as fast as possible. The velocity is calculated with MIN (Rapid Traverse Velocity (G0), Reference Velocity, Maximum Velocity).

If a number of axes are to be driven in rapid traverse, the velocity is determined by that axis that requires the most time for its movement.

An accurate stop (G60 [► 142]) is cancelled with G0.

The rapid traverse velocity is set individually for each axis. This can be edited in the axis parameters in the XAE under NCI parameters.



General Settings Parameter Dynamics Online Functions Coupling Compensation					
	Parameter	Offline Value	Online Value	Type	Unit
+	Maximum Dynamics:				
+	Default Dynamics:				
+	Manual Motion and Homing:				
+	Fast Axis Stop:				
+	Limit Switches:				
+	Monitoring:				
+	Setpoint Generator:				
-	NCI Parameter:				
	Rapid Traverse Velocity (G0)	2000.0		F	mm/s
	Velo Jump Factor	0.0		F	
	Tolerance ball auxiliary axis	0.0		F	
	Max. position deviation, aux. axis	0.0		F	
+	Other Settings:				

6.2.3 Linear Interpolation

Command	G1 or G01 (standard setting)
Cancellation	G0 [► 137], G2 [► 139] or G3 [► 139]

Under linear interpolation the tool moves, with feedrate F, along a straight line that can be freely located in space. The movement of the axes involved is completed at the same moment.

The feedrate (short: feed), F, describes the rate of displacement in millimeters per minute. This value is effective globally, so that it is not necessary to program it again if the same feed is to be used later for other geometrical movements.

Sample:

```
N10 G90
N20 G01 X100.1 Y200 F6000
```

In this example the axes are moved linearly to the position described. The Z axis is not mentioned in this program, and therefore retains its old position.

6.2.4 Circular Interpolation

Circular arcs can be programmed in a number of ways. Two types must be distinguished between. One of these is an arc in the working plane [► 131] (e.g. the XY plane), and the other is an arc that can be freely located in space (a CIP circle).

Clockwise circular interpolation

Command	G2 or G02
Cancellation	G0 [► 137], G1 [► 138] or G3 [► 140]

Function G2 describes the path of a clockwise circular arc. This function requires the working plane [► 131] to have already been defined (G17 [► 131] by default).

In order to describe the circle unambiguously, further parameters are required in addition to the end point. A choice is available between center point programming and radius programming.

Radius Programming

In radius programming, the radius of the circle is programmed as well as the end point. Either of the letters 'B' or 'U' may be used for the radius.

Since the direction is prescribed with G2, the circle is also unambiguously described. The starting point is determined by the previous geometrical movements.

Sample 1:

```
N10 G01 G17 X100 Y100 F6000
N20 G02 X200 B200
```

● Angle programming for >180° angles

i If an angle of more than 180° is to be traversed, the radius must be stated negatively.

● Full circle programming

i The start and the end points must be different so that the center can be calculated. Radius programming can therefore not be used for programming a full circle. Center point programming can be used for this purpose.

Centerpoint Programming

Center point programming represents an alternative to the method that has just been described. The advantage of center point programming is that full circles can also be described in this way.

Under the standard settings, the center point is always given relative to the starting point of the arc. The parameters I, J, and K are used for this purpose. Here,

- I represents the X-component
- J represents the Y-component and
- K represents the Z-component.

At least one of these parameters is 0 and therefore does not have to be included in the program.

Sample 2:

```
N10 G01 G17 X100 Y100 F6000
N20 G02 I50 J0 (J is optional) X200
N30 M30 (program end)
```

Sample 3:

```
N10 G01 G18 X100 Y100 Z100 F6000
N20 G02 I0 K50 X150 Z150 (quarter circle in ZX plane)
N30 M30
```

By programming an item of machine data, it is also possible to enter the center point absolutely. The command @402 is required for write access to a machine data bit.

In the following example, the circle from the first example is programmed using the absolute circle center.

Sample 4:

```
N10 G01 G17 X100 Y100 F6000
N20 @402 K5003 K5 K1 (center point programming absolute)
N30 G02 I150 J100 X200
N40 @402 K5003 K5 K0 (center point programming relative)
N50 M30
```

Anticlockwise Circular Interpolation

Command	G3 or G03
Cancellation	G0 [▶ 137], G1 [▶ 138] or G2 [▶ 139]

The function G3 describes a circular arc anticlockwise. The parameters and entry possibilities are the same as under G2.

Circular accuracy

Command	#set paramRadiusPrec(<param>)#
Parameter	param: maximum allowed radius tolerance 0.001 < param < 1.0 (default 0.1)

The 'set paramRadiusPrec' function is used to parameterize the required circular accuracy. This parameter affects circles programmed with G02 or G03.

With center point programming, an error is generated if the difference in radius length is greater than <param>.

Centre point correction

Command	CPCON (standard setting)
Cancellation	CPCOF

In center point programming the circle is overdetermined. For data consistency, the center point is usually corrected. Normally only a marginal modification of the center point is required. After the center point correction, the magnitude of the input radius equals the output radius.

If the start and end point are very close together, the center point offset may be large. This may lead to problems with automatically generated G-Code (postprocessor). For manually written G-Code, the CPCON setting (center point correction on) is recommended.

CIP circle

Command	CIP
Cancellation	End of block

The circles discussed so far can only be used in the principal planes. The CIP circle can also be used to program an arc anywhere in space. For this, it is necessary to program not only an end point but also some other point on the path.

The 3 points (the starting point is given implicitly) may not be collinear. This is required in order to describe the circle unambiguously. It is thus not possible to program a full circle in this way.

I, J and K are available as path point parameters. By default, their values are relative to the starting point of a circular path.

Sample 5:

```
N10 G01 X100 Y100 F6000  
N20 CIP X200 Y200 I50 J50 K50
```

Notice In order to be able to follow a CIP circle, the cutter radius compensation [► 187] cannot be active.

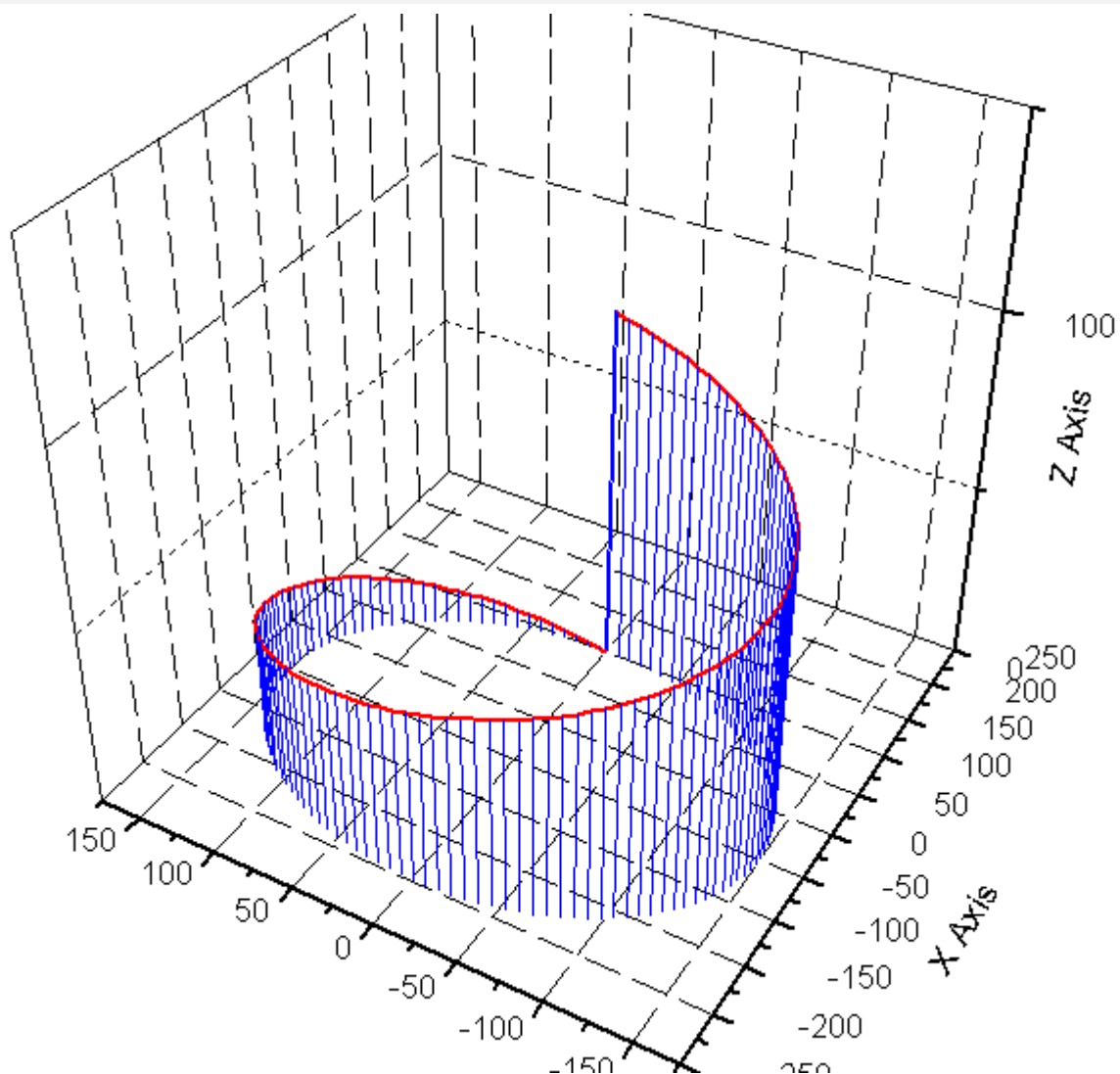
6.2.5 Helix

If a circular motion is superimposed onto a perpendicular linear movement, a helix is obtained. A helix can only be programmed in the principal planes. The same parameters as are used for a circle in the principal plane are used. At the same time the axis that is perpendicular to the plane is driven.

The helix can be used together with the cutter radius compensation [► 187].

Sample:

```
N10 G01 G17 X100 Y0 Z0 F6000  
N20 G03 I-50 Z100  
M30
```



6.2.6 Dwell Time

Command	G4 or G04
Cancellation	End of block
Parameter	F or X

G4 is used to switch on a dwell time. It is used to interrupt workpiece machining between two NC blocks for a programmed time (in seconds).

Sample:

```
N10 G01 X100 F6000
N20 G04 X0.5 (pause in sec)
N30 G02 X300
...
```

Notice The dwell time must be programmed in a dedicated set, and the parameters (X or F) must be programmed after G04.

6.2.7 Accurate Stop

block-by-block

Command	G9 or G09
Cancellation	End of block

The accurate stop instruction is used, for example, when sharp contour corners must be manufactured. At the contour transition the set path velocity is reduced to zero and then increased again. This ensures that the programmed position is approached precisely.

Notice G09 acts only on the set value side. The actual values can be checked with TPM (target position monitoring), for example.

modal

Command	G60
Cancellation	G0 [▶ 137]

Description:

see above

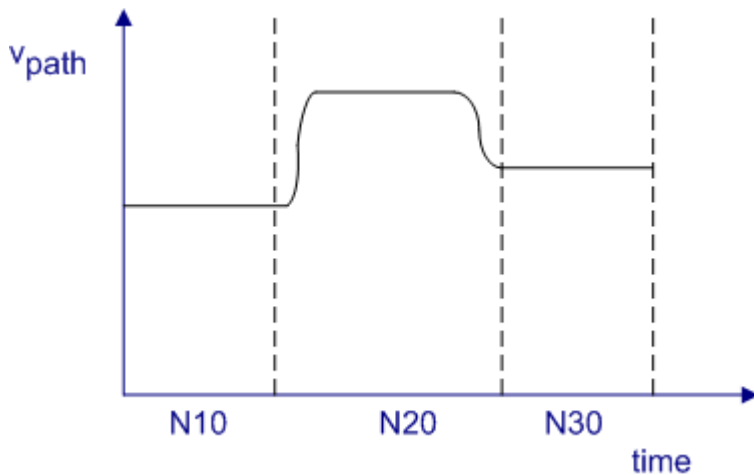
see also [target position monitoring \[▶ 146\]](#) (TPM)

6.2.8 Feed interpolation

Constant feed interpolation

Command	FCONST (standard setting)
Cancellation	FLIN

The programmed velocity is applied as fast as possible with the constant feed interpolation (default).



Sample 1:

```

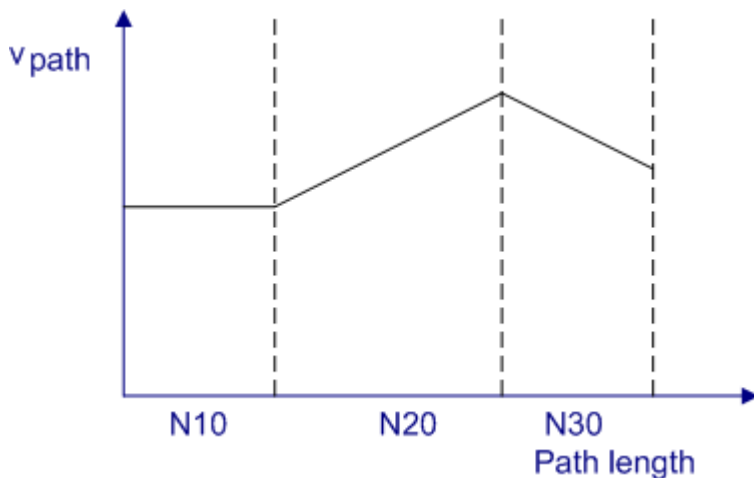
N05 FCONST
N10 G01 X1000 F50000
N20 G01 X2500 F80000
N30 G01 X3500 F60000
...

```

Linear feed interpolation

Command	FLIN
Cancellation	FCONST

The linear feed interpolation transfers the velocity linearly over the path from v_{start} to v_{end} .



Sample 1:

```

N05 FCONST
N10 G01 X1000 F50000
N15 FLIN
N20 G01 X2500 F80000
N30 G01 X3500 F60000
...

```

Notice If the velocity on the segment transition has to be reduced more drastically than the programmed segment velocity, due to the geometry or M function for example, then the linear velocity is maintained as long as possible. The reduced segment velocity will be delayed, only if required dynamically.

6.2.9 Zero Offset Shifts

A range of zero offset shifts are available in TwinCAT NC I. They describe the distance between the origins of the workpiece and of the machine.

Zero shift suppression

Command	G53 (standard setting)
Cancellation	G54 [► 144] to G59 [► 145]

The zero shift is suppressed modally with G53. The suppression affects both the adjustable and the programmable zero shift.

Adjustable zero shift

Command	G54 G55 G56 G57
Cancellation	G53 [► 144] or selection of another configurable zero shift

The commands G54 to G57 can be used within the NC program to switch back and forth between the zero shifts.

Parameterization

The configurable zero shift can be parameterized in different ways

1. PLC function block [ltpWriteZeroShiftEx \[► 260\]](#) (recommended standard)
2. XAE [Interpreter element \[► 16\]](#)
3. from the DIN-program

The parameters are saved for each interpolation channel. This means that the adjustable zero shifts are channel dependent.

Notice The selection of a zero shift must be made in its own block. In order for the movement corresponding to the shift to be actually made it is necessary that at least the axes involved are named in a following geometrical block.

Sample 1:

```
N10 G01 X100 Y0 Z0 F6000
N20 G54 (activates adjustable zero offset shift (NPV))
N30 G01 X Y Z
N40 M30
```

In sample 1 all involved axes are named in line 30. The effect of this is that the zero shifts are applied to all the axes.

Sample 2:

```
N10 G01 X100 Y0 Z0 F6000
N20 G54 (activates adjustable zero offset shift (NPV))
N30 G01 X200 Y
```

In line 30 of sample 2 the X axis is taken to position 200 + shift in the X direction. The Y axis only moves to accommodate the shift, and the Z axis is not moved.

Parameterization from the DIN program

Command	#set paramZeroShift(G<n>; <value x>; <value y>; <value z>)#
Parameter G<n>	Zero shift to be parameterized (G54..G59)
Parameter <value>	Coordinates of the zero shift

'#set paramZeroShift(..)#' parameterizes the zero shift but does not activate it. This requires explicit programming of the G-Code.

Sample 3:


```

N10 G01 X100 Y0 Z0 F6000
N20 R12=200
N30 #set paramZeroShift( G54; 100.0; R12; -20)#
N40 G54 (activates adjustable zero offset shift (NPV))
N50 G01 X200 Y Z

```

Programmable zero shift

Command	G58 or G59
Cancellation	G53 [► 144]

Programmable zero shifts exist in addition to the adjustable ones. This type of zero shift is directly described from the NC program.



Addition of zero shifts

The programmable zero shift is only effective when the adjustable zero shift is active. This means that the total shift is the sum of

- set zero shift (G54, G55, G56 or G57)
- first programmable zero shift (G58)
- second programmable zero shift (G59)

Sample 4:

```

N10 G01 X100 Y0 Z0 F6000
N20 G54 (activates adjustable zero offset shift (NPV))
N30 G58 X0.5 Y0.5 Z0.5 (1st prg. zero offset shift)
N50 X Y Z (movements for the zero offset shift)
...
M30

```

Behavior with incremental dimension notation

Default behavior

Changing the origin also affects the incremental dimension.

Sample 5:

```

N10 G01 X100 Y0 Z0 F6000
N20 G54 (activates adjustable zero offset shift (NPV))
N25 G58 X10 Y10 Z0
N30 G91 (Incr. dimensions)
N40 G01 X200 Y0
N50 ...

```

In N40 Y moves to 10 in the basic coordinate system. A shift in origin also shifts the point of reference for incremental dimension programming, resulting in a travel path for Y.

In this way a contour, which is fully programmed based on the incremental dimension, can be positioned at any point through a zero shift.

The behavior of G91 is parameterizable.

Command	Description
ZeroShiftIncOn	The zero shifts are also applied under G91 once the axis is named. (standard setting)
ZeroShiftIncOff	The zero shift is not applied under G91.

Sample 6:

```

N10 G01 X100 Y0 Z0 F6000
N15 ZeroShiftIncOff
N20 G54 (activates adjustable zero offset shift (NPV))
N25 G58 X10 Y10 Z0
N30 G91 (Incr. dimensions)
N40 G01 X200 Y
N50 ...

```

Since 'ZeroShiftIncOff' is set in sample 6, the X-axis in N40 is moved by 200 mm independently of the new zero shift. The Y-axis does not move as no target coordinate is programmed for it.

See also [ToolOffsetIncOn/Off](#) [► 184]

6.2.10 Target Position Monitoring

Command	TPM
Cancellation	End of block

The command 'TPM' is used to trigger target position monitoring from the NC program. At the end of the geometry this always leads to an accurate stop on the set value side and subsequent checking of the target position window. Block relaying takes place when the monitoring conditions are met for all axes in the group.

Like for PTP, this function is enabled and parameterized individually for each axis. This means that different limits can be selected for auxiliary axes than for the path axes, for example.

Sample 1:

```
N10 G01 X100 Y100 F6000
N20 G01 X300 Y100 TPM
...
```

At the end of the motion of N20, target position monitoring is performed both for the X axis and for Y axis (provided target position monitoring is enabled for both axes).

Sample 2:

```
N10 G01 X100 Y100 F6000
N20 G01 X300 Y100
N30 M61 (Type Handshake)
N40 TPM
...
```

TPM can also be programmed in a dedicated block. In this case the last positioning is checked (of N20 in this case).

General Settings Parameter Dynamics Online Functions Coupling Compensation					
	Parameter	Offline Value	Online Va...	T...	Unit
+	Maximum Dynamics:				
+	Default Dynamics:				
+	Manual Motion and Homing:				
+	Fast Axis Stop:				
+	Limit Switches:				
-	Monitoring:				
	Position Lag Monitoring	TRUE	TRUE	B	
	Maximum Position Lag Value	5.0	5.0	F	mm
	Maximum Position Lag Filter Time	0.02	0.02	F	s
	Position Range Monitoring	TRUE	TRUE	B	
	Position Range Window	5.0	5.0	F	mm
	Target Position Monitoring	TRUE	TRUE	B	
	Target Position Window	2.0	2.0	F	mm
	Target Position Monitoring Time	0.02	0.02	F	s
	In-Target Alarm	TRUE	TRUE	B	
	In-Target Timeout	5.0	5.0	F	s
	Motion Monitoring	FALSE	FALSE	B	
	Motion Monitoring Window	0.1	0.1	F	mm
	Motion Monitoring Time	0.5	0.5	F	s
+	Setpoint Generator:				
+	NCI Parameter:				
+	Other Settings:				

Download Upload Expand All Collaps All Select All

Notice If target position monitoring is enabled for an axis, the target position alarm (PEH) should also be active. Time monitoring results in a channel error after the timeout (or before), if the axis is not yet in the target position window. In order to avoid unnecessary channel errors, a sufficiently large timeout value should be selected (e.g. 5 - 10 s). If no PEH time monitoring is active and the axis is permanently outside the position window, no block relaying takes place and the NC remains stationary when viewed from outside. The SAF is in Waiting state (not to be confused with Interpreter state).

See also [accurate stop](#) [► 142] (G09).

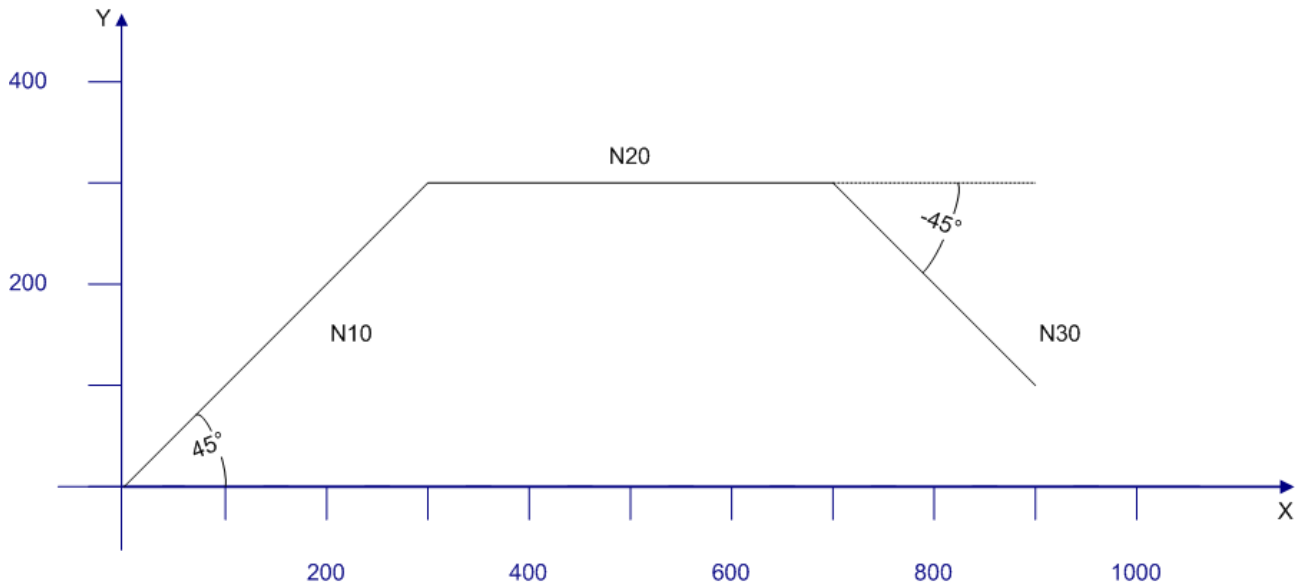
6.2.11 Contour definitions

Angle and segment length

In this type of programming the angle and the magnitude (segment length) are always quoted, similarly to polar co-ordinates.

Parameter	Description
ANG	Angle in degrees with reference to the abscissa ($-360 \leq \text{ang} \leq 360$)
SEG	Magnitude of the segment length

Sample 1:



```
N10 G01 ANG=45 SEG=424.264 F60000
N20 G01 ANG=0 SEG=400
N30 G01 ANG=-45 SEG=282.843
```

or

```
N10 G01 ANG=45 SEG=424.264 F60000
N20 G01 X700 Y300
N30 G01 ANG=-45 SEG=282.843
```

Restrictions:

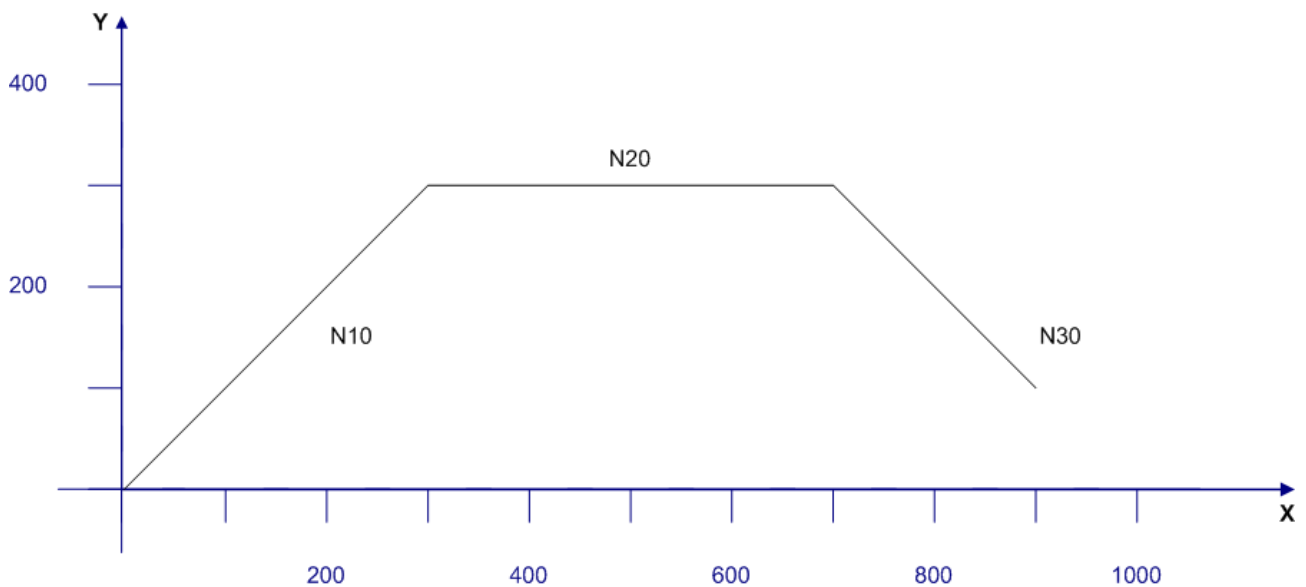
- The programming may only be done in the chosen principal plane.
- The length of the segment must be greater than zero, and refers to the projection in the principal plane.

Notice It is additionally possible to program rounding or chamfering. The ANG and SEG parameters must be programmed in every block. The assignment may use R-parameters, but formulas cannot be programmed.

Angle and one component in the plane

As above, an angle is programmed, but the length of the segment is no longer specified directly. It is calculated from a component in the selected principal plane.

Sample 2:



```
N10 G01 ANG=45 X300
```

```
N20 G01 ANG=0 Z700  
R10=100
```

```
N30 G01 ANG=315  
X=R10
```



Runtime error

If either two components in the plane are quoted or none at all, the result is a runtime error. A runtime error is also generated if the movement is parallel to the abscissa or to the ordinate, and there is therefore no intersection.

6.2.12 Rotation

It is also possible to program a rotation as well as the zero shift [► 143]. A distinction is drawn between absolute and additive rotation.

The rotation can turn the co-ordinate axes (X, Y and Z) in the workpiece coordinate system.

This makes it possible to machine inclined surfaces (in the plane or in space).

Absolute Rotation

Command	ROT X<value(x)> Y<value(y)> Z<value(z)>
Cancellation	ROT (without parameters)

The rotation instructions must be programmed in their own block. Angles must always be stated in degrees.

Direction of Rotation

A positive angle describes rotation in the direction of the positive co-ordinate axis, the rotation being anti-clockwise.

Carrying Out the Rotation

The sequence of rotations is of critical importance when a coordinate system is being rotated. In TwinCAT NC I rotations are always carried out in the following sequence around the global coordinate system:

1. Rotation around the Z-axis,
2. Rotation around the Y-axis,
3. Rotation around the X-axis.

This sequence is maintained even if the parameters are programmed in a different order.

The origin of the tool coordinate system is always used as the center point of the rotation. This means that the total zero offset shift currently active describes the rotation center.

Additive Rotation

In addition to absolute programming of rotation it is also possible to carry this out additively. The same conditions apply to this as do to absolute rotation.

Command	AROT X <Wert(x)> Y<Wert(y)> Z<Wert(z)>
Cancellation	ROT (without parameters)

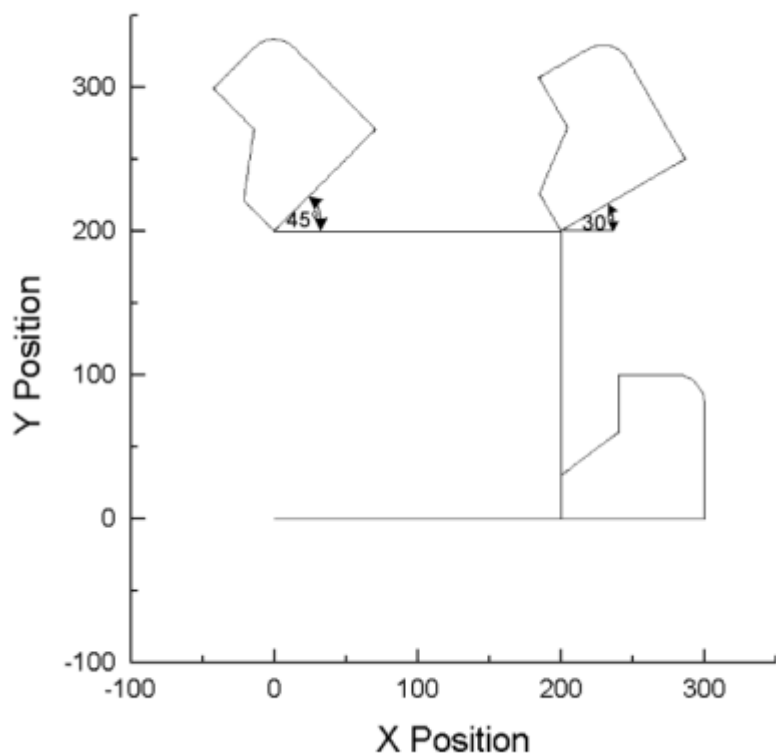
Sample:

```

N10 G01 G17 X0 Y0 Z0 F60000
N20 G55
N30 G58 X200 Y0
N50 L47
N60 G58 X200 Y200
N65 ROT Z30
N70 L47
N80 G58 X0 Y200
N90 AROT Z15
N100 L47
N110 M30

L47
N47000 G01 X0 Y0 Z0 (movements for zero shift & rotation)
N47010 G91 (incremental dimensions)
N47020 G01 X100
N47030 G01 Y80
N47040 G03 X-20 Y20 I-20 J0
N47050 G01 X-40
N47060 G01 Y-40
N47070 G01 X-40 Y-30
N47080 G01 Y-30
N47090 G90
N47100 M17

```



In this example, the same contour is traversed under different rotations. Since the contour (L47) is programmed in incremental dimensions, and the starting point is described by means of the programmed zero shift, the rotation is clear to see.

Note:

Once the ROT or AROT command has been programmed, the complete path vector (X, Y & Z) must be assigned.

Rotation extensions

In the default configuration the whole path vector must be programmed after each ROT command. Since this is difficult to realize in some applications, this calculation can optionally be performed automatically in the interpreter. To use this option, 'RotExOn' should be included at the start of the NC program.

Command	RotExOn
Cancellation	RotExOff

Sample:

```

N10 RotExOn
...
N100 G54 (activate zero point & point of rotation)
N110 ROT X90
N120 G0 Z3 (preposition the tool)
N130 G01 Z-10 F6000 (lower to cutting depth)
N140 G01 X100
N150 G01 Z3 (raise to preposition)
...
N1000 RotExOff
N1010 M30

```

Calculate rotation

Command	CalcRot[R<s>; R<t>; R<u>]
	CalcInvRot[R<s>; R<t>; R<u>]
Parameter	The 3 R-parameters describe the vector to be calculated. The calculation will write the result into this R-parameter, and the original value will therefore be overwritten.

The function **CalcRot** rotates a three-dimensional vector through the current rotation angle. The rotation angles had been determined by ROT or AROT. The sequence of the calculation is the same as is used for the rotation itself, that is Z, Y and X.

The **CalcInvRot** function behaves in precisely the opposite way. The signs of the currently valid rotation angles are inverted, and the order of calculation is X, Y and Z. In other words, the vector is turned back, so to speak.

Neither CalcRot nor CalcInvRot generate any geometry, but merely carry out the calculation of the vector.

Sample:

```

N10 G01 X40 Y10 Z0 F6000 (the axes are moved
without rotation)
N20 R1=40 R2=10 R3=0

N30 ROT Z45

(What is the position to which X, Y, must be taken so that no
movement is executed?)
N40 CalcInvRot[R1; R2; R3]
N50 G01 X=R1 Y=R2 Z=R3 (R1=35.35 R2=-21.21 R3=0)
N60 ...

```

Command	RotVec[R<x>; R<y>; R<z>; R<α>; R<β>; R<γ>]
Parameter	The 3 R-parameters (x..z) describe the vector to be rotated through. The calculation will write the result into this R-parameter, and the original value will therefore be overwritten. The last 3 R-parameters describe the angle.

The function **RotVec** rotates a three-dimensional vector through the specified angle. The order of the rotation is Z, Y and X, like for ROT. RotVec is a calculation routine solely for rotating a vector. It has no effect on ROT or AROT.

6.2.13 Mirror

The mirror functionality changes the sign of named axes. This enables subroutines to be reused.

Mirroring

Command	Mirror <opt. X> <opt. Y> <opt. Z>
Cancellation	Mirror (without parameters)

The mirror instructions must be programmed in a dedicated block. Mirrored axes must be named without further parameters.

Sample:

```

N20 G54
N30 G58 X100 Y100
N40 L100

N50 G58 X-100 Y100
N60 Mirror X
N70 L100

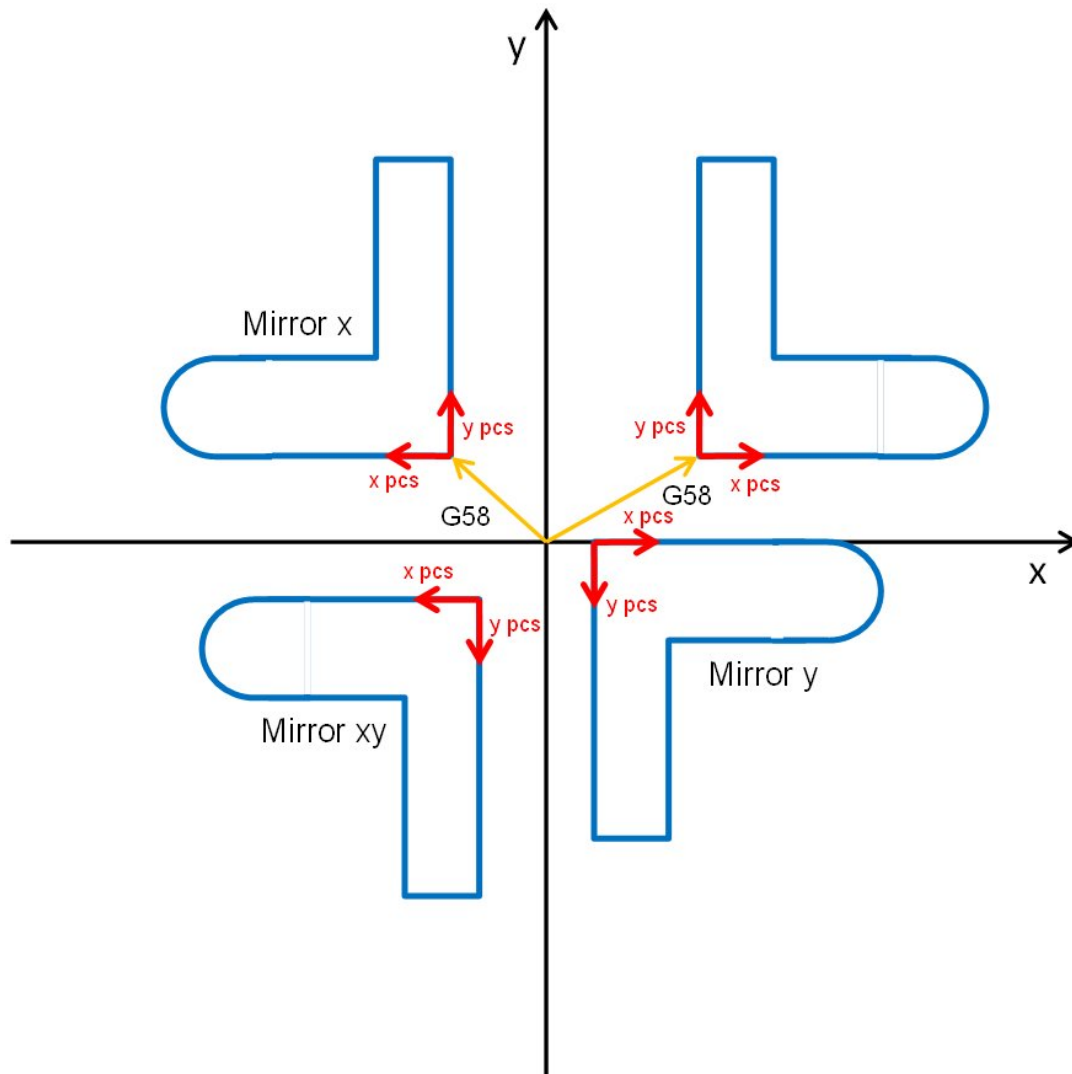
N80 G58 X-50 Y-50
N90 Mirror X Y
N100 L100

N110 G58 X10 Y-10
N120 Mirror Y
N130 L100

N140 Mirror (turn off mirror)
N150 G0 X0 Y0
M02

L100
N1000 G0 X200 Y0 Z10 F60000 (move to start pos)
N1020 G01 Z0
N1030 G03 X200 Y100 J50
N1040 G01 X50
N1050 G01 Y400
N1060 G01 X0
N1070 G01 Y0
N1080 G01 X200
N1090 G01 Z10
M17

```

If a zero shift is present (G54...G59), the mirror functionality depends on the currently programmed coordinate system.

6.2.14 Smoothing of segment transitions

6.2.14.1 Overview

Overview

In general, at segment transitions polygon functions (G01 blocks) contain kinks within their contour. At these transitions polygon functions are not steadily differentiable with respect to their spatial coordinate, thus leading to dynamic-unsteadinesses, if at these transitions the path velocity is not reduced to zero value. To actually avoid to have to reduce path velocity to zero value segment transitions of polygon functions can be smoothed out by blending at those transitions.

	Execution	Supported Segment Transitions	Acceleration of Axis Components	Max. Tolerance	Adaptive Tolerance Radius	Command
<u>Circular Smoothing</u> [► 158]	Interpreter	Straight line/straight line	Step change in acceleration (value parameterizable via the C1 factor)	1/2 of the input or output segment	No	paramCircularSmoothing (...)
<u>Parabolic Smoothing</u> [► 155] <type>: 2	NC kernel	Straight line/straight line	Step change in acceleration to a constant level (value parameterizable via the C1 factor)	1/3 of the input or output segment	Can be selected	paramVertexSmoothing (...)
<u>Biquadratic Smoothing</u> [► 155] <type>: 3	NC kernel	Straight line/straight line	Constant acceleration - the acceleration is 0 at the entry and exit - no intermediate point required	1/3 of the input or output segment	Can be selected	paramVertexSmoothing (...)
<u>Bézier Curve of the 3rd Order</u> [► 155] <type>: 4	NC kernel	All	Step change in acceleration to a linear level (can be parameterized with the C1 factor)	1/3 of the input or output segment	Can be selected, has an effect for straight-line transitions	paramVertexSmoothing (...)
<u>Bézier Curve of the 5th Order</u> [► 156] <type>: 5	NC kernel	All	Constant acceleration - the acceleration is 0 at the entry and exit - no intermediate point required	1/3 of the input or output segment	Can be selected, has an effect for straight-line transitions	paramVertexSmoothing (...)
<u>'Old' Bézier Blending</u> [► 156] <type>: 1	NC kernel	All	Constant acceleration - the acceleration is 0 at the entry, the exit and at the symmetric intermediate point	1/4 of the input or output segment	No	paramSplineSmoothing (...) paramVertexSmoothing (...)

Blending takes effect from the transition between the subsequent two segments.



Principle of Blending

The radius of the tolerance sphere can be altered at any time within the NC program and can be switched off again by setting the radius to 0. Blending remains active until the next reset of the interpreter or a TwinCAT runtime restart.

6.2.14.2 Parabolic smoothing

Parabola smoothing

Command	#set paramVertexSmoothing(<type>; <subtype>; <radius>)#
Parameter <type>	For parabola smoothing: 2
Parameter <subtype>	1: Constant tolerance radius [► 158] 2: Distance between intersection and vertex [► 158] 3: Adaptive tolerance radius [► 158]
Parameter <radius>	Max. radius of the tolerance sphere

For parabola smoothing a parabola is inserted geometrically into the segment transition. This ensures a steady velocity transition within the tolerance radius.

The parabola is only inserted for straight line/straight line transitions.

6.2.14.3 Biquadratic smoothing

Bi-quad smoothing

Command	#set paramVertexSmoothing(<type>; <subtype>; <radius>)#
Parameter <type>	For biquadratic smoothing: 3
Parameter <subtype>	1: Constant tolerance radius [► 158] 2: Distance between intersection and vertex [► 158] 3: Adaptive tolerance radius [► 158]
Parameter <radius>	Max. radius of the tolerance sphere

With biquadratic smoothing there is no step change in acceleration in the axis components. With the same radius, a smaller input velocity may therefore be required than for parabolic smoothing.

The operating principle of the subtypes is identical to that of the parabolic subtypes.

6.2.14.4 Bezier curve of the 3rd order

Bezier curve of the 3th order

Command	#set paramVertexSmoothing(<type>; <subtype>; <radius>)#
Parameter <type>	for the Bezier curve of the 3th order: 4
Parameter <subtype>	1: Constant tolerance radius [► 158] 2: Distance between intersection and vertex [► 158] 3: Adaptive tolerance radius [► 158]
Parameter <radius>	Max. radius of the tolerance sphere

In case of the 3rd order Bezier curve a step change in acceleration appears in the axis components when the tolerance sphere is entered. The max. size is limited by the acceleration of the axis components and the C1 factor.

This blending can be used for all segment transitions. The subtypes 2 and 3 only work for straight line / straight line transitions.

● Acute angles at the segment transition

i The Bezier splines are generated by default, even at very acute angles. In order to avoid the dynamic values being exceeded, a considerable reduction velocity is required in this case. However, since the dynamics are held constant in the spline, the movement across the spline can be quite slow. In this case it is often practical to start the segment transition with an accurate stop. The command [AutoAccurateStop \[► 159\]](#) can be used to avoid having to calculate the angles manually.

6.2.14.5 Bezier curve of the 5th order

Bezier curve of the 5th order

Command	#set paramVertexSmoothing(<type>; <subtype>; <radius>)#
Parameter <type>	for the Bezier curve of the 5th order: 5
Parameter <subtype>	1: Constant tolerance radius [► 158] 2: Distance between intersection and vertex [► 158] 3: Adaptive tolerance radius [► 158]
Parameter <radius>	Max. radius of the tolerance sphere

With 5th order Bezier blending, **no** step change in acceleration occurs in the axis components on entry into the tolerance sphere. In other words, the path axis acceleration is always constant if blending is selected.

This blending can be used for all segment transitions. The subtypes 2 and 3 only work for straight line / straight line transitions.

● Acute angles at the segment transition

i The Bezier splines are generated by default, even at very acute angles. In order to avoid the dynamic values being exceeded, a considerable reduction velocity is required in this case. However, since the dynamics are held constant in the spline, the movement across the spline can be quite slow. In this case it is often practical to start the segment transition with an accurate stop. The command [AutoAccurateStop \[► 159\]](#) can be used to avoid having to calculate the angles manually.

6.2.14.6 Old Bezier blending type

● Functions for compatibility with existing projects

i These functions are provided for compatibility reasons. For new projects [Bezier curve of the 3rd order \[► 155\]](#) or [Bezier curve of the 5th order \[► 156\]](#) should be used.

Old Bezier blending with paramVertexSmoothing

Command	#set paramVertexSmoothing(<type>; <subtype>; <radius>)#
Parameter <type>	For Bezier Spline smoothing: 1
Parameter <subtype>	For Bezier Spline smoothing: 1
Parameter <radius>	radius of the tolerance sphere

Sample 1:

```
N10 R57=100
#set paramVertexSmoothing(1; 1;R57)#
```

Old Bezier blending with paramSplineSmoothing

With the aid of smoothing, it is possible to insert a Bezier spline automatically between two geometrical entries. It is only necessary to program the radius of the tolerance sphere. This describes the maximum permissible deviation from the programmed contour in the segment transition. The advantage of this type of smoothing as opposed to rounding with an arc is that there are no step changes in acceleration at the segment transitions.

The radius of the tolerance sphere can be altered at any time within the NC program, and can be switched off again by setting the radius to 0. If the radius is not reset to 0, it remains active until the next interpreter reset or TwinCAT restart.

Command	#set paramSplineSmoothing(<radius>)#
Parameter <radius>	Radius of the tolerance sphere

or alternatively

#set paramVertexSmoothing(...)

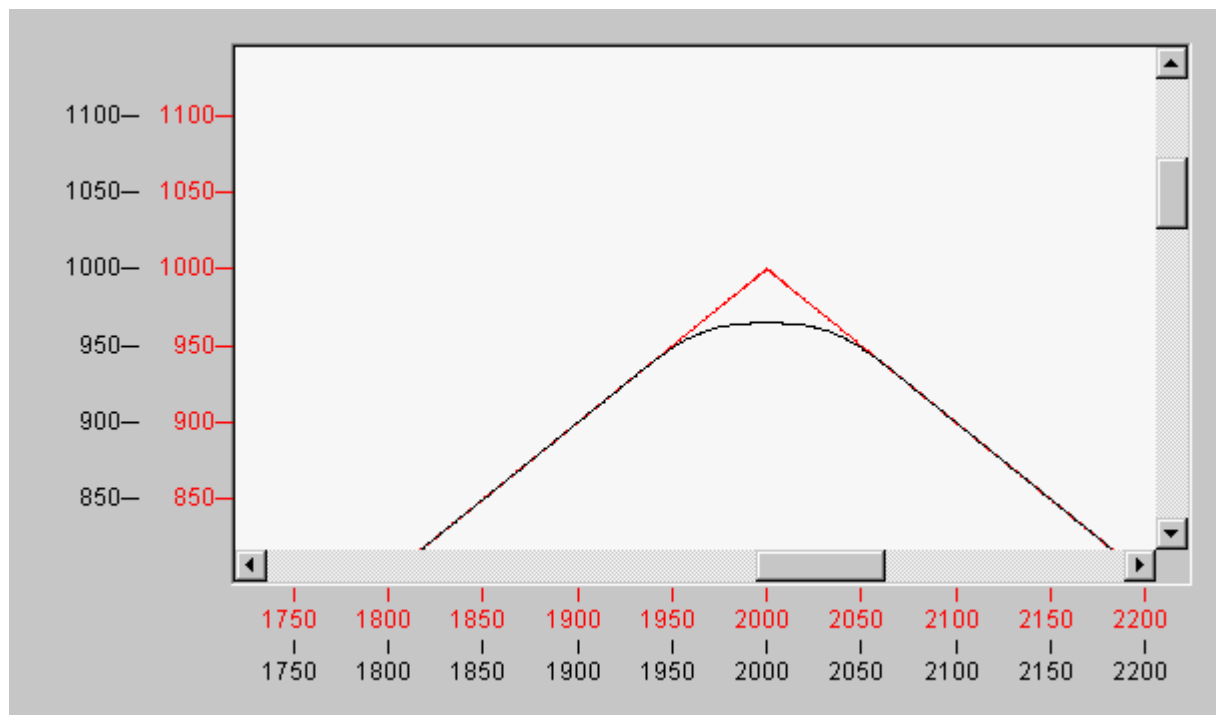
Sample 1:

```
N10 R57=100
#set paramSplineSmoothing(R57) #
```

Sample 2:

```
N10 G01 X0 Y0 F6000
N20 X1000
#set paramSplineSmoothing(100) #
N30 X2000 Y1000
N40 X3000 Y0
M30
```

The new parameter is valid from the transition between the subsequent two segments. In example 2, the new value for the tolerance sphere is applicable at the segment transition from N30 to N40. The diagram below shows a contour with and without spline at the segment transition.

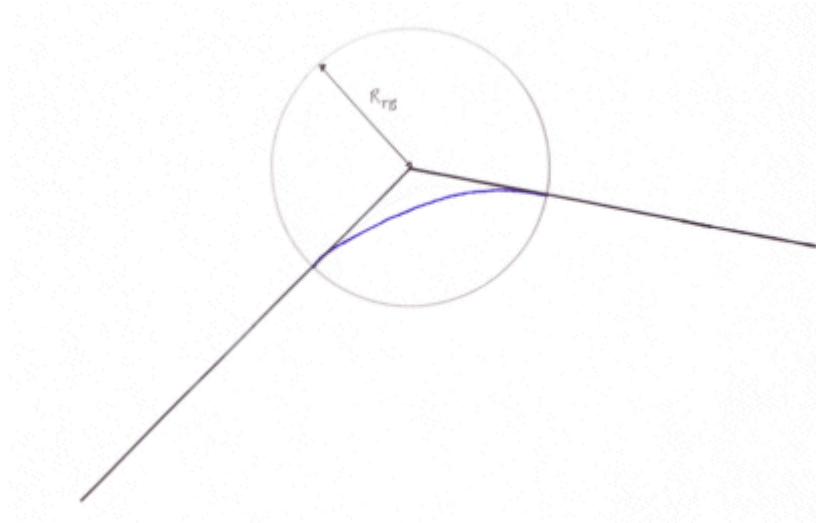


The splines are generated even at very sharp angles by default. In order to avoid the dynamic values being exceeded, a considerable reduction velocity is required in this case. However, as the dynamics are held constant, the movement across the spline can be quite slow. In this case it is often practical to start the segment transition with an accurate stop. In order to avoid manual calculation of the angles, an `'AutoAccurateStop [P 159]'` command is available which can also be initiated via the NC program.

6.2.14.7 Subtypes

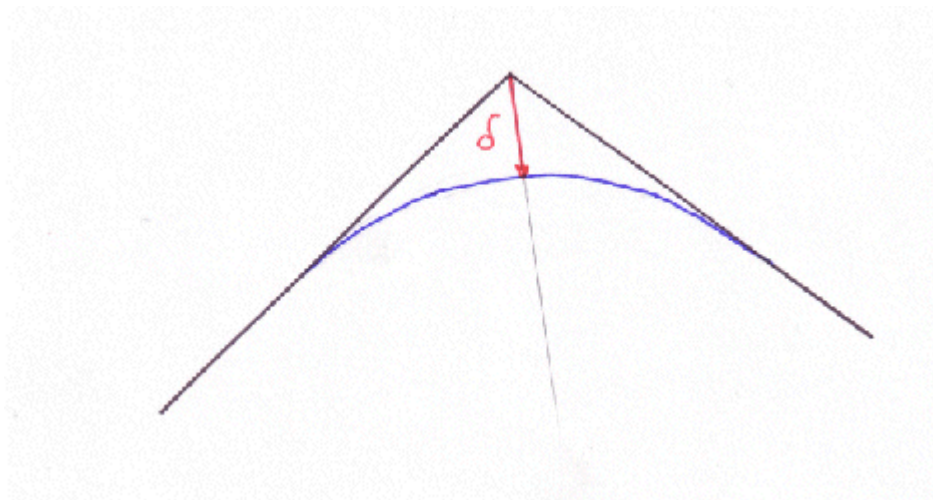
Constant tolerance radius (subtype 1)

If subtype 1 is selected, the maximum tolerance radius (R_{TB}) is used for blending. R_{TB} is reduced if and only if the input or output segment is less than $3 \cdot R_{TB}$.



Distance between intersection and vertex (subtype 2)

The distance between the programmed segment transition and the vertex of the parabola is specified with the subtype 2. The tolerance radius (R_{TB}) results from this. If a segment is too short, then the distance is shortened so that the tolerance radius is a max. of $1/3$.



Adaptive tolerance radius (subtype 3)

Within the tolerance radius (including constant tolerance radius) the system ensures that the maximum permissible acceleration is not exceeded. Depending on the deflection angle and the velocity, the maximum axis acceleration within the smoothing segment may be different. The aim of an adaptive tolerance radius is maximum acceleration during smoothing. In order to achieve this, the smoothing radius is reduced based on the programmed velocity and dynamics. In other words, if the programmed velocity is changed, the tolerance radius can also change. The override has no influence on the radius.

6.2.15 Circular Smoothing

It is possible with the aid of circular smoothing to insert an arc automatically between two straight lines. It is only necessary to program the radius of the arc.

The radius of the circular smoothing can be altered at any time within the NC program, and can be switched off again by setting the radius to 0. Rounding must be switched off before the end of the program or a decoder stop [► 170].

Command	#set paramCircularSmoothing(<radius>)#
Parameter <radius>	Radius of the circular smoothing arc

Sample:

```
N10 R57=4.5
#set paramCircularSmoothing(R57)#
...
#set paramCircularSmoothing(0)#
N1000 M02
```

Notice When combined with cutter radius compensation, please note that first the radius compensation is calculated, then the circular smoothing is added. The smoothing radius thus refers to the TCP.

Notice The old command paramGroupVertex continues to be supported. However, it cannot be used to transfer R parameters.

Syntax:

```
#set paramGroupVertex(<grp>,<radius>)#
```

The first parameter describes the group to which the circular smoothing refers. This value is currently always 1. The second parameter is used to specify the circular smoothing radius.

6.2.16 Automatic Accurate Stop

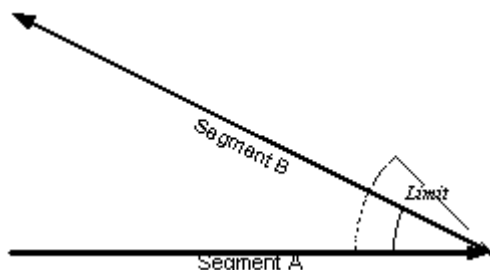
Command	#set paramAutoAccurateStop(<angle>)#
Parameter <angle>	Limit angle (in degrees) after which an accurate stop is inserted
Deselect	#set paramAutoAccurateStop(0)#

An accurate stop after a defined limit angle is inserted between two segments with the aid of the 'AutoAccurateStop' command.

For circle segments, the angle is calculated from the tangents at the points of entry and leaving.

Sample:

```
#set paramAutoAccurateStop(45)# (angle in
degrees)
N10 G01 X1000 Y0 Z0 F60000 (start position: X0 Y0 Z0)
N20 X0 Y500
...
```



An accurate stop is inserted between segments A and B in this example.

Application field:

This command should be used in conjunction with Bezier blending, if acute angles are programmed in the NC program.

See also:

- [Bezier curve of the 3th order \[► 155\]](#)
- [Bezier curve of the 5th order \[► 156\]](#)
- ['Old' Bezier curve \[► 156\]](#)

Notice This function has not yet been implemented for segment transitions with a helix.

6.2.17 Delete Distance to Go

Command	DeIDTG
Cancellation	End of block

The DeIDTG (**delete distance to go**) command is activated block by block via the NC program. This command enables deleting of the residual distance of the current geometry from the PLC with the function block `ltpDelDtgEx` [► 210]. In other words, if the command is issued while the block is processed, the motion is stopped with the usual deceleration ramps. The NC program then processes the next block. An error message is generated if the PLC command is not issued during the execution of a block with "delete distance to go" selected.

The "delete distance to go" command always effects an implicit decoding stop, i.e. an exact positioning always occurs at the end of the block.

Sample:

```
N10 G01 X0 Y0 F6000
N20 DeIDTG G01 X2000
N30 G01 X0
```

Notice DeIDTG must not be active when cutter radius compensation is active.

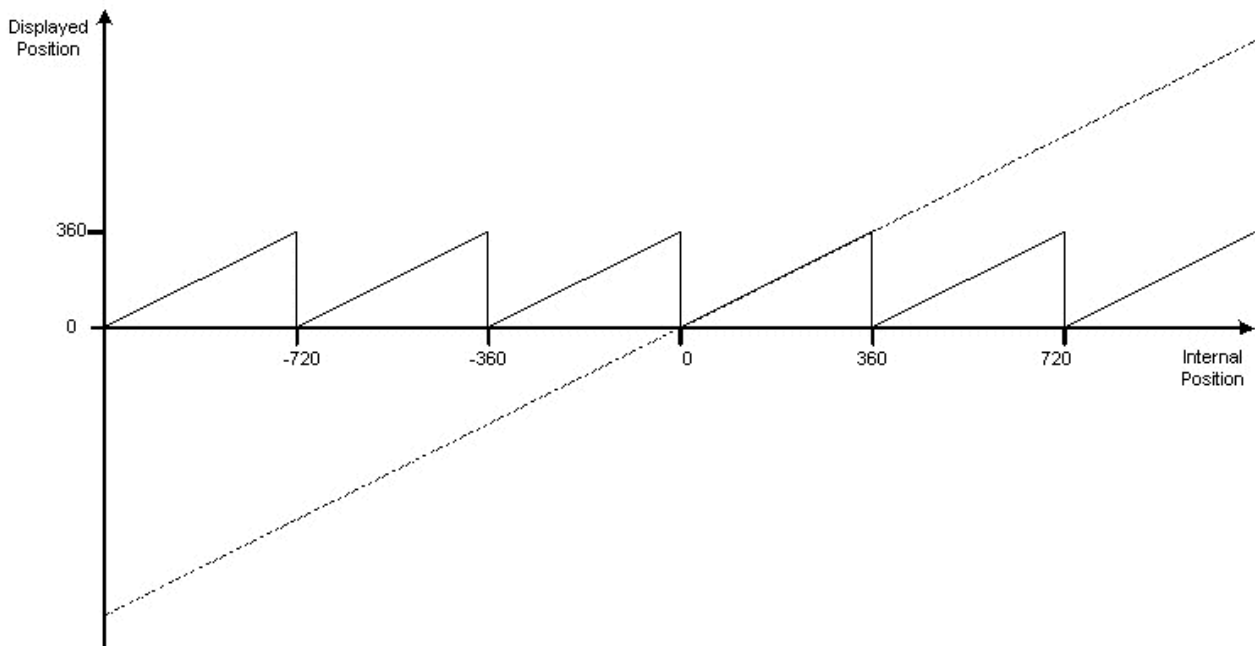
6.2.18 Modulo Movements

Command	MOD[<axis and target modulo position>]
Cancellation	End of block
Parameter 1	Axis for modulo operation
Parameter 2	Arithmetic sign for the direction of rotation (optional)
Parameter 3	Modulo position

The modulo position is programmed in the same way as normal positioning.

The MOD command is effective for specific blocks, and must be explicitly programmed for every axis that is selected for modulo operation. The modulo position's arithmetic sign specifies the direction of rotation.

- Positive sign: The axes moves in the 'larger' direction
- Negative sign: The axes moves in the 'smaller' direction
- Exception: The axis cannot move to modulo -0, since zero has no sign

**Sample 1:**

```

N10 G90
N20 G01 MOD[X200] Y30 F600
N30 G01 X200

```

N20 specifies a move in a positive direction for X to modulo position 200. Y moves to absolute position 30. In block N30, X is moved absolutely to position 200, i.e. **not** modulo.

**Modulo Operation Applicable to Q-Axes**

The Q-axes are the auxiliary axes. The MOD command can be applied to Q-axes. E.g.
 N20 G01 MOD[Q4=200] Y30 F600.

Modulo movements of more than 360 degrees

The MOD command also allows movements of more than a 360 degrees to be made.

Modulo position = number of necessary rotations * 360 + modulo position

Sample 2:

```

N10 G90
N20 G01 X3610 F6000
N30 R1=360
N40 G01 MOD[X=R1+20]

```

In this example, the X axis moves 360 degrees to modulo position 20.

Restrictions and notes of for modulo movements:

- No radius compensation may be active for the modulo axis.
- No zero shift may be active for the modulo axis.
- During relative programming (G91 [► 130]) the modulo command is not evaluated, so that the axis referred to in square brackets is treated as if the MOD command had not been given.

Modulo factor

The modulo factor is constant, and is 360.

6.2.19 Auxiliary axes

Auxiliary axes (also known as Q axes) can be added to an interpolation group in addition to the actual path axes (X, Y & Z). The auxiliary axis can be seen as a type of slave for the path, i.e. it has no direct influence on the path velocity. In addition to the 3 path axes, 5 auxiliary axes can also be interpolated for each channel.

The function block 'CfgBuildExt3DGroup [► 201]' from the library Tc2_NCI, for example, may be used for adding to the interpolation group from the PLC.

Syntax

The auxiliary axes are addressed as Q1..Q5 from the part program. The numerical value may be assigned directly, or an R-parameter.

Sample 1:

```
(start position X=Y=Z=Q1=0)
N10 G01 X100 Q1=47.11 F6000
...
```

If an NC block is programmed with one or more path axes and an auxiliary axis, both axes start **simultaneously** and also reach the destination **together**.

Swiveling of the auxiliary axes

The term "swiveling of the auxiliary axes" is used if the path length within a motion set is zero. This is often the case during 'swiveling' of a tool, with the feed angle relative to the contour being changed.

Since the path length is zero, there is no link to the path, and the movements of the auxiliary axes are calculated via a virtual path. However, this has no influence on the real path of X, Y and Z, but here too all auxiliary axes are started simultaneously and also arrive at the destination simultaneously.

Here too, the velocity is specified via the F-parameter and now refers to the auxiliary axis with the greatest travel distance.

Sample 1:

```
(start position X=Y=Z=Q1=Q2=0)
N10 G01 X100 F6000
N20 Q1=100 Q2=200 F3000
...
```

In N20, the velocity of Q2 is now 3000 and that of Q1 is 1500, since the travel distance is $Q1=Q2/2$.

6.2.19.1 Calculation of the velocity

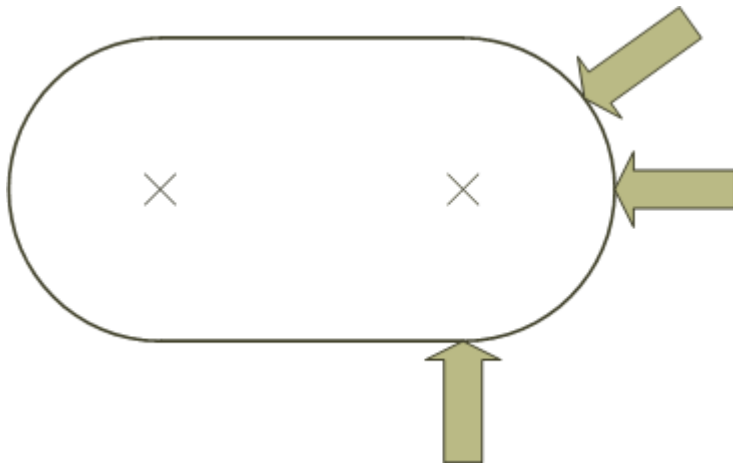
Initially, only the path axes (X, Y and Z) are considered for the calculation of the path velocity.

The path and the travel distance of the individual auxiliary axes result in a fixed coupling ratio for each auxiliary axis within a segment. The target velocity of the auxiliary axis is thus also known. If this velocity is greater than the permitted maximum velocity for this auxiliary axis, the path velocity is reduced until the upper speed limit is adhered to. In other words, exceeding of the velocity limits of the auxiliary axes also has an indirect effect on the path velocity.

6.2.19.2 Path velocity at segment transitions

The reduction of the path velocity is explained below by means of an example. The contour of a stadium is particularly suitable for this purpose. The aim is for the feed angle of a tool relative to the path tangent to remain constant.

On the stadium straight, the orientation of the tool remains constant, i.e. the tool is not turned. In contrast, the orientation relative to the base coordinate system must be changed continuously within the circle. Assuming the path velocity in the transition between straight and circle is not reduced to zero, a step change in velocity is inevitably generated for the swiveling axis (but not for the path axes!).



This step change in velocity of the auxiliary axis is freely parameterizable and depends on the machine. Extreme cases would be for the path velocity at such segment transitions to be reduced to zero, or for the velocity not to be reduced at all.

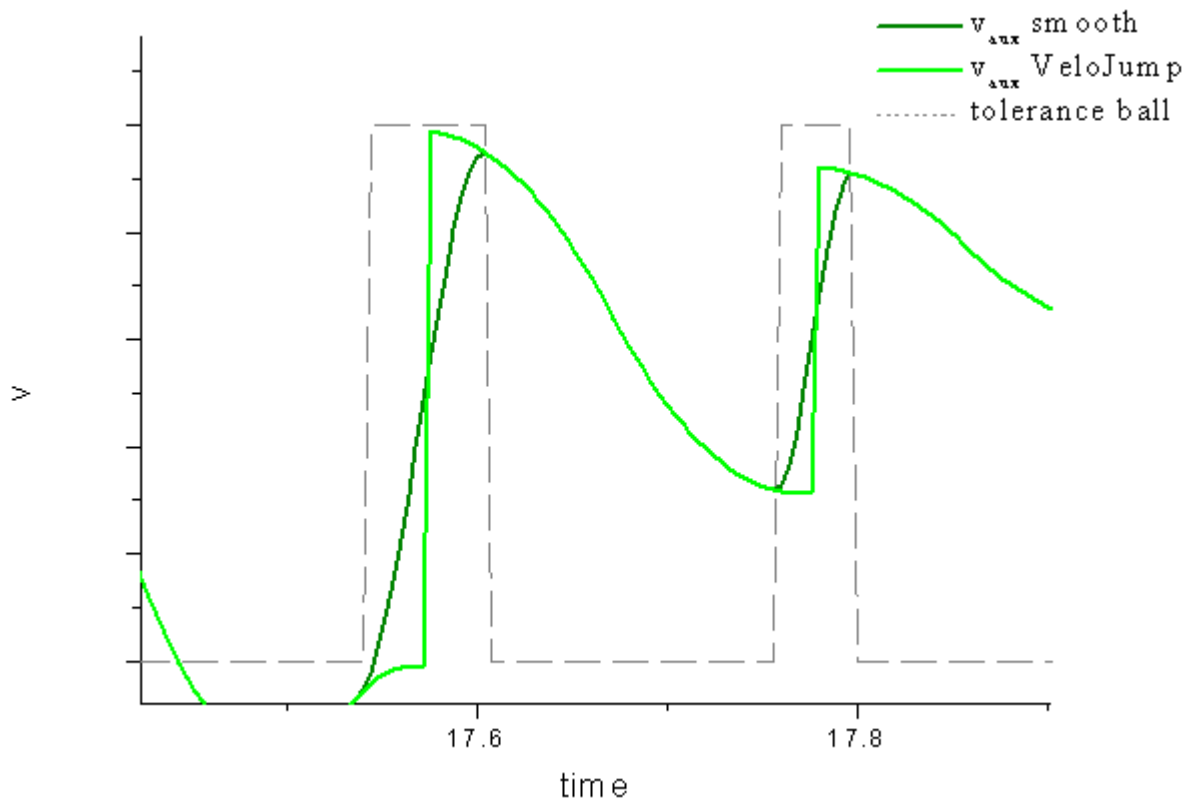
The global axis parameter 'VeloJumpFactor', which can be set individually for each axis, is used for the parameterization. The resulting velocity and the calculation is described in more detail in the TwinCAT NCI appendix on page [Parameterisation](#) [► 339].

Smoothing of the velocity at segment transitions

As has been described above, step changes in velocity can occur at the segment transitions. The size of these steps can be affected by the VeloJump parameter.

It is further possible for a tolerance sphere to be specified for every auxiliary axis. This sphere is symmetrical with the path at a segment transition. On entering this sphere, the velocity of the auxiliary axis is continuously modified to reach the set velocity at the exit of the sphere. The step changes in velocity are, in other words, eliminated. This does imply that the auxiliary axis is subject to a positional error when it is within the sphere. On entering the sphere the change to the new target velocity of the axis starts immediately. This avoids an overshoot in position, and the position is again precise at the borders of the sphere.

If it happens that the specified sphere is larger than 1/3 of the path, its radius is automatically restricted to that value.



Selection and Deselection

The tolerance sphere of the auxiliary axis is an axis parameter (IO: 0x108). It can be set in TwinCAT XAE axis interface Specification Axes.

● Parameterization of the axis parameters

i The parameters described here only take effect for axes that are in the interpolation group as auxiliary axes (Q1..Q5). For path axes (x,y,z) the parameters 'Velo Jump Factor', 'Tolerance ball auxiliary axis' and 'Max. position deviation, aux. axis' have no influence.

Diagnostics

It is possible to record the tolerance sphere of each auxiliary axis and the position error that results from this for diagnostic purposes. It is also possible to access the variables via ADS. They are to be found in the "Index offset" specification for Group state (Index group 0x3100 + ID) (IO: 0x54n and 0x56n).

Effect on VeloJump, if the size of the tolerance sphere is reduced

If the size of the tolerance sphere has to be reduced due to the given geometry, the VeloJump parameter is automatically adjusted for this segment transition. I.e. the path velocity in the transition is reduced more strongly. So the dynamics of the auxiliary axis is not exceeded for smaller tolerance spheres.

Positional deviation of the auxiliary axis if the tolerance sphere has to be reduced

The parameter 'maximum permitted positional deviation of the auxiliary axis' **only** takes effect if the tolerance sphere would have to be reduced due to the geometry.

The aim is to keep the path velocity high despite the smaller tolerance sphere, as long as the resulting position error does not exceed a threshold value. To this end the velocity of the auxiliary axis is kept constant and the position error is calculated. If the error is smaller than the maximum positional deviation the velocity is maintained for this segment transition, and the resulting position error is compensated in the next segment (the tolerance sphere then becomes unnecessary for this segment transition).

In the event that the position error would exceed the maximum deviation, the reduced tolerance sphere takes effect, including the VeloJump factor. And the path velocity is reduced if necessary.

Example 1:

Initial conditions:

- Set tolerance sphere: 5
- Max. positional deviation: 1
- The given geometry results in an effective tolerance sphere of 0.2, for example
- The potential positional deviation is 0.3

Resultant behavior:

- The path velocity remains at a constant high level
- The velocity of the auxiliary axis is kept constant
- For this transition no tolerance sphere is required
- The resulting positional deviation is compensated in the subsequent segment

Example2:

Initial conditions:

- Set tolerance sphere: 5
- Max. positional deviation: 1
- The given geometry results in an effective tolerance sphere of 1.2, for example
- The potential positional deviation is 1.1

Resultant behavior:

- The tolerance sphere is adjusted
- The VeloJump parameter is adjusted
- The path velocity is reduced at the segment transition
- There is **no** positional deviation that has to be compensated

Parameterization

The parameterization of the maximum permitted positional deviation is an Specification Axes. By default this feature is switched off (deviation = 0.0)

6.3 Supplementary Functions

6.3.1 M-Functions

Task: Signal exchange between NC and PLC

A range of equipment, such as collet chucks, drill drives, transport equipment etc. is best not driven directly by the NC, but indirectly, using the PLC as an adapting and linking controller. This makes it easy to consider feedback or safety conditions, without having to adapt the NC program, or even the NC system. The NC's M-functions involve digital signal exchange: functions are switched on or off, activated or deactivated. The transfer of numerical working parameters is not provided for here, but can be implemented in other ways (H-functions [► 169], T-numbers [► 169] etc.).

6.3.1.1 Available M-functions

Number of M-functions

A total of 160 M-functions are available per channel

M function	Meaning
0..159	Freely definable M-functions (except 2, 17, 30)
2	Program end
17	End of subprogram

M function	Meaning
30	Program end with deletion of all fast M functions

All M-functions (apart from the 3 pre-defined M-functions - M2, M17, M30) are freely definable. This means that, depending on the machine type, M8 can be used to switch on a cooling medium or indeed for any other functionality, for example. The machine manufacturer can select the function as required.

Like any other rules, the rules for reserved M-functions are read when TwinCAT is started. Additionally, an internal code is generated for these functions in the interpreter, which is responsible for the behavior described. These 3 M-functions therefore do not have to be described in the table. It makes sense to parameterize M2 and M30, even if M-functions are used.



Priority of M-Functions in the TwinCAT 3 development environment

If M-functions are defined as well in the `m_defs.t<xx>` file as in the development environment, only those M-functions act that are defined in the development environment.

Types of M-functions

Basically, two signal exchange versions are available: fast signal bits, or transfer secured by handshake.

Secured Handshakes

M-functions that require feedback must be processed using bi-directional signal exchange between the NC and the PLC. If an M-function of type handshake is programmed, the velocity is reduced to 0 at this point. The PLC uses the [ltpIsHskMFunc \[► 233\]](#) function to check whether an M-function with handshake is present, in which case the number of the M-function is determined via [ltpGetHskMFunc \[► 225\]](#). The NC is in a waiting state and will not process further NC commands until the PLC has acknowledged the M-function. Processing of the NC program continues once acknowledgement has been received from the PLC ([ltpConfirmHsk \[► 209\]](#)).

This procedure permits the operation of the equipment controlled by the NC to be securely coordinated with the equipment controlled by the PLC. It is therefore advisable to acknowledge the M-function for starting the spindle (e.g. M3) once a minimum speed has been reached.

Since this kind of M-function involves synchronous functions, it is only ever possible for one M-function with handshake to be active in the NC program.

Fast signal bits

If no feedback is required from the PLC, fast signal bits can be used for activating M-functions. Since the NC does not have to wait for the PLC with these M-functions, [look-ahead \[► 128\]](#) can combine the segments. In this way it is possible to apply an M-function without velocity reduction.

A fast M-function can be detected in the PLC via [ltpIsFastMFunc](#). This makes it possible to start any action from the PLC during a movement (laser on/off, cutter on/off, ...). Afterwards the M-function has to be reset with [ltpResetFastMFuncEx](#). This makes it possible to use the M-function more than once.

A combination of fast signal bits and handshake is also possible. Since a handshake always requires acknowledgement from the PLC, the velocity has to be reduced to 0 in this case.

6.3.1.2 Resetting of M-functions

Resetting fast signal bits

The signal bits are active until they are reset explicitly, or until an M30 (end of program) or channel reset is executed.

Resetting with reset list

Each M-function can reset up to 10 fast M-functions. If cooling medium is switched on with M8, for example, the cooling medium can be switched off again with M9. To this end simply enter M8 in the reset list for M9.



Resetting a Fast M-Function Requires a Fast M-Function

A fast M-function can be reset only by a fast M-function. There is no alternative possibility in this case to reset a fast M-function by a non-fast handshake M-function.

Automatic reset

During parameterization of the M-function an 'auto-reset flag' can be set. This means that the M-function is automatically reset at the end of the block.

In order for the PLC to be able to see the signal, the duration of the motion block must be long enough, or this M-function is combined with a handshake. The handshake may come from the same or a different M-function.

Reset from the PLC

The fast M-functions can be reset from the PLC via the [ltpResetFastMFunc](#) [► 298] function block. For reasons of transparency, mixed resets using via PLC and NC should be avoided.

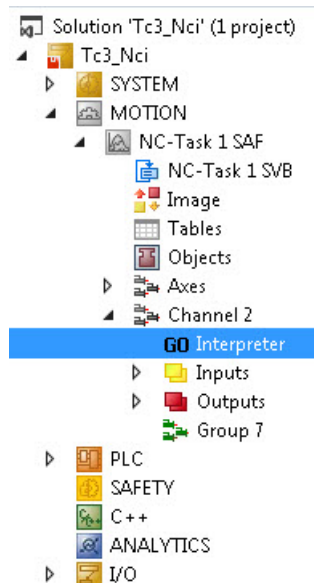
Delete all pending M-functions

A channel stop and a channel reset are used to reset all pending M-functions. This is true for the 'handshake' type M-functions, and also for the fast signal bits. If the NC program is terminated properly with M30, all M-functions are also cleared.

6.3.1.3 Parameterization of M-functions

The M-functions are parameterized in TwinCAT XAE. A dedicated M-function table is used for each interpolation channel.

Activation of the TwinCAT configuration is required to enable a configuration of M-functions.



General Interpreter M-Functions R-Parameter Zero Points Tools Editor MDI						
	No	HShake	Fast	Reset (3,6,...)	Comment	
M	26	BM	None			
M	31	AM	BMAutoRe...			
M	50	None	AM	55		
M	51	None	AM	55		
M	52	None	AM	55		

AM = After Move
 BM = Before Move

No

Number of M-function to be parameterized. The value must be between 0 and 159

HShake

If a value other than 'None' is entered, the M-function is of type 'Handshake'

- *None*: No handshake
- *BM* (Before Move): If a movement is programmed in the same block, the handshake is completed **before** the movement
- *AM* (After Move): If a movement is programmed in the same block, the handshake is completed **after** the movement

Fast

If a value other than 'None' is entered, a 'fast signal bit' type M-function is executed

- *None*: No fast M-function is executed
- *BM* (Before Move): If a movement is programmed in the same block, the output is completed **before** the movement.
- *AM* (After Move): If a movement is programmed in the same block, the output is completed **after** the movement.
- *BMAutoReset* (Before Move & Automatic Reset): If a movement is programmed in the same block, the output is completed **before** the movement. In addition, the M-function is automatically canceled at the end of the block, i.e. the M-function is active on a per-block basis. In order to ensure that the PLC recognizes the M-function, the duration of the associated motion block must be long enough (at least 2 PLC cycles), or an additional M-function with handshake should be programmed.
- *AMAutoReset* (After Move & Automatic Reset): This parameterization is only meaningful if either an M-function of type handshake is programmed at the same time (or parameterized), or if the M-function is only used for resetting other M-functions. Without an additional handshake the PLC will usually not be able to detect this M-function.
- All other combinations can be selected for compatibility reasons.

Reset

Up to 10 M-functions can be entered for cancellation when a reset is called.

Notice In the event that no reset-signal-bit is in fact set, the bits to be cleared are reset immediately before setting the new signal bits.

Import/Export

The M-functions are parameterized individually for each channel. The parameterization can be transferred to other channels via the import/export function.

6.3.1.4 Combination of M functions

- Within each line, only **one** 'handshake' type M function must be programmed!
- Within a single line, up to 10 'signal bit' M functions may be programmed
- A combination of the two options above is allowed

Sample:

```
N10 G01 X1000 F60000
N20 M10 M11 M12 X2000 (M10 & M11 are signal bits)
      (M12 is of type handshake)
M30
```

Examples of meaningful and practically applicable rule combinations:

- An M-function is to be active for the duration of a movement and then be automatically cleared. Select 'None' in the HShake column and 'BMAutoReset' in the Fast column. The signal bit generated could, for instance, control a glue application valve.
- An M-function starts a drill motor, and the subsequent movements may only be started after an appropriate run-up time, and then only when the drill is ready for operation. Select 'BM' in the HShake column. The PLC acknowledges the request after a certain delay time and only if the frequency converter is ready for operation.
- A drill motor is started with an M-function. In order not to have to wait for the drive to run up, the M-function is programmed in the block before the one for the drill movement. In the following movement (the drill movement itself) it is however still essential to ensure that the drive has reached its full rotation speed. For this variant either two different M-functions have to be used (lead signal as signal bit, safety query as handshake) or a Fast 'BMAutoReset' and HShake 'AM' M-function is used.

6.3.1.5 Behavior in case of an error

If a runtime error occurs during the execution of an NC program (e.g. following error monitoring is activated), the NC program is interrupted. In this case the M functions, provided they are set, remain pending. This means that the PLC program may have to ensure that M functions are not executed.

6.3.2 H, T and S Parameters

H-, T- and S-parameters are used to transfer parameters from the NC interpreter to the PLC.

In this context the H-parameter stands for auxiliary parameter and is of type DINT (32 bit signed).

The T and S parameters are of type WORD, and stand for Tool and Spindle.

Sample:

```
H=4711
R1=23
S=R1
T4711
```

Notice No R-parameter can be assigned for the T-parameter. Furthermore, the assignment is made without assignment operator ('=').

T- and S-parameters take effect at the start of a block, H-parameters take effect at the end of the programmed block.

6.3.3 Decoder stop

Code	Function
@714 [► 170]	Decoder stop
@716 [► 170]	Decoder stop with axis position rescan
@717 [► 171]	Decoder stop with trigger event, conditional decoder stop

6.3.3.1 Decoder stop (@714)

The interpreter offers the option to execute a decoder stop in the NC program. In this case the interpreter waits until a certain external event occurs. Execution of the NC program does not continue until this event has taken place.

A decoder stop can be used, for instance, to switch block skipping [► 128] on or off from the PLC, or to re-assign R parameters [► 135].

Two events are available for continuing processing:

- Acknowledgement of an M-function [► 165]
- SAF task is empty

Acknowledgement of an M-function

Decoding of the NC program is interrupted until the M-function [► 165], which is programmed immediately prior to the decoder stop, is acknowledged. In other words, the M-function must be of type "handshake".

Sample 1:

```
N10...
N20 M43 (M-function with handshake)
N30 @714 (decoder stop)
N40 ...
```

SAF task is empty

The decoder stop does not necessarily have to be programmed in conjunction with an M-function. If the SAF task runs out of travel commands, an event is sent to the interpreter. This event causes the interpreter to start up again.

Notice The decoder stop must not be programmed when the tool compensation or circle smoothing are active, because they wouldn't work anymore.

6.3.3.2 Decoder Stop with Axis Position Rescan (@716)

In addition to the common decoder stop (see Decoder stop (@714) [► 170]), there is a decoder stop at which the axis positions of the interpolation channel are read again. This stop is required, if, for example, axes are moved during a tool change via PTP and are subsequently not returned to the old position. Another possible application is a change in axis configuration via an M function (with handshake).

If a decoder stop with rescan is programmed, it is essential to program an M-function with handshake immediately before it.

Sample 2:

```
N10...
N20 M43 (M function with handshake carries out a tool change, for
example)
N30 @716 (Decoder stop with rescan)
N40 ...
```

Notice The decoder stop must not be programmed when the tool compensation or circle smoothing are active, because they wouldn't work anymore.

6.3.3.3 Decoder Stop with external trigger event (@717)

Sometimes the question of whether the NC part of the program must wait or can continue may depend, for instance, on events in the PLC. With the two types of [M-functions](#) [▶ 165](#) this can give rise to the following problems:

- Handshake: Because of the M-function's handshake the path velocity must be brought to zero at the location where the M-function is programmed, after which confirmation is awaited from the PLC.
- On The Fly (also known as a fast M-function): Because no confirmation from the PLC is waited for, there is also no way for the partial program to wait for the PLC.
- Even a combination of the two types of M-function does not help here.

Sample:

During positioning with a flying M-function, a process A is initiated by the NC partial program. It is assumed here that the set of processes in the NC program is typically long enough for process A to be completed in the PLC. If A is ready, then the NC partial program should execute the next segment with look-ahead. In case A is not ready, however, then the NC should stop at the end of the segment and wait until process A has finished. It is exactly this scenario that can be implemented with the command @717. The PLC here sends the so-called 'GoAhead [▶ 230](#)]' command when process A has finished.

```
N10 ...
N20 G0 X0 Y0 Z0
N30 G01 X500 F6000
N40 M70 (flying M-function that triggers process A)
N50 G01 X700
N60 @717 (decoder stop with external trigger event)
N70 G01 X1000
N80 ...
```

If the GoAhead signal reaches the PLC early enough, then blocks N50 and N70 are linked by look-ahead, and the path velocity is not then reduced. If the signal arrives during the deceleration phase of N50, then the velocity is once more increased. Otherwise, the machine waits for the signal from the PLC.

Notice The decoder stop must not be programmed when the tool compensation or circle smoothing are active, because they wouldn't work anymore.

The function block 'ltpGoAheadEx' returns the error code 0x410A, if no @717 is present in the interpreter at the time of the call.

6.3.4 Jumps

Code	Function
@100 ▶ 171]	Unconditional jump
@121 ▶ 172]	Jump if unequal
@122 ▶ 172]	Jump if equal
@123 ▶ 172]	Jump if less or equal
@124 ▶ 172]	Jump if less
@125 ▶ 172]	Jump if greater or equal
@126 ▶ 172]	Jump if greater
@111 ▶ 172]	Case block

Unconditional jump

Command	@100
Parameter	K or R

The parameter describes the jump destination. This must have an indication of direction ('+' or '-').

Sample 1:

```

N10 ..
...
N120 @100 K-10

```

In this example, execution continues from line 10 after line 110 has been interpreted. The sign indicates the direction in which the line to be searched can be found.

Jump if unequal

Command	@121	
Parameter 1	R<n>	Comparison value
Parameter 2	K or R<m>	Comparison value
Parameter 3	K	Jump destination with direction indication

Sample 2:

```

N10 ..
...
R1=14
N120 @121 R1 K9 K-10
N130 ...

```

Jump if equal

cf. [Jump if not equal \[► 172\]](#)

Jump if less or equal

cf. [Jump if not equal \[► 172\]](#)

Jump if less

cf. [Jump if not equal \[► 172\]](#)

Jump if greater or equal

cf. [Jump if not equal \[► 172\]](#)

Jump if greater

cf. [Jump if not equal \[► 172\]](#)

Case block

Command	@111	
Parameter 1	R<n>	Comparison value
Parameter 2	K or R<m>	First comparison value
Parameter 3	K	First jump destination
Parameter 4	K or R<m>	Second comparison value
...		

Sample 3:

```

N100 R2=12 (R2=13) (R2=14)
N200 @111 R2 K12 K300
K13 K400
K14 K500

N300 R0=300
N310 @100 K5000

N400 R0=400
N410 @100 K5000

N500 R0=500

```

```
N510 @100 K5000
```

```
N5000 M30
```

A case block is made in line 200. If R2 = 12 a jump is made to line 300.

If R2 = 13, the jump destination is line 400. If R2 = 14, the jump destination is line 500.

In the event that none of the conditions is satisfied, execution simply continues with the next line (in this case, line 300).

6.3.5 Loops

The various types of loop are described below.

Code	Loop type	Aborting condition
@131	While Loop [► 173]	while equal
@132	While Loop [► 173]	while not equal
@133	While Loop [► 173]	while greater
@134	While Loop [► 173]	while greater or equal
@135	While Loop [► 173]	while less
@136	While Loop [► 173]	while less or equal
@141	Repeat Loop [► 174]	repeat until equal
@142	Repeat Loop [► 174]	repeat until not equal
@143	Repeat Loop [► 174]	repeat until greater
@144	Repeat Loop [► 174]	repeat until greater or equal
@145	Repeat Loop [► 174]	repeat until less
@146	Repeat Loop [► 174]	repeat until less or equal
@151	For-To Loop [► 174]	
@161	For-DownTo Loop [► 174]	

Loops can be nested.

While loops

Command	@13<n>	where 1 ≤ n ≤ 6
Parameter 1	R<m>	Comparison value
Parameter 2	K or R<k>	Comparison value
Parameter 3	K	Jump destination for the case that the condition is not met

A while loop is executed for as long as the condition is satisfied. The test is made at the beginning of the loop. If the condition is not or no longer met, a jump to the specified line takes place (parameter 3).

At the end of the While loop an unconditional jump (@100 [► 171]) must be programmed. The target of this jump is the line number of the while loop.

The loop's exit condition is specified with <n>.

Sample 1:

```
N100 R6=4
N200 @131 R6 K4 K600 (K600 is the target of the jump, when the condition is no longer satisfied)
N210 ...
N220 @100 K-200

N600 ...

N5000 M30
```

The loop (lines 200 to 220) is repeated for as long as $R6 = 4$. Once the condition is no longer satisfied, execution jumps to line 600.

Repeat loops

Command	@14<n>	where $1 \leq n \leq 6$
Parameter 1	R<m>	Comparison value
Parameter 2	K or R<k>	Comparison value
Parameter 3	K	Jump destination at the start of the loop

In a repeat loop, the interrogation takes place at the end of the loop. This means that the loop is executed at least once. The loop is only ended, to continue with the rest of the program, when the condition is satisfied.

Sample 2:

```
N200 ...
N210 ...
N300 @141 R6 K25 K-200
```

The loop is repeated until $R6 = 25$. The second constant in line 300 gives the jump target (the start of the loop).

For-To loops

Command	@151 <variable> <value> <constant>

A for-to loop is a counting loop that is executed until the *variable* equals the *value*. The test is made at the beginning of the loop. If that condition is satisfied, execution jumps to the line specified by the *constant*.

The variable must be incremented (@620) at the end of the loop, and there must be an unconditional jump to the start of the loop.

Sample 3:

```
N190 R6=0
N200 @151 R6 K20 K400
N210 ...
N290 @620 R6 (increment R6)
N300 @100 K-200
```

For-Downto Loops

Command	@161 <variable> <value> <constant>

A for-downto loop is a counting loop. The behaviour is similar to that of a for-to loop. The difference is merely that the variable is decremented (@621) by 1 at the end of the loop.

6.3.6 Subroutine techniques

As in other fields, it is also valuable in NC programming to organize frequently used command sequences as subroutines. This makes it possible to employ pre-prepared and tested functions in various workpiece programs.

Subroutines are identified within a program by a number. This number must be unique: there must be only one subroutine with a particular number (1..>2.000.000.000).

As interpretation proceeds, the calling program is suspended. The text of the subroutine is worked through, as often as necessary. Processing then returns to the calling program after the call location.

It is of course possible for one subroutine to call another subroutine. This call is executed in a similar way. This causes a stack of return information to be created. For technical reasons this nesting of subroutines is presently limited to 20 levels.

Definition of a Subroutine

The code for a subroutine can be written to the same file as the calling program. In this case the subroutine is linked directly: it is automatically also loaded as the file is read. If it is to be made generally available then it must be written in its own file that must be located in the CNC directory.

The name of the file begins with the letter 'L', and continues with a string of digits. This digit string must repeat the subroutine number, without any leading '0's.

The code should contain a label to indicate the starting point of the subroutine. Like the file name, it consists of the letter 'L' and the digit sequence described above.

The interpreter starts immediately after this label.

Subroutine syntax:

```
(Date: L2000.NC)
L2000
N100...
N110...
...
N5000 M17 (return command)
```

Calling a Subroutine

The following syntax must be used to call a subroutine from some block within the NC program. It is important that the expression "L2000" does not stand at the start of the line, in order to avoid confusion with a subroutine label.

```
(syntax of the subroutine call)
N100 L2000
```

In the following sample the expression "P5" causes the subroutine to be repeated 5 times.

```
(n-fold subroutine call (here: 5- fold))
N100 L2000 P5
```

Dynamic subroutine call

In some cases the subroutine to be called is not known until runtime. In this case the subroutine can be called with an R-parameter, thereby avoiding the need for a CASE instruction. The value for R must be allocated or calculated in a dedicated line.

```
(Dynamic call of a subroutine)
N099 R47=R45+1
N100 L=R47
```

Parameter passing

Parameters are passed to subroutines with the aid of [R-parameters](#) [► 135]. Note that R-parameters are not saved automatically (see [Rescuing R-parameters](#) [► 135]).

Use of Parameters

R-parameters can, in general, be freely used within subroutines. This has a number of consequences that can lead to errors if they are not borne in mind. On the other hand their careful use offers the NC-programmer a range of useful working techniques.

Results of Subroutines

If an R-parameter is changed without its contents being saved and restored, the change is effective after a return from the subroutine. If this was not intended, the result can be machine behavior that was not planned.

This feature can however be deliberately used in order to make the continuation of the processing dependent on the results of a subroutine. No restriction need be considered here other than those on the R-parameters.

Sample:

```

N100 L2000
N110 R2=R3+R4
...
N999 M30

L2000
N10 R3=17.5
N20 R4=1
N99 M17

```

Values are specified here in a subroutine. The values are then used in the calling program.

Ending a Subroutine

A subroutine is ended with M17.

6.3.7 Dynamic Override

Command	DynOvr=<value> or DynOvr = R<n>
Cancellation	DynOvr=1

Sample:

```

N10 G01 X100 Y200 F6000
N20 DynOvr=0.4
N30 G01 X500

```

'DynOvr' can be used to make percentage changes to the dynamic parameters of the axes in the group while the NC program is running. This also results in new values for the motion dynamics. The new dynamic values become valid, without any stop, when the line is executed. This means, for the example illustrated above, that in block 10 the old values will still be used for the deceleration, while the new values will be used for acceleration in block 20.

Scope of Definition

$0 < \text{DynOvr} \leq 1$

See also [change in path dynamics](#) [► 176].

6.3.8 Altering the Motion Dynamics

Command	#set paramPathDynamics
Parameter <acc>	Value of the maximum permitted path acceleration in mm/s ² .
Parameter <dec>	Value of the maximum permitted deceleration in mm/s ² .
Parameter <jerk>	Value of the maximum permitted jerk in mm/s ³ .

Sample:

```

N10 G01 X100 Y200 F6000
N15 R4=3000
N20 #set paramPathDynamics( 700; 700; R4 )#
N30 G01 X500

```

The 'paramPathDynamics' command can be used to alter the motion dynamics as the NC program is running. The new dynamic values become effective as from the line in which they are programmed. For the example illustrated, this means that the whole of block 10 is still treated with the default values. The new parameters are used for block 30 from the start of the segment.

This command limits all path axes to the parameterized dynamic values, although the path itself can have higher dynamics, depending on its orientation. The dynamics of auxiliary axes remains unchanged.

See also [dynamic override](#) [► 176].

Notice The dynamic values changed via the NC program remain active until the interpreter is next reset and/or TwinCAT has been restarted.

Notice The old command 'paramGroupDynamics' continues to be valid. However, it cannot be used to transfer R parameters.

Command	#set paramGroupDynamics(<grp>,<acc>,<dec>,<jerk>)#
Parameter <grp>	Group for which the alteration of the motion dynamics is to be effective. Presently always 1.
Parameter <acc>	Value of the maximum permitted path acceleration in mm/s ² .
Parameter <dec>	Value of the maximum permitted deceleration in mm/s ² .
Parameter <jerk>	Value of the maximum permitted jerk in mm/s ³ .

Sample:

```
N10 G01 X100 Y200 F6000
N20 #set paramGroupDynamics( 1, 700, 700, 3000 )#
N30 G01 X500
```

Change in axis dynamics

Command	#set paramAxisDynamics
Parameter <axis>	Axis in the interpolation group: X: 0 Y: 1 Z: 2 Q1: 3 ... Q5: 7
Parameter <acc>	Value of the maximum permitted acceleration in mm/s ²
Parameter <dec>	Value of the maximum permitted deceleration in mm/s ² .
Parameter <jerk>	Value of the maximum permitted jerk in mm/s ³ .

Sample:

```
N10 G01 X100 Y200 F6000
N15 R4=30000
N20 #set paramAxisDynamics( 0; 1500; 1400; R4 )#
N30 G01 X500
```

'paramAxisDynamics' can be used to change the axis dynamics at runtime. Generally the behavior is the same as for 'paramPathDynamics', except that here the dynamics can be specified individually for each axis.

6.3.9 Change of the Reduction Parameters

C0 reduction ▶ 177
C1 reduction ▶ 178
C2 reduction ▶ 179

C0 reduction

In some types of machine it is not absolutely necessary to reduce the path velocity to 0 at knee-points. 2 reduction methods are available

- VeloJump
- DeviationAngle

VeloJump

Command	#set paramVeloJump(<C0X>; <C0Y>; <C0Z>)#
Parameter <C0X>	Reduction factor for C0 transitions: X axis: $C0X \geq 0.0$
Parameter <C0Y>	Reduction factor for C0 transitions: Y axis: $C0Y \geq 0.0$
Parameter <C0Z>	Reduction factor for C0 transitions: Z axis: $C0Z \geq 0.0$

The 'paramVeloJump' command can be used to alter the velocity step change factors as the NC program is running. The new values come into effect via the block execution in the programmed line. You can find further details of the means of operation in the appendix under [Parameterization](#) [► 339].

Sample:

```
N10 G01 X100 Y200 F6000
N20 R2=4.5
N30 #set paramVeloJump( 1.45; R2; R2 )#
N40 G01 X500
```

**Resetting parameters**

The VeloJump parameters changed via the NC program remain active until the interpreter is next reset and/or TwinCAT has been restarted.

DeviationAngle (not yet released)

Command	#set paramDevAngle(<C0Factor>; <AngleLow>; <AngleHeigh>)#
Parameter <C0Factor>	Path reduction factor for C0 transitions: $1.0 \geq C0 \geq 0.0$
Parameter <AngleLow>	Angle in degrees from which reduction takes effect: $0 \leq \varphi_l < \varphi_h \leq \pi$
Parameter <AngleHeigh>	Angle in degrees from which reduction to $v_{link} = 0.0$ takes effect: $0 \leq \varphi_l < \varphi_h \leq \pi$

The 'paramDevAngle' command is used to describe the parameters for the C0 reduction. In contrast to the VeloJump reduction method, in which the velocity step change is influenced directly, in the DeviationAngle method the velocity step change depends upon the angle. You can find further details of the means of operation in the appendix under [Parameterization](#) [► 339].

Sample:

```
N10 G01 X100 Y200 F6000
N20 #set paramDevAngle(0.15; 5; 160 )#
N30 G01 X500
```

**Resetting parameters**

The DeviationAngle parameters changed via the NC program remain active until the interpreter is next reset and/or TwinCAT has been restarted.

C1 reduction factor

Command	#set paramC1ReductionFactor(<C1Factor>)#
Parameter <C1Factor>	C1 reduction factor

The 'paramC1ReductionFactor' command is used to change the C1 reduction factor while the NC program is running.

The new parameter comes into effect at the segment transition at which the reduction factor is programmed. In the example shown, the new value for the C1 reduction is therefore already effective in the segment transition from N10 to N30.

A floating point value or an 'R parameter' can be provided as parameter.

You can find further details of the means of operation in the appendix under [Parameterization](#) [► 339].

Sample:

```
N10 G01 X100 Y200 F6000
N20 #set paramC1ReductionFactor( 0.45 )#
N30 G01 X500
```

**Resetting parameters**

The C1 reduction factor changed via the NC program remains active until the interpreter is next reset and/or TwinCAT has been restarted.

C2 reduction factor

Command	#set paramC2ReductionFactor(<C2Factor>)#
Parameter <C2Factor>	C2 reduction factor

The 'paramC2ReductionFactor' command is used to change the C2 reduction factor while the NC program is running.

The command takes effect in the segment transition for which the reduction factor is programmed. In the example shown, the new value for the C2 reduction is therefore already effective in the segment transition from N10 to N30.

A floating point value or an 'R parameter' can be provided as parameter.

Sample:

```
N10 G01 X100 Y200 F6000
N20 #set paramC2ReductionFactor( 1.45 )#
N30 G01 X500
```

**Resetting parameters**

The C2 reduction factor changed via the NC program remains active until the interpreter is next reset and/or TwinCAT has been restarted.

6.3.10 Change of the Minimum Velocity

Command	#set paramVeloMin(<VeloMin>)#
Parameter <VeloMin>	Minimum path velocity

The 'paramVeloMin' command can be used to alter the minimum path velocity while the NC program is running. The new velocity comes into effect via the block execution in the programmed line.

A floating point value or an 'R parameter' can be provided as parameter.

Sample:

```
N10 G01 X100 Y200 F6000
N20 #set paramVeloMin( 2.45 )#
N30 G01 X500
```

**Resetting parameters**

The minimum velocity changed via the NC program remains active until the interpreter is next reset and/or TwinCAT has been restarted.

**Programming the velocity**

The unit of velocity is mm/sec and is therefore equivalent to the usual XAE units.

6.3.11 Read Actual Axis Value

Command	@361	
Parameter 1	R<n>	R parameter to which the actual axis value is assigned

Parameter 2	K<m>	Constant for the axis coordinate that is to be read 0: X axis 1: Y axis 2: Z axis 3: Q1 axis 4: Q2 axis ... 7: Q5 axis

Sample 1:

```

N10 G0 X0 Y0 Z0 F24000
N30 G01 X1000
N40 @361 R1 K0 (read position of x axis)
N50 R0=X
N60 G01 X=R0+R1
N70 M30

```

A decoder stop is implicitly executed by @361 command. This ensures that, in this example, the position is read when block N30 has been processed.

A possible application would be in combination with the deletion of any remaining travel.

Read actual axes value without decoder stop

Command	#get PathAxesPos(R<a>; R; R<c>)#	
Parameter 1	R<a>	R parameter to which the actual axes value of the X axis is assigned
Parameter 2	R	R parameter to which the actual axes value of the Y axis is assigned
Parameter 3	R<c>	R parameter to which the actual axes value of the Z axis is assigned

The command #get PathAxesPos()# reads the current actual positions of the path axes (X, Y & Z). It behaves similarly to @361, with the difference that this command does not trigger an implicit decoder stop. This means that the programmer must himself ensure that at the time when the command is being processed in the interpreter the axes have not yet moved, or else a decoder stop (@714) must be programmed in the block before this command.

#get PathAxesPos()# is an alternative to @361, but it is linked to certain specific conditions.

Sample 2:

```

@714(optional)
N27 #get PathAxesPos( R0; R1; R20 )#

```

Notice If a path axis is not assigned (e.g. no axis is assigned to Z) the value 0 is passed to the associated R parameter.

6.3.12 Skip virtual movements

Command	#skip VirtualMovements(<parameter>)#
Parameter	0 (default): virtual movements are "completed". 1: Virtual movements are skipped

Movements of unavailable but programmed main axes (X, Y & Z) can be skipped with the command 'skip VirtualMovements'.

Sample:

The interpolation group (CfgBuildGroup) contains only assignments for the X and Y axis. The Z axis is **not** assigned, but programmed in the parts program.

```
(Startposition X0 Y0 Z0)
N10 #skip VirtualMovements(1)#
N20 G01 X100 Y200 F6000
N30 G01 Z1000 (virtual movement, because z is not assigned)
N40 G01 X500
```

Segment N30 is skipped during execution of this program.

6.3.13 Messages from NC program

Command	#MSG (<message level>; <mask>; "<text>")#
<message level>	• ITP The message is issued from the interpreter. This means that the message generally appears well before the execution in the NC kernel. • NCK The message is issued from the NC kernel when the NC block is executed. This means it appears at the same time as the block execution (SAF)
<mask>	STRING
<text>	the text to be displayed

```
N10 G0 X0 Y0
N20 G01 X100 Y0 F6000

N30 #MSG( NCK; STRING; "this is a text")#

N40 G01 X200 Y-100
```

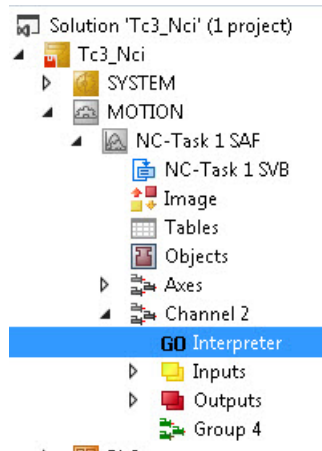
The text can **not** be used to transfer further parameters (e.g. R-parameters).

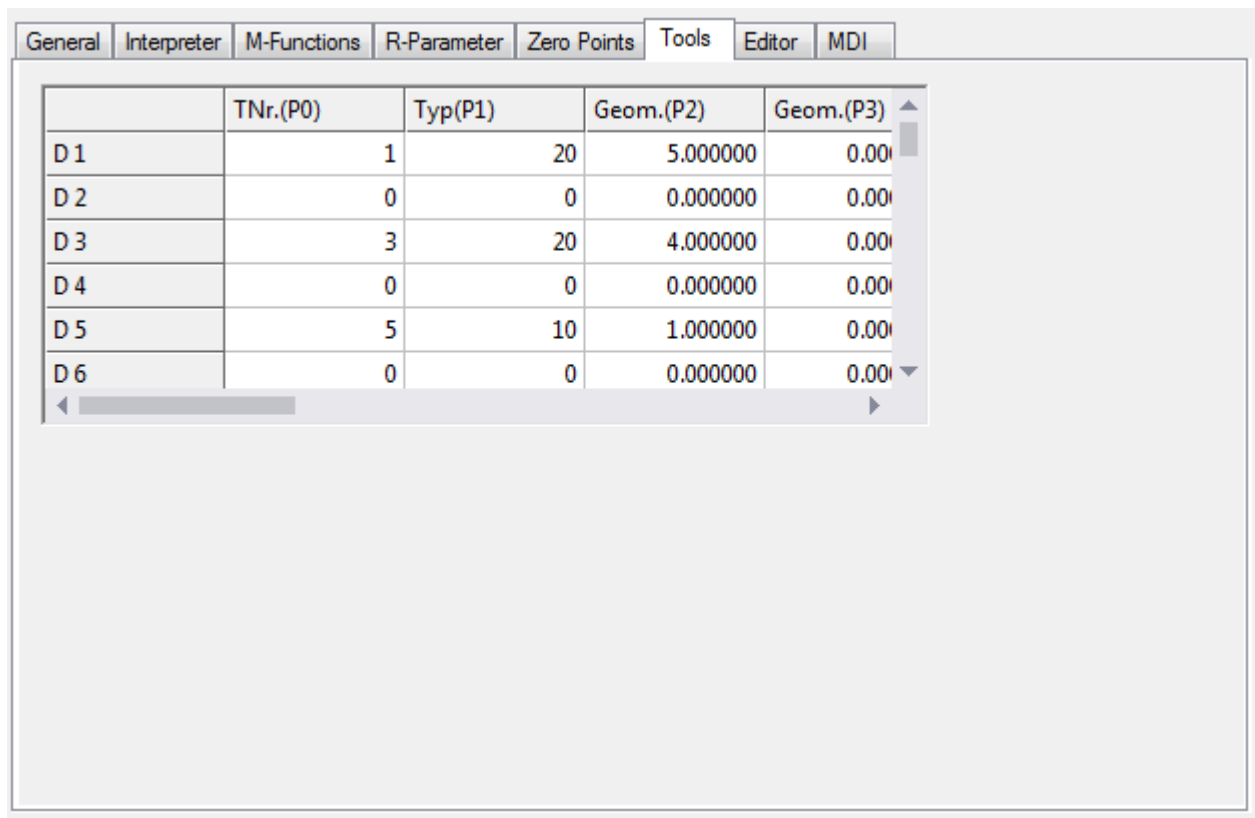
Internally the message is handled like a note.

6.4 Tool Compensation

6.4.1 Tool Data

The NC has 255 memory locations (D1..D255) available for each channel for tool data. The parameters for the tool data can be written directly in the XAE. The data is saved as an ASCII file (<channel ID>.wz) which is kept in the TwinCAT\CNC directory. These files are automatically loaded when TwinCAT is started.





Currently two tool types are supported:

- Drills
- Shaft Cutters

The relevant columns (parameters) for this type of tool are described below.

Drills

Parameter	Meaning
0	Tool number When this D-word is called, a tool number that is specified here can be given at the same time.
1	Tool type The drill is type 10 .
2	Geometry: Length Describes the length of the drill.
5	Wear: Length Describes the wear on the drill. The wear has to be given as a negative value, since it is added to the length.
8	Cartesian tool displacement [► 184] in X direction
9	Cartesian tool displacement in Y direction
10	Cartesian tool displacement in Z direction

Shaft Cutters

Parameter	Meaning
0	Tool number When this D-word is called, a tool number that is specified here can be given at the same time.
1	Tool type The shaft cutter is type 20

Parameter	Meaning
2	Geometry: Length Length of the shaft cutter.
4	Geometry: Radius
5	Wear: Length
7	Wear: Radius
8	Cartesian tool displacement [► 184] in X direction
9	Cartesian tool displacement in Y direction
10	Cartesian tool displacement in Z direction

Writing of tool data

Editing tool data with the XAE

As already mentioned, the tool data can be written directly from the XAE. To do this, edit the window shown above.

Parameterization of tool data via the PLC

In addition, tool data can be read and written from the PLC with the function block `ItpWriteToolDescEx` [► 259].

Writing tool data from the parts program

In some applications, it is more convenient to write the tool data directly from the part program.

The tool set to be overwritten must not be active during the write process. This means, for example, if tool radius compensation with parameter set D10 is active, this cannot be overwritten, as long as D10 is still selected.

Command	<code>#set ToolParam(<Zeile>; <Spalte>;<Wert>)#</code>
Parameter <line>	Describes the tool parameter line (1..255) Corresponds to the D number
Parameter <column>	Column to be written (0..15)
Parameter <value>	Parameter value to be transmitted

Sample:

```
N10 G0 X0 Y0 Z0
N20 G01 X100 F60000
N30 R1=10 R2=4 R3=20.3
N40 #set ToolParam(10; 0; 5)# #set ToolParam(10;1;20)#
N50 #set ToolParam(R1; R2; R3)#
N60 G41 X200 Y D10
...
```

Notice No formulas may be transmitted as parameters. Writing of the tool data does not require a decoder stop.

Reading tool data from the parts program

This command can be used to assign tool data to an R-parameter.

Command	<code>#get ToolParam(<line>; <column>;<R-Param>)#</code>
Parameter <line>	Writes to the tool parameter line (1..255); this corresponds to the D number
Parameter <column>	Column to be written (0..15)
Parameter <R-Param>	R-parameter in which the date is entered

Sample:

```
N10 G0 X0 Y0 Z0
N20 G01 X100 F60000
N30 R1=10 R2=4
```

```

N40 #get ToolParam(10; 0; R5) # #getToolParam(10;1;R20) #
N50 #get ToolParam(R1; R2; R3) #
N60 G41 X200 Y D10
...

```

Notes:

Notice No formulas may be transmitted as parameters. Reading of the tool data does not require a decoder stop.

6.4.2 Selecting and Deselecting the Length Compensation

Length compensation can only be selected when G0 [► 137] or G1 [► 138] are in effect. The working plane [► 131] must be selected to which the length compensation is perpendicular.

The feed direction is specified with P (see working plane and feed direction [► 131]).

To effect the movement corresponding to the length compensation, the axis concerned must at least be mentioned.

Sample:

```

N10 G17 G01 X0 Y0 Z0 F6000
N20 D1 X10 Y10 Z
N30 ...
N90 M30

```

Notice Length correction is automatically selected when cutter radius compensation [► 187] is selected. To deselect length correction, D0 has to be programmed. It is again here necessary to at least mention the axis concerned in order to move to the new position.

6.4.3 Cartesian Tool Translation

Cartesian tool displacement refers to an offset between the reference point of the tool carrier and the reference point of the tool itself. In many cases, these reference points have the same location, so that a 0 can be entered for the tool displacement.

Parameter

The parameters for a translation are entered into the tool data [► 181] in the same way as the tool length etc. Parameters 8 to 10 are available for this purpose. Here

- P8 always describes the X-component
- P9 always describes the Y-component
- P10 always describes the Z-component

independently of the choice of level.

General	Interpreter	M-Functions	R-Parameter	Zero Points	Tools	Editor	MDI
	TNr.(P0)	Typ(P1)	Geom.(P2)	Geom.(P3)			
D 1	1	20	5.000000	0.000000			
D 2	0	0	0.000000	0.000000			
D 3	3	20	4.000000	0.000000			
D 4	0	0	0.000000	0.000000			
D 5	5	10	1.000000	0.000000			
D 6	0	0	0.000000	0.000000			

Selecting and deselecting Cartesian tool displacement

As in the case of length compensation, tool displacement is switched on with D<n> (n>0). In order to travel to the translated location, the axes must at least be named. This means that the displacement affects the positioning when the axis is called for the first time. It is also possible for a new final position to be entered for the axis.

The function is switched off with D0. Here again, it is necessary for the axes at least to be named, if the axes are to travel to their new co-ordinates.

Sample 1:

```
N10 G17 G01 X0 Y0 Z0 F6000
N20 D1 X10 Y10 Z (Z-Axis is repositioned)
N30 ...
N90 M30
```

Sample 2:

```
N10 G17 G01 X0 Y0 Z0 F6000
N20 D1 X10 Y10 (Z-Axis is not moved)
N30 ...
N90 M30
```

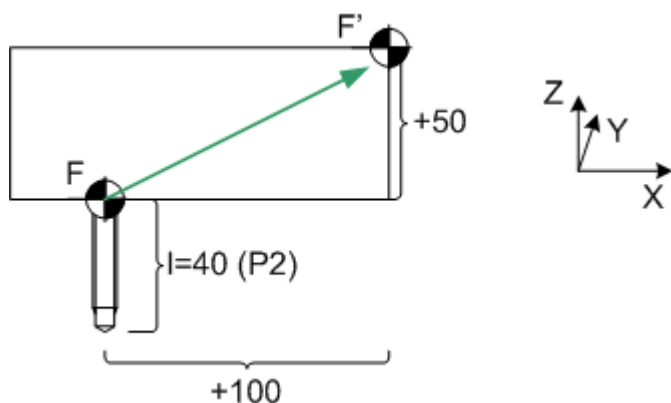


Using tool displacement and rotation

If the Cartesian tool displacement is used in combination with [rotation](#) [► 149], then the compensation will only be correct if the aggregate (the tool carrier) is also rotated through the same angle.

Application sample

It often happens that a processing machine's tool carrier contains a number of tools. The appropriate tool is pneumatically activated according to the kind of machining required. Since, however, the tools are located at different positions, Cartesian tool displacement is required.



Tool parameters

Parameter	Value
0	0..65535
1	10
2	40
5	0
8	100.0
9	0.0
10	50

Behavior with incremental dimension notation

Default behavior

If a new tool offset (and also length compensation) is selected in incremental dimensions (G91), then the compensation is applied once the axis is named.

Sample 3:

```
(Tooloffset D1: X10 Y20 Z30)
N10 G01 D1 X100 Y0 Z0 F6000
N20 G91 (incremental dimension)
N30 D2 (Tooloffset D2: X100
Y200 Z300)
N30 Z10
N40 ...
```

Command	Description
ToolOffsetIncOn	The tool displacements and length compensations are also applied under G91 once the axis is named. (standard setting)
ToolOffsetIncOff	The tool displacement and length compensation are not applied under G91.

Sample 4:

```
(Tooloffset D1: X10 Y20 Z30)
N05 ToolOffsetIncOff
N10 G01 D1 X100 Y0 Z0 F6000
N20 G91 (incremental dimension)
N30 D2 (Tooloffset D2: X100
Y200 Z300)
N30 Z10
N40 ...
```

In N10 the Tooloffset is applied to all 3 axes. I.e. the axes move in the machine coordinate system (MCS) to X110 Y10 Z30.

In N30 the new Tooloffset of the Z-axis is **not** applied. This results in MCS X110 Y10 **Z40**.

See also [ZeroShiftIncOn/Off](#) [► 143]

6.4.4 Cutter Radius Compensation

6.4.4.1 Miller/Cutter Radius Compensation Off

Miller/Cutter Radius Compensation Off

Command	G40 (standard setting)
Cancellation	G41 [► 187] or G42 [► 188]

The G40 function switches the miller/cutter radius compensation off. The [length radius compensation \[► 184\]](#) will still remain active until it is switched off with D0. Between G40 and end of program it is mandatory to program at least one geometry element.

6.4.4.2 Miller/cutter radius compensation left

Miller/cutter radius compensation left

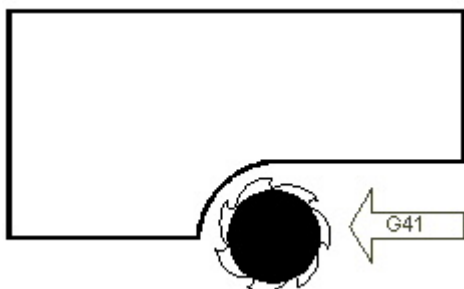
Command	G41
Cancellation	G40 [► 187]

The function G41 switches on the miller/cutter radius compensation. The tool is located to the **left** of the workpiece in the direction of movement.

As has already been seen for the [length compensation \[► 184\]](#), the cutter radius compensation can only be activated when [G0 \[► 137\]](#) or [G1 \[► 138\]](#) is in effect. The axes of the plane must be driven when the cutter radius compensation is selected.

Sample:

```
N10 G17 G01 X0 Y0 Z0 F6000
N20 G41 X10 Y20 Z D1
N30 X30
N40 G40 X10 Y10 Z
N50 M30
```



Cutter radius compensation does not apply to full circles

The cutter radius compensation does not support full circles. Full circles have to be split into semicircles, for sample.

Notes:

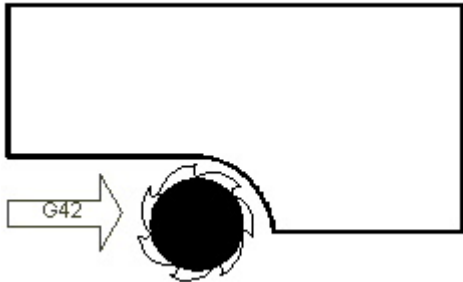
- The cutter radius compensation should be deactivated before the end of the NC program, in order to close it properly. Between G40 and end of program it is mandatory to program at least one geometry element.
- If a [decoder stop \[► 170\]](#) is programmed, cutter radius compensation has to be disabled first.
- For arcs, radius compensation can lead to a change in the path velocity at the contour. See also '[Path velocity in arcs \[► 192\]](#)'.
- See [Orthogonal contour approach/departure \[► 192\]](#).

6.4.4.3 Miller/cutter radius compensation right

Miller/cutter radius compensation right

Command	G42
Cancellation	G40 [▶ 187]

The function G42 switches on the miller/cutter radius compensation. The tool is located to the **right** of the workpiece in the direction of movement.



Cutter radius compensation does not apply to full circles

The cutter radius compensation does not support full circles. Full circles have to be split into semicircles, for sample.

Notice If a change is to be made from G41 to G42, then a G40 should be programmed between the two movements.

6.4.4.4 Departure and approach behavior of the miller/cutter radius compensation

This chapter describes the approach and departure behavior when the miller/cutter radius compensation is switched on or off. This behavior depends on the start position and cannot be influenced in any other way.

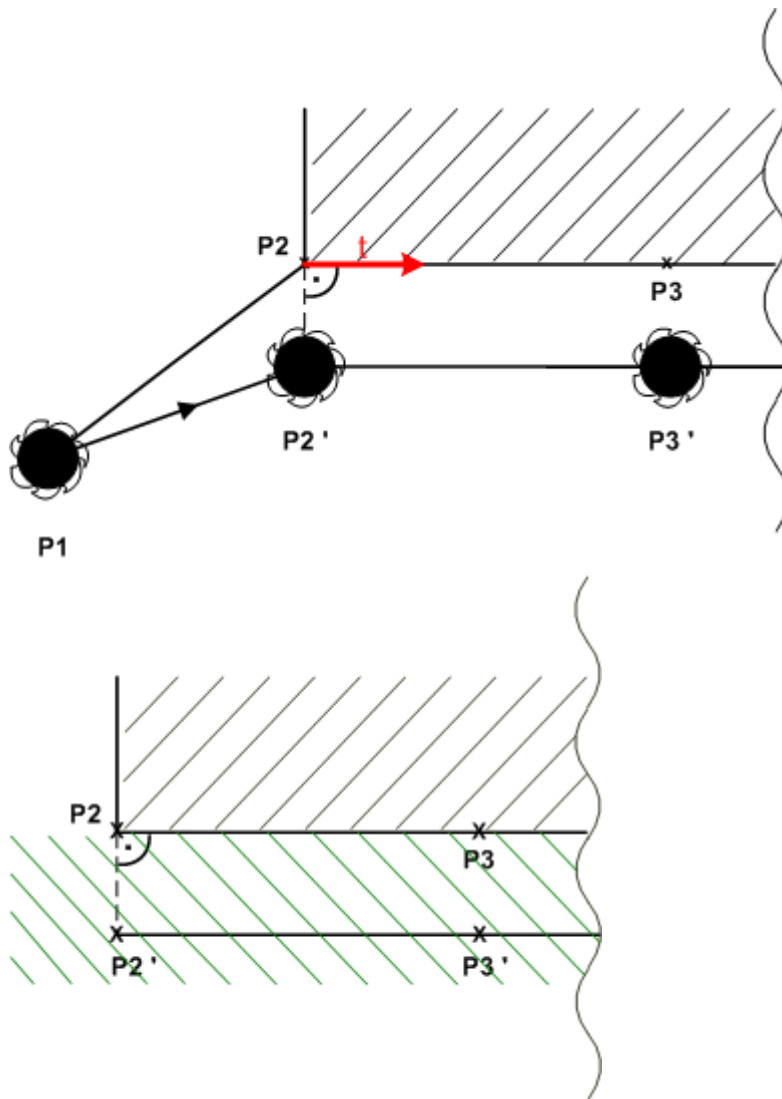
After the radius compensation is switched on, it must be applied. This means the cutter is at one point P1 (without radius compensation) and travels to P2', with the cutter radius being compensated at point P2'.

Point P2' depends on the start position P1 within the plain. A distinction is made between 3 basic cases. These cases are exemplified below during application of the radius compensation with a programmed G42 (right compensation).

Similar rules apply for the deactivation of the compensation, except that the tangent t is determined at the end of the path segment, with similar conditions being derived.

Case 1: P1 to the right of the path tangent t

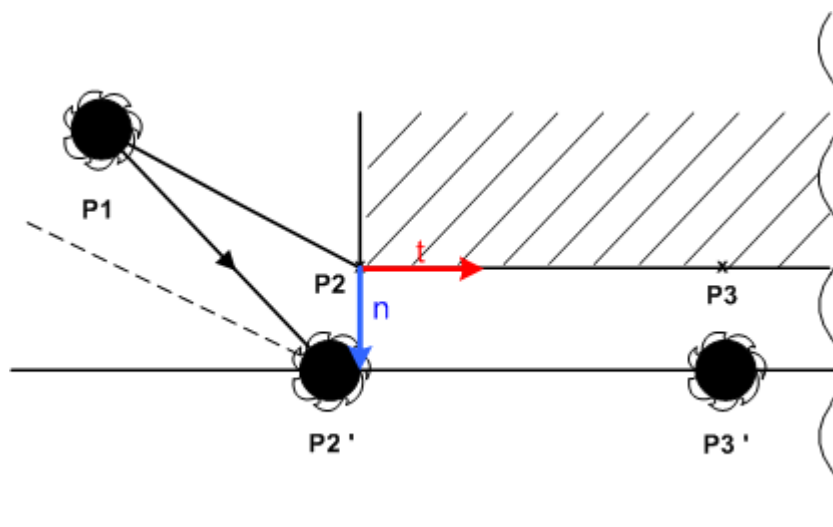
If the starting point P1 is to the right of the path tangent t, P2' is orthogonal to the tangent. This start-up behavior applies to the range hatched in green.

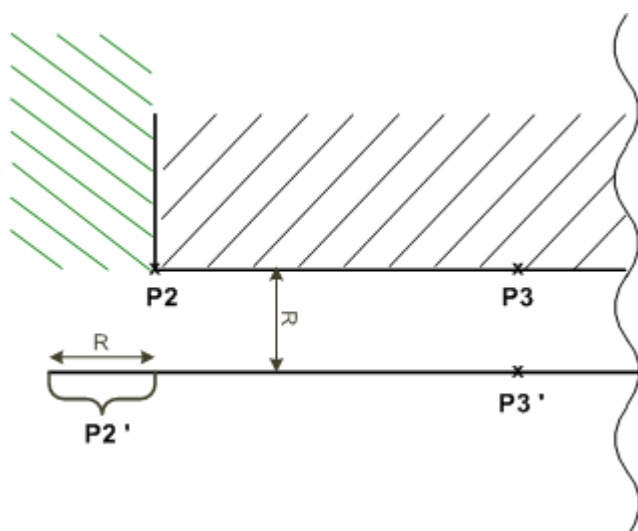


Case 2: P1 the right of the normal n and to the left of the path tangent t

If the start position P1 is to the right of the normal n and to the left of the path tangent t , P2' is moved. P2' results from the intersection of the parallel of P1P2 and the offset distance P2P3. Both straight lines are offset by radius R .

This behavior applies to the range hatched in green.

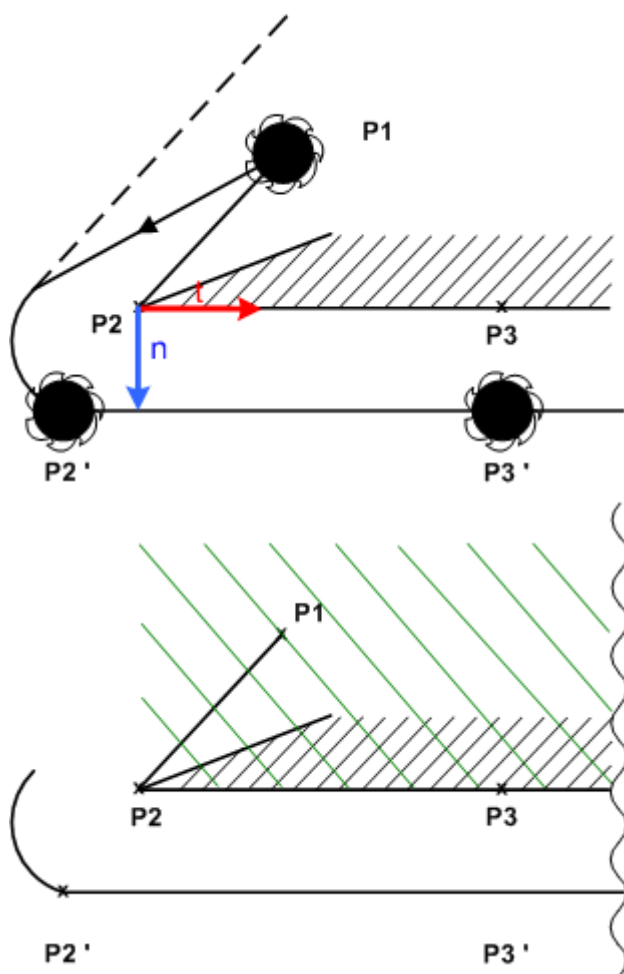




Case 3: P1 to the left of the normal n and to the left of the path tangent t

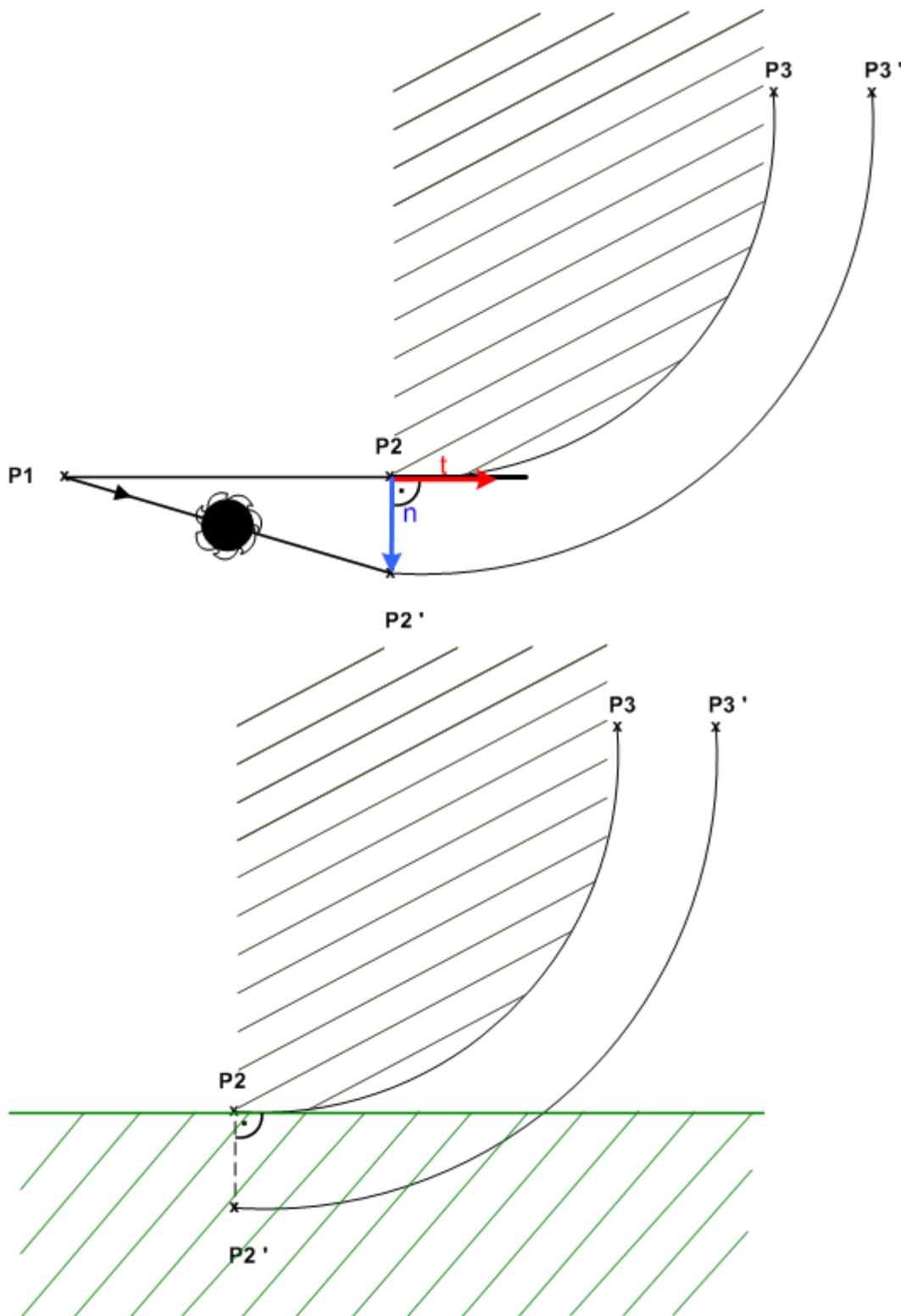
If the start position $P1$ is to the left of the normal n and also to the left of the path tangent t , an additional circle segment is inserted during approaching of $P2'$. In order to avoid free cutting at $P2$, $P2'$ is not orthogonal to the start tangent of the section $P2P3$.

The additional circle segment is inserted for all start positions within the hatched green region.



A circle segment follows after the offset

The radius compensation is invariably applied via a straight line. (This must be set in the part program, since otherwise a runtime error will be generated). The contour can then start with a circle. The rules for starting and stopping are the same as before, i.e. here too the path tangent of the contour for P2 is determined, and a distinction is made between the three cases described.



If P2' is always to be approached orthogonal to the path tangent of P2, independent of the starting point, this can be realized with an additional command (see [Orthogonal contour approach/departure](#) [► 192]).

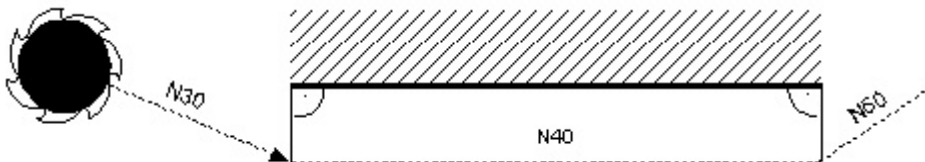
6.4.5 Orthogonal Contour Approach/Departure

Command	NORM
Cancellation	End of block
Programmable with	G40 [► 187] G41 [► 187] G42 [► 187]

The 'NORM' command has the effect that the contour is approached orthogonally when cutter radius compensation is switched on. The actual position of the cutter is irrelevant. When de-selecting, the last segment with active compensation is also left orthogonally.

Sample:

```
N10 G17
N20 G01 X0 Y0 Z0 F6000
N30 G42 NORM X100 Y0 D5
N40 X200
N50 G40 NORM X220 Y0
N60 M30
```



Notice The Norm command has hitherto only been implemented for straight line/straight line transitions.

6.4.6 Path Velocity in Arcs

When the cutter radius compensation [► 187] is active, the programmed radius changes for arcs. This in turn alters the velocity. The following commands are used to specify whether the feed value refers to the contour or the tool center point.

Constant Feed at the Contour

Command	CFC (standard setting)
Cancellation	CFIN or CFTCP

With CFC (constant feed contour) the feedrate at the contour is held constant.

Constant Feed at the Internal Radius

Command	CIN
Cancellation	CFC or CFTCP

With CFIN (constant feed internal radius) the feedrate at internal radii is reduced. This results in a constant velocity at the contour. The velocity at external radii is not increased.

Constant Feed of the Tool Centre Point

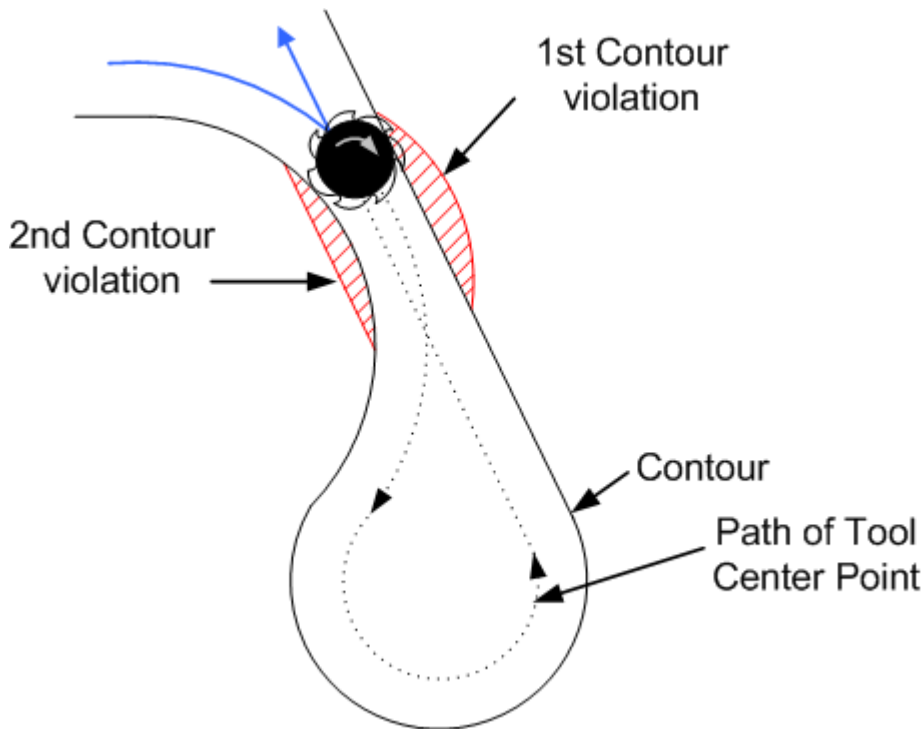
Command	CFTCP
Cancellation	CFC or CFIN

With CFTCP (constant feed tool center point) the feedrate of the tool's center point is kept constant. This means that at internal radii the velocity at the contour is increased, and that it is correspondingly reduced at external radii.

6.4.7 Bottle Neck Detection

If the cutter radius is not considered when a part program is created, the cutter may inadvertently process the opposite side of the workpiece. This leads to a contour collision with the workpiece, or, in other words, a bottleneck was programmed.

Command	CDON
Cancellation	CDOF



In this form, this behavior can only occur in combination with cutter radius compensation (G41/G42). In order to prevent such contour collisions, monitoring can be switched on from the part program via **CDON**. For it to be active, cutter radius compensation must also be selected.

The response of the NCI when a bottleneck is detected can be parameterized via the PLC. 3 cases are distinguished:

- Error and abort
If a bottleneck is detected, TwinCAT generates a runtime error and aborts the program execution.
- Notification and modification of the contour
If a bottleneck is detected, the contour is modified such that a contour collision is avoided (see Figure 1: blue line). However, this also means that segments may be left out, depending on the program. Furthermore, a note is entered in the application viewer to say that a bottleneck was detected.
- Notification and contour collision
If a bottleneck is detected, the contour is not changed and no error is generated. Only a message is entered in the application viewer.

Significant computing resources are required for contour collision monitoring. It should therefore only be selected if it is actually required. Furthermore, the amount of look-ahead for the bottleneck detection should be specified. This requires the number of future segments to be determined that are monitored relative to the n-th segment, in order to check for bottlenecks. The selected number of segments should not be too large, since this would put unnecessary strain on the system. The value for the look-ahead is also parameterized from the PLC.

Function blocks for parameterizing the bottleneck detection:

- [ItpSetBottleNeckModeEx](#) [► 245]
- [ItpGetBottleNeckModeEx](#) [► 216]
- [ItpSetBottleNeckLookAheadEx](#) [► 243]

- [ItpGetBottleNeckLookAheadEx \[► 214\]](#)

Sample:

```
N10 G0 X0 Y0 Z0
N20 CDON
N30 G01 G41 D3 X100 F6000 (cutter radius 30mm)
...
N40 G01 X200
N50 G02 X220 Y-74.641 I0 J-40
N60 G01 X300 Y-104
N70 G01 X230 Y120
N80 G40 D0 Y200
N90 CDOF
...
M30
```

6.5 Command overview

6.5.1 General command overview

Command	Description	block-by-block / modal	Default
ANG [► 148]	Contour line programming (angle)	s	
AROT [► 149]	Rotation additive	m	
CalcInvRot [► 149]	Calculates the inverse rotation of a vector	s	
CalcRot [► 149]	Calculates the rotation of a vector	s	
CDOF [► 193]	Bottleneck detection off	m	Default
CDON [► 193]	Bottleneck detection on	m	
CFC [► 192]	Constant velocity at the contour	m	Default
CFIN [► 192]	Constant velocity in the interior circle	m	
CFTCP [► 192]	Constant velocity of tool center point	m	
CIP [► 139]	Circular interpolation	s	
CPCOF [► 139]	Centre point correction off	m	
CPCON [► 139]	Centre point correction on	m	Default
DelDTG [► 160]	Delete Distance to Go	s	
DYNQVR [► 176]	Dynamic Override	m	
FCONST [► 142]	Constant feed programming	m	Default
FLIN [► 142]	Linear feed programming	m	
G00 [► 137]	Rapid traverse	m	
G01 [► 138]	Straight line interpolation	m	Default
G02 [► 139]	Clockwise circular interpolation	m	
G03 [► 139]	Anticlockwise circular interpolation	m	
G04 [► 142]	Dwell time	s	
G09 [► 142]	Accurate stop	s	
G17 [► 131]	Plane selection XY	m	Default

Command	Description	block-by-block / modal	Default
G18 [► 131]	Plane selection ZX	m	
G19 [► 131]	Plane selection YZ	m	
G40 [► 187]	No miller/cutter radius compensation	m	Default
G41 [► 187]	Miller/cutter radius compensation left	m	
G42 [► 187]	Miller/cutter radius compensation right	m	
G53 [► 143]	Zero shift suppression	m	Default
G54 [► 143]	1st adjustable zero shift	m	
G55 [► 143]	2nd adjustable zero shift	m	
G56 [► 143]	3rd adjustable zero shift	m	
G57 [► 143]	4th adjustable zero shift	m	
G58 [► 143]	1st programmable zero shift	m	
G59 [► 143]	2nd programmable zero shift	m	
G60 [► 142]	Accurate stop	m	
G70 [► 132]	Dimensions inch	m	
G71 [► 132]	Dimensions metric	m	Default
G74 [► 137]	Programmed traverse to reference point	s	
G90 [► 130]	Reference dimension notation	m	Default
G91 [► 130]	Incremental dimension notation	m	
G700 [► 132]	Dimensions in inches with calculation of the feed	m	
G710 [► 132]	Dimensions metric with calculation of the feed	m	
Mirror [► 152]	Mirroring coordinate system	m	
MOD [► 160]	Modulo movement	s	
MSG [► 181]	Messages from the NC program	s	
NORM [► 192]	orthogonal approach of and departure from the contour	s	
P+ [► 131]	Feed direction positive	m	Default
P- [► 131]	Feed direction negative	m	
paramAutoAccurateStop [► 159]	Automatic Accurate Stop	m	
paramAxisDynamics [► 176]	Parameterization of the axis dynamics	m	
paramC1ReductionFactor [► 177]	C1 reduction factor	m	
paramC2ReductionFactor [► 177]	C2 reduction factor	m	

Command	Description	block-by-block / modal	Default
paramCircularSmoothing [► 158]	Circular smoothing	m	
paramDevAngle [► 177]	C0 reduction - deflection angle	m	
paramGroupVertex [► 158]	Circular smoothing (old)	m	
paramGroupDynamic [► 176]	Pathway dynamics (old)	m	
paramPathDynamics [► 176]	Pathway dynamics	m	
paramRadiusPrec [► 140]	Circular accuracy	m	
paramSplineSmoothing [► 156]	Smoothing with Bezier Splines	m	
paramVertexSmoothing [► 153]	Smoothing of Segment Transitions	m	
paramVeloJump [► 177]	C0 reduction - max. step change in velocity	m	
paramVeloMin [► 179]	Minimum velocity	m	
paramZeroShift [► 143]	Parameterization of the configurable zero shift	m	
PathAxesPos [► 180]	Reads the actual position	s	
ROT [► 149]	Absolute rotation	m	
RotExOff [► 149]	Extended rotation function off	m	Default
RotExOn [► 149]	Extended rotation function on	m	
RotVec [► 149]	Calculation routine for rotating a vector	s	
RParam [► 135]	Initialization of R-parameters	s	
RToDwordGetBit [► 135]	Converts an R-parameter to DWord and checks whether a defined bit is set	m	
SEG [► 148]	Contour line programming (segment length)	s	
skip VirtualMovements [► 180]	Skip virtual movements	m	
ToolOffsetIncOff [► 184]	Cartesian tool displacement and length compensation is not applied under G91	m	
ToolOffsetIncOn [► 184]	Cartesian tool displacement and length compensation is applied under G91	m	Default
ToolParam [► 181]	Writing and reading of tool parameters	m	
TPM [► 146]	Target position monitoring	s	
ZeroShiftIncOff [► 143]	Zero shift is not applied under G91	m	

Command	Description	block-by-block / modal	Default
ZeroShiftIncOn [► 143]	Zero shift is applied under G91	m	Default

Address	Description
Q<n> [► 162]	Axis label for auxiliary axis (1 <= n <= 5)

6.5.2 @-Command Overview

Several variations of these commands are often possible, since K for a constant, R for an R-parameter or P for an R-parameter used as a pointer can be used for parameters. For example, the notation K/R/Pn should be understood to mean "either a number or an R-parameter or a pointer".

The following @-commands are available:

Command	Versions	Function
@40 [► 135]	@40 Kn Rn Rm	Save register on the stack
@41 [► 135]	@41 Rn Rm	Save register on the stack
@42 [► 135]	@42 Kn Rm Rn	Restore register from stack
@43 [► 135]	@43 Rm Rn	Restore register from stack
@100 [► 171]	@100 K±n @100 Rm	Unconditional jump
@111 [► 171]	@111 Rn K/Rn Km ...	Case block
@121 [► 171]	@121 Rn K/Rn Kn	Jump if unequal
@122 [► 171]	@122 Rn K/Rn Kn	Jump if equal
@123 [► 171]	@123 Rn K/Rn Kn	Jump if less or equal
@124 [► 171]	@124 Rn K/Rn Kn	Jump if less
@125 [► 171]	@125 Rn K/Rn Kn	Jump if greater or equal
@126 [► 171]	@126 Rn K/Rn Kn	Jump if greater
@131 [► 173]	@131 Rn K/Rn Kn	Loop while equal
@132 [► 173]	@132 Rn K/Rn Kn	Loop while unequal
@133 [► 173]	@133 Rn K/Rn Kn	Loop while greater
@134 [► 173]	@134 Rn K/Rn Kn	Loop while greater or equal
@135 [► 173]	@135 Rn K/Rn Kn	Loop while less
@136 [► 173]	@136 Rn K/Rn Kn	Loop while less or equal
@141 [► 173]	@141 Rn K/Rn Kn	Repeat until equal
@142 [► 173]	@142 Rn K/Rn Kn	Repeat until unequal
@143 [► 173]	@143 Rn K/Rn Kn	Repeat until greater
@144 [► 173]	@144 Rn K/Rn Kn	Repeat until greater or equal
@145 [► 173]	@145 Rn K/Rn Kn	Repeat until less
@146 [► 173]	@146 Rn K/Rn Kn	Repeat until less or equal
@151 [► 173]	@151 Rn K/Rn Kn	FOR_TO loop
@161 [► 173]	@161 Rn K/Rn Kn	FOR_DOWNTO loop
@200	@200 Rn	Delete a variable
@202	@202 Rn Rm	Swap two variables
@302	@302 K/R/Pn K/R/Pn R/Pn	Read machine data bit
@361 [► 179]	@361 Rn Km	Read machine-related actual axis value

Command	Versions	Function
@372	@372 Rn	Extract the NC-Channel-ID and store it in a variable
@402 [► 139]	@402 K/R/Pn K/R/Pn K/R/Pn	Write machine data bit
@610	@610 Rn Rn	Find absolute value of a variable
@613	@613 Rn Rn	Find square root of a variable
@614	@614 Rn Rm Rm	Find square root of the sum of the squares of two variables $x = \sqrt{a^2 + b^2}$
@620 [► 173]	@620 Rn	Increment variable
@621	@621 Rn	Decrement variable
@622	@622 Rn	Find integer part of a variable
@630 [► 135]	@630 Rn Rm	Find sine of a variable
@631 [► 135]	@631 Rn Rm	Find cosine of a variable
@632 [► 135]	@632 Rn Rm	Find tangent of a variable
@633 [► 135]	@633 Rn Rm	Find cotangent of a variable
@634 [► 135]	@634 Rn Rm	Find arcsine of a variable
@635 [► 135]	@635 Rn Rm	Find arccosine of a variable
@636 [► 135]	@636 Rn Rm	Find arctangent of a variable
@714 [► 170]	@714	Decoder stop
@716 [► 170]	@716	Decoder stop with rescan of the axis positions
@717 [► 170]	@717	Decoder stop with external trigger event

Machine data

Access to the following machine data is supported:

Byte	Bit	Action
5003 [► 139]	5	0: IJK words specify the distance between the center of the circle and the starting point. 1: IJK are absolute data giving the center of the circle.

7 PLC NCI Libraries

Requirements

Overview of PLC NCI libraries	Description
PLC Library: Tc2_NCI [► 199]	Function blocks for the configuration of the interpolation group (e.g. formation of the 3D group) and for operating the interpreter (G-Code (DIN 66025)) such as loading and starting the NC program.
PLC Library: Tc2_PlcInterpolation [► 313]	Programming of multi-dimensional movements from the PLC (alternative to using G-Code (DIN 66025))

7.1 PLC Library: Tc2_NCI

7.1.1 Configuration

The library Tc2_NCI provides function blocks for general NC axis configuration. This makes it possible to configure or to reconfigure axes in a simple way directly from the PLC.

Function block	Description
CfgBuild3DGroup [► 199]	Groups up to 3 PTP axes into a 3D group
CfgBuildExt3DGroup [► 201]	Groups up to 3 PTP axes and 5 auxiliary axes into a 3D group
CfgAddAxisToGroup [► 202]	Configures a single axis at a particular location within a group (PTP, 3D, FIFO)
CfgReconfigGroup [► 203]	Removes 3D (FIFO) axis allocations and returns the axes to their personal PTP group
CfgReconfigAxis [► 204]	Returns a single axis from, for example, a 3D group, to its personal PTP group
CfgRead3DAxisIds [► 205]	Reads the axis IDs (axis allocation) of a 3D group
CfgReadExt3DAxisIds [► 206]	Reads the axis IDs (axis allocation) of a 3D group with auxiliary axes

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.1.1 CfgBuild3DGroup



The function block CfgBuild3DGroup configures a 3D group with up to 3 PTP axes (X, Y and Z).

Inputs

```
VAR_INPUT
  bExecute      : BOOL;
  nGroupId      : UDINT;
  nXAxisId      : UDINT;
  nYAxisId      : UDINT;
  nZAxisId      : UDINT;
  tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nGroupId	UDINT	ID of the 3D group
nXAxisId	UDINT	ID of the PTP axes
nYAxisId	UDINT	ID of the PTP axes
nZAxisId	UDINT	ID of the PTP axes
tTimeout	TIME	ADS Timeout-Delay

Outputs

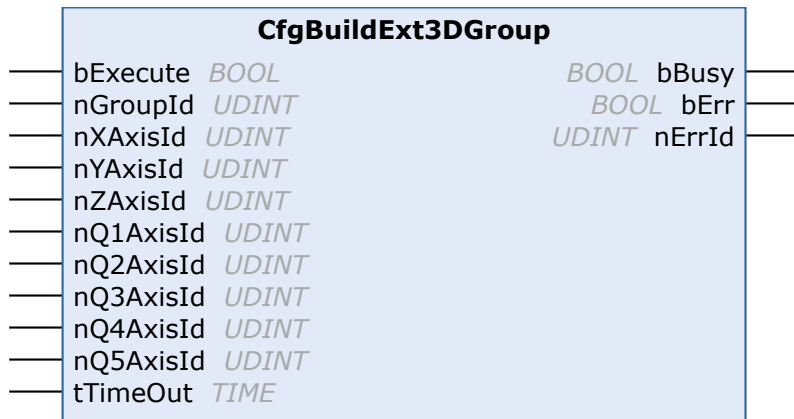
```
VAR_OUTPUT
  bBusy        : BOOL;
  bErr         : BOOL;
  nErrId       : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.1.2 CfgBuildExt3DGroup



The function block CfgBuildExt3DGroup configures a 3D group with up to 3 path axes (X, Y and Z). Additionally, up to 5 auxiliary axes (Q1..Q5) can be configured.

The axis IDs of the PTP axes that are to be included in the interpolation group are applied at the inputs **nXAxisId** to **nQ5AxisId**.

NOTICE

The assignment of the auxiliary axes must start with nQ1AxisId. No gaps between auxiliary axes are permitted. This means that if, for example, nQ3AxisId is to be assigned, then nQ2AxisId must also be assigned a valid axis ID.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nGroupId      : UDINT;
    nXAxisId      : UDINT;
    nYAxisId      : UDINT;
    nZAxisId      : UDINT;
    nQ1AxisId     : UDINT;
    nQ2AxisId     : UDINT;
    nQ3AxisId     : UDINT;
    nQ4AxisId     : UDINT;
    nQ5AxisId     : UDINT;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is executed when a positive edge is encountered.
nGroupId	UDINT	ID of the 3D group
nXAxisId	UDINT	Axis IDs of the PTP axes to be included in the interpolation group.
nYAxisId	UDINT	
nZAxisId	UDINT	
nQ1AxisId	UDINT	
nQ2AxisId	UDINT	
nQ3AxisId	UDINT	
nQ4AxisId	UDINT	
nQ5AxisId	UDINT	
tTimeout	TIME	ADS Timeout-Delay

🔧 Outputs

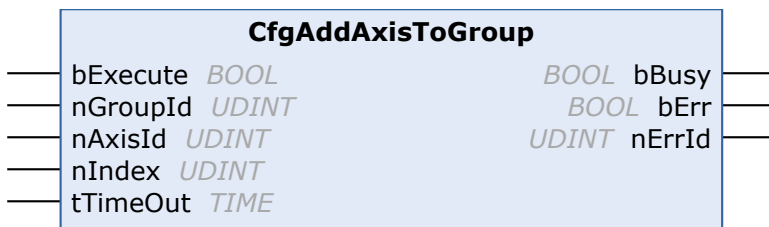
```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.1.3 CfgAddAxisToGroup



The function block CfgAddAxisToGroup configures a single axis at a particular location within an existing group (PTP, 3D, FIFO).

🔧 Inputs

```
VAR_INPUT
  bExecute      : BOOL;
  nGroupId      : UDINT;
  nAxisId       : UDINT;
  nIndex        : UDINT;
  tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nGroupId	UDINT	ID of the target group
nAxisId	UDINT	ID of the axis to be configured
nIndex	UDINT	Position of the axis within the group; can have values between 0 and n-1. Depending on the type of group, n has the following value: PTP: n = 1, 3D: n = 3, FIFO: n = 8
tTimeOut	TIME	ADS Timeout-Delay

🔌 Outputs

```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.1.4 CfgReconfigGroup



The function block CfgReconfigGroup removes the axis allocation of an existing group (NCI or FIFO), returning the axes to their personal PTP group.

🔌 Inputs

```
VAR_INPUT
  bExecute      : BOOL;
  nGroupId      : UDINT;
  tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nGroupId	UDINT	ID of the group to be resolved
tTimeOut	TIME	ADS Timeout-Delay

🔌 Outputs

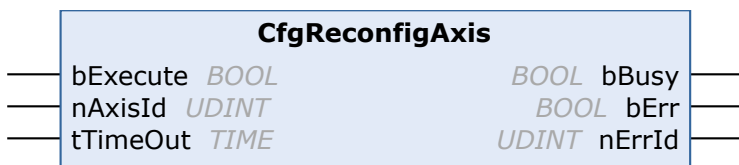
```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.1.5 CfgReconfigAxis



The function block CfgReconfigAxis returns a single axis from, for example, a 3D group, to its personal PTP group.

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    nAxisId       : UDINT;
    tTimeOut      : TIME;
END_VAR
  
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nAxisId	UDINT	ID of the axis to be returned
tTimeOut	TIME	ADS Timeout-Delay

Outputs

```

VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
  
```

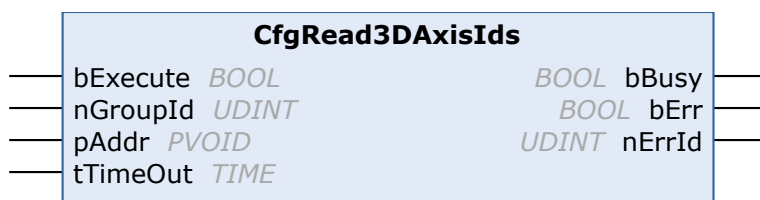
Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.

Name	Type	Description
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.1.6 CfgRead3DAxisIds



The function block CfgRead3DAxisIds reads the axis configuration of a 3D group.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nGroupId      : UDINT;
    pAddr         : PVOID;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nGroupId	UDINT	ID of the 3D group
pAddr	PVOID	Address of the variable into which the function block writes the axis IDs of the group assignment (array with three elements of type UDINT).
tTimeout	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.

Name	Type	Description
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Sample:

```

VAR
    (* instance *)
    ReadAxIds : CfgRead3DAxisIds;
    AxIds : ARRAY[1..3] OF UDINT;
END_VAR

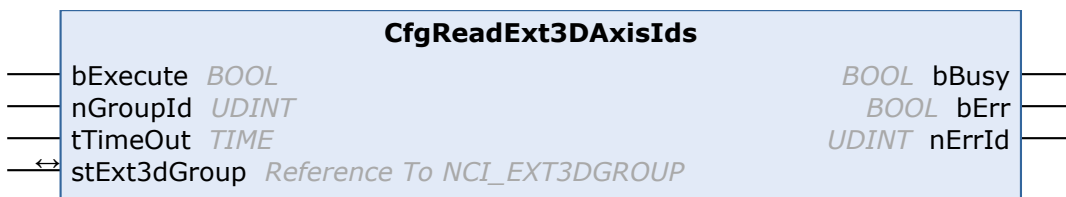
ReadAxIds( bExecute := TRUE,
           nGroupId := 4,
           pAddr := ADR( AxIds ),
           tTimeout := T#1s );

```

AxIds now contains the three axis IDs for the 3D group with the group ID 4.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.1.7 CfgReadExt3DAxisIds

The function block CfgReadExt3DAxisIds reads the axis configuration of the extended 3D group.

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    nGroupId      : UDINT;
    tTimeout      : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nGroupId	UDINT	ID of the 3D group
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```

VAR_IN_OUT
    stExt3dGroup : NCI_EXT3DGROUP;
END_VAR

```

Name	Type	Description
stExt3dGroup	NCI_EXT3DGROUP	Instance of the structure NCI_EXT3DGROUP (enter axis IDs of the current interpolation group here)

🔌 Outputs

```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```
TYPE NCI_EXT3DGROUP :
STRUCT
  nXAxisId      : UDINT;
  nYAxisId      : UDINT;
  nZAxisId      : UDINT;
  nQ1AxisId     : UDINT;
  nQ2AxisId     : UDINT;
  nQ3AxisId     : UDINT;
  nQ4AxisId     : UDINT;
  nQ5AxisId     : UDINT;
END_STRUCT
END_TYPE
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2 NCI POU's

The TwinCAT library Tc2_NCI contains function blocks for operation of the NC interpreter from the PLC.

The following function blocks are included in the library Tc2_NCI .

Function block	Description
ItpConfirmHsk [► 209]	Acknowledges an M-function of type handshake
ItpDelDtGEx [► 210]	Triggers "Delete Distance to go" in the NC
ItpEnableDefaultGCode [► 211]	Executes a user-defined standard G-Code before the start of each NC program
ItpEStopEx [► 213]	Triggers the NCI EStop
ItpGetBlockNumber [► 214]	Provides the block number of the NC program for the cyclic interface
ItpGetBottleNeckLookAheadEx [► 214]	Provides the value of the look-ahead for bottleneck detection
ItpGetBottleNeckModeEx [► 216]	Provides the response mode for bottleneck detection
ItpGetChannelId [► 217]	Provides the channel ID
ItpGetChannelType [► 217]	Provides the channel type of the cyclic interface

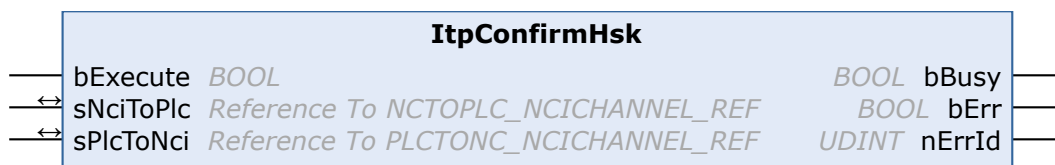
Function block	Description
ItpGetCyclicLRealOffsets [► 218]	Provides the index offset of the LREAL variables used in the cyclic channel interface
ItpGetCyclicUdintOffsets [► 220]	Provides the index offset of the UDINT variables used in the cyclic channel interface
ItpGetError [► 221]	Provides the error number
ItpGetGeoInfoAndHParamEx [► 222]	Reads information of the currently active segment and past and future segments.
ItpGetGroupAxisIds [► 223]	Provides the axis IDs that were configured for the group
ItpGetGroupId [► 224]	Provides the group ID
ItpGetHParam [► 225]	Provides the current H-parameter from the NC
ItpGetHskMFunc [► 225]	Provides the current M-function number of type handshake
ItpGetItfVersion [► 226]	Provides the current version of the cyclic interface
ItpGetOverridePercent [► 226]	Provides the channel override in percent
ItpGetSetPathVelocity [► 227]	Returns the current path set velocity
ItpGetSParam [► 228]	Provides the current S-parameter from the NC
ItpGetStateInterpreter [► 228]	Provides the current interpreter state
ItpGetTParam [► 229]	Provides the current T-parameter from the NC
ItpGoAheadEx [► 230]	Triggers the GoAhead function (decoder stop with external trigger event)
ItpHasError [► 231]	Determines whether an error is present
ItpIsFastMFunc [► 232]	Determines whether the M-function number provided is present in the form of a fast M-function
ItpIsEStopEx [► 233]	Determines whether an EStop is executed or pending
ItpIsHskMFunc [► 233]	Determines whether an M-function of type handshake is present
ItpLoadProgEx [► 234]	Loads an NC program using program names
ItpReadCyclicLRealParam1 [► 236]	Reads the first LReal parameter from the cyclic channel interface
ItpReadCyclicUdintParam1 [► 236]	Reads the first UDINT parameter from the cyclic channel interface
ItpReadRParamsEx [► 237]	Reads arithmetic parameters
ItpReadToolDescEx [► 238]	Reads the tool description from the NC
ItpReadZeroShiftEx [► 240]	Reads the zero offset shift from the NC
ItpResetEx2 [► 241]	Carries out a reset of the interpreter or of the NC channel
ItpResetFastMFuncEx [► 242]	Resets a fast signal bit
ItpSetBottleNeckLookAheadEx [► 243]	Sets the value of the look-ahead for bottleneck detection
ItpSetBottleNeckModeEx [► 245]	Sets the response mode when bottleneck detection is switched on
ItpSetCyclicLRealOffsets [► 246]	Sets the index offsets of the LREAL variables used in the cyclic channel interface
ItpSetCyclicUdintOffsets [► 247]	Sets the index offsets of the UDINT variables used in the cyclic channel interface
ItpSetOverridePercent [► 249]	Sets the channel override in percent
ItpSetSubroutinePathEx [► 250]	Optionally sets the search path for subroutines
ItpSetToolDescNullEx [► 251]	Sets all tool parameters (including number and type) to null

Function block	Description
ItpSetZeroShiftNullEx [► 252]	Set all zero offset shifts to null
ItpSingleBlock [► 253]	Enables or disables the single block mode in the NCI.
ItpStartStopEx [► 255]	Starts or stops the interpreter (NC channel)
ItpStepOnAfterEStopEx [► 256]	Enables further processing of the parts program after an NCI EStop
ItpWriteRParamsEx [► 257]	Writes arithmetic parameters
ItpWriteToolDescEx [► 259]	Writes the tool description into the NC
ItpWriteZeroShiftEx [► 260]	Writes the zero offset shift into the NC
Block search (for description of the functionality see Blocksearch [► 262])	
ItpBlocksearch [► 262]	Sets the interpreter to a user-defined location, so that NC program execution continues from this point.
ItpGetBlocksearchData [► 265]	Reads the current state after an NC program interruption.
ItpStepOnAfterBlocksearch [► 266]	Starts the motion after a block search.
Retrace	
ItpEnableFeederBackup [► 267]	Enables the backup list for retracing
ItpIsFeederBackupEnabled [► 269]	Reads whether the backup list for retracing is active
ItpIsFirstSegmentReached [► 270]	Reads whether the start position is reached during retracing
ItpIsFeedFromBackupList [► 270]	Reads whether feeder entries were sent from the backup list
ItpIsMovingBackwards [► 271]	Reads whether backward movement occurs on the current path
ItpRetraceMoveBackward [► 272]	Performs a backward movement on the path
ItpRetraceMoveForward [► 273]	Performs a forward movement on the path. This is called to cancel retracing.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.1 ItpConfirmHsk



The function block ItpConfirmHsk confirms the currently present M-function.

If the channel override is set to 0 or an E-stop is active, no M-functions are acknowledged during this time. The busy signal of ItpConfirmHsk therefore remains active and must continue to be called.

Inputs

```
VAR_INPUT
    bExecute : BOOL;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc : NCTOPLC_NCICHANNEL_REF;
    sPlcToNci : PLCTONC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).
sPlcToNci	PLCTONC_NCICHANNEL_REF	Structure of cyclic channel interface between PLC and NCI (type: PLCTONC_NCICHANNEL_REF [► 345]).

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.2 ItpDelDtgEx



The function block ItpDelDtgEx triggers "Delete distance to go". There is a more detailed description in the [Interpreter \[► 160\]](#) documentation.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [▶ 344]).

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.3 ItpEnableDefaultGCode



The function block ItpEnableDefaultGCode enables execution of a user-defined G-Code before the start of each NC program from the PLC. The default program is executed before the loaded program when the actual NC program starts.

This function block enables rotation of the coordinate system for all NC programs to be executed, for example.

The standard G-Code must be stored as "DefaultGCode<Channel-Number>.def" in the TwinCAT\Mc\Nci directory.

Inputs

```
VAR_INPUT
  bExecute      : BOOL;
  bUseDefaultGCode : BOOL;
  tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
bUseDefaultGCode	BOOL	If this variable is TRUE, the default G-Code is activated through a rising edge at bExecute. If the variable is FALSE, the default G-Code is disabled.
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
  sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).



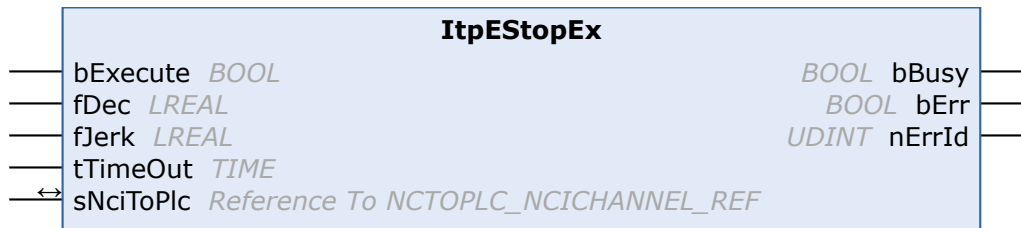
Not available for GST

This function block is not available if the GST interpreter is used.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.4 ItpEStopEx



The function block ItpEStopEx triggers the NCI EStop and enables a controlled stop on the path. The limit values for the deceleration and the jerk are transferred as parameters. If these should be smaller than the currently active dynamic parameters, the transferring parameters are rejected.

 Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    fDec          : LREAL;
    fJerk         : LREAL;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
fDec	LREAL	Max. deceleration during stopping. If fDec is smaller than the currently active deceleration, fDec is rejected. This ensures that the deceleration occurs at least with the standard ramp.
fJerk	LREAL	Max. jerk during stopping. If fJerk is smaller than the currently active jerk, fJerk is rejected.
tTimeOut	TIME	ADS Timeout-Delay

 Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

 Outputs

```
VAR_OUTPUT
    bBusy          : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.

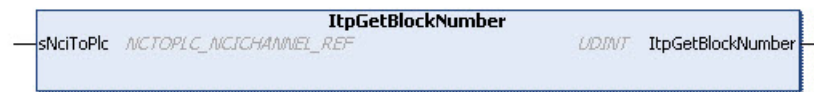
Name	Type	Description
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

See also [ItpStepOnAfterEStopEx](#) [► 256].

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.5 ItpGetBlockNumber



The function ItpGetBlockNumber returns the block number of the NC program for the cyclic interface.

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetBlockNumber	UDINT	Block number of the active geometry segment

Sample

```

VAR
    nBlockNumber      : UDINT;
    sNciToPlc AT%I*    : NCTOPLC_NCICHANNEL_REF;
END_VAR

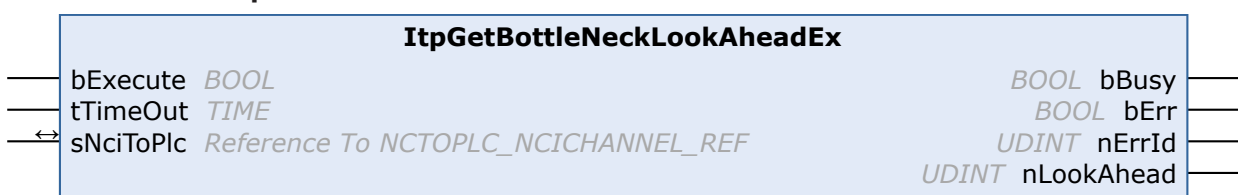
nBlockNumber := ItpGetBlockNumber(sNciToPlc);

```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.6 ItpGetBottleNeckLookAheadEx



The function block `ItpGetBottleNeckLookAheadEx` determines the maximum size of the look-ahead for the bottleneck detection (contour collision monitoring).

A more detailed description can be found in the [Interpreter \[► 193\]](#) documentation.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: <code>NCTOPLC_NCICHANNEL_REF [► 344]</code>).

Outputs

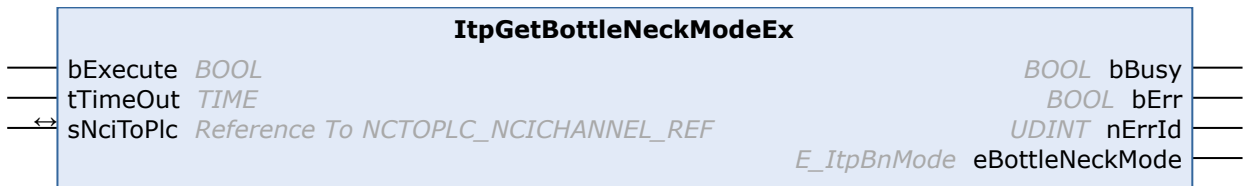
```
VAR_OUTPUT
    bBusy          : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
    nLookAhead     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. If the function block has a timeout error, 'Error' is TRUE and 'nErrId' is 1861 (hexadecimal 0x745). Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).
nLookAhead	UDINT	Value of the look-ahead for bottleneck detection

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.7 ItpGetBottleNeckModeEx



The function block `ItpGetBottleNeckModeEx` reads the behavior in the event of a contour collision (bottleneck).

A more detailed description can be found in the [Interpreter \[► 193\]](#) documentation.

➡ Inputs

```
VAR_INPUT
    bExecute          : BOOL;
    tTimeOut          : TIME;
END VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeOut	TIME	ADS Timeout-Delay

 / **Inputs/Outputs**

```
VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
  eBottleNeckMode : E_ItpBnMode
END VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. If the function block has a timeout error, 'Error' is TRUE and 'nErrId' is 1861 (hexadecimal 0x745). Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Name	Type	Description
eBottleNeckMode	E_ItpBnMode	Enum for the behavior in the event of a contour collision

```
TYPE E_ItpBnMode:
```

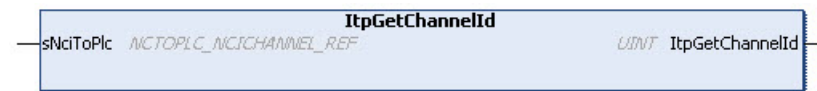
```
(
    ItpBnm_Abort := 0,
    ItpBnm_Adjust := 1,
    ItpBnm_Leave := 2
);
```

```
END_TYPE
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.8 ItpGetChannelId



The function ItpGetChannelId determines the channel ID from the cyclic interface.

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetChannelId	UDINT	Channel ID

Sample

```
VAR
    nChnId          : UDINT;
    sNciToPlc AT%I* : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

```
nChnId := ItpGetChannelId( sNciToPlc );
```

see also: [ItpGetGroupId](#) [► 224]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.9 ItpGetChannelType



The function ItpGetChannelType returns the channel type of the cyclic interface.

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetChannelType	E_ItpChannelType	Channel type

```
TYPE E_ItpChannelType :
(
    ItpChannelTypeNone,
    ItpChannelTypeInterpreter,
    ItpChannelTypeKinematic,
    ItpChannelType_InvalidItfVer := 16#4B14 (*ErrTcNciItp_ItfVersion the cyclic channel interface does not match to the requested function/fb *)
);
END_TYPE
```

Sample

```
VAR
    nChannelType      : E_ItpChannelType;
    sNciToPlc AT%I*   : NCTOPLC_NCICHANNEL_REF;
END_VAR

nChannelType := ItpGetChannelType( sNciToPlc );
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.10 ItpGetCyclicLrealOffsets



The function block ItpGetCyclicLrealOffsets is used to read the current configuration of the cyclic channel interface for LREAL variables.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
  sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
  bBusy          : BOOL;
  bErr           : BOOL;
  nErrId         : UDINT;
  nIndexOffsetParam1 : UDINT;
  nIndexOffsetParam2 : UDINT;
  nIndexOffsetParam3 : UDINT;
  nIndexOffsetParam4 : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).
nIndexOffsetParam1	UDINT	Group state (Index Offset) for parameter 1
nIndexOffsetParam2	UDINT	Group state (Index Offset) for parameter 2
nIndexOffsetParam3	UDINT	Group state (Index Offset) for parameter 3
nIndexOffsetParam4	UDINT	Group state (Index Offset) for parameter 4

See also:

- [ItpReadCyclicLRealParam1](#) [► 236]
- [ItpSetCyclicLRealOffsets](#) [► 246]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.11 ItpGetCyclicUDintOffsets



The function block `ItpGetCyclicUDintOffsets` is used to read the current configuration of the cyclic channel interface for UDINT variables.

Inputs

```
VAR_INPUT
    bExecute           : BOOL;
    tTimeOut           : TIME;
END VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeOut	TIME	ADS Timeout-Delay

/ Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
    bBusy          : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
    nIndexOffsetParam1 : UDINT;
    nIndexOffsetParam2 : UDINT;
    nIndexOffsetParam3 : UDINT;
    nIndexOffsetParam4 : UDINT;
END VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.

Name	Type	Description
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).
nIndexOffsetParam 1	UDINT	Group state (<u>Index Offset</u>) for parameter 1
nIndexOffsetParam 2	UDINT	Group state (<u>Index Offset</u>) for parameter 2
nIndexOffsetParam 3	UDINT	Group state (<u>Index Offset</u>) for parameter 3
nIndexOffsetParam 4	UDINT	Group state (<u>Index Offset</u>) for parameter 4

See also:

- [ItpReadCyclicUdintParam1 \[► 236\]](#)
- [ItpSetCyclicUdintOffsets \[► 247\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.12 ItpGetError

The function ItpGetError returns the error number, see description of [NC error codes](#).

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetError	UDINT	Error number



ItpGetError evaluates the variable 'nItpErrCode' from the cyclic interface.

Example

```

VAR
    bItpError      : BOOL;
    nErrId         : UDINT;
    sNciToPlc AT%I*: NCTOPLC_NCICHANNEL_REF;
END_VAR

```

```

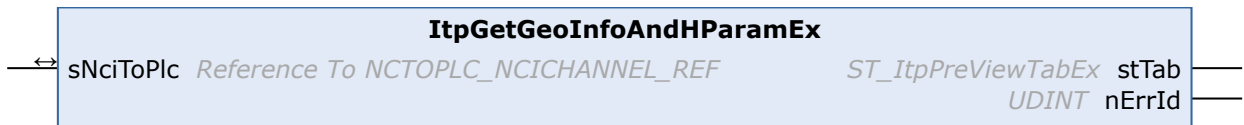
bItpError := ItpHasError( sNciToPlc );
IF bItpError THEN
    nErrId := ItpGetError( sNciToPlc );
    ...
END_IF

```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.13 ItpGetGeoInfoAndHParamEx



The function block `ItpGetGeoInfoAndHParamEx` reads information of the currently active segment, as well as past and future segments. These include block number, H-parameter and residual path length on the segment.

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: <code>NCTOPLC_NCICHANNEL_REF</code> [► 344]).

Outputs

```

VAR_OUTPUT
    stTab          : ST_ItpPreViewTabEx;
    nErrId         : UDINT;
END_VAR

```

Name	Type	Description
stTab	ST_ItpPreViewTabEx	Structure containing the segment data. See <code>ST_ItpPreViewTabEx</code> [► 222] .
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in <code>nErrId</code> can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

ST_ItpPreViewTabEx

```

TYPE ST_ItpPreViewTabEx :
STRUCT
    nDcTime          : UDINT := 0;
    nReserved        : UDINT := 0;
    arrLines         : ARRAY[1..NCI_MAX_PREVIEWTABLINES] OF ST_ItpPreViewTabLine;
END_STRUCT
END_TYPE

```

Name	Type	Description
nDcTime	UDINT	Current timestamp in ns. This timestamp can be used in synergy with the <code>Tc2_NciXFC</code> library.
nReserved	UDINT	

Name	Type	Description
arrLines	ARRAY[1..NCI_MAX_P REVIEWTABLINES] OF ST_ItpPreViewTabLine	Array of segment-related information (size 20). The entry at position 11 of the array corresponds to the currently active segment. Segments that have already been processed are displayed at positions 1-10 of the array, future segments at positions 12-20. See ST_ItpPreViewTabLine [► 223].

ST_ItpPreViewTabLine

```

TYPE ST_ItpPreViewTabLine :
STRUCT
    fLength          : LREAL := 0.0;
    nBlockNo         : UDINT := 0;
    nHParam          : UDINT := 0;
    nEntryID         : UDINT := 0;
    nReserved        : UDINT := 0;
END_STRUCT
END_TYPE

```

Name	Type	Description
fLength	LREAL	Remaining segment length. For segments that are not yet active this corresponds to the total segment length. For past segments the distance moved since the end of the segment is specified.
nBlockNo	UDINT	Block number programmed by the user
nHParam	UDINT	Value of the H-parameter [► 169] that is active from the start of the next segment.
nEntryID	UDINT	Command ID generated by the system
nReserved	UDINT	

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.14 ItpGetGroupAxisIds



ItpGetGroupAxisIds is a function that returns an array of axes IDs that were configured for the group.

Inputs/Outputs

```

FUNCTION ItpGetGroupAxisIds
VAR_IN_OUT
    sNciToPlc AT%I* : NCTOPLC_NCICHANNEL_REF;
    nNciAxisIds    : ARRAY[1..8] OF DWORD;
END_VAR

```

Name	Type	Description
nNciAxisIds	ARRAY[1..8] OF DWO RD	Array of axis IDs
sNciToPlc	NCTOPLC_NCICHANN EL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is only accessed for reading. (Type NCTOPLC_NCICHANNEL_REF [► 344])

Return value

Name	Type	Description
ItpGetGroupAxisIds	DWORD	Error number



ItpGetGroupAxisIds evaluates the information of the variable 'nAcsAxisIDs[8]' from the cyclic interface.

Example

```
VAR
    nNciAxisIds      : ARRAY[1..8] OF DWORD;
    sNciToPlc AT%I*  : NCTOPLC_NCICHANNEL_REF;
    nVersionErr      : DWORD;
END_VAR

nVersionErr := ItpGetGroupAxisIds(nNciAxisIds, sNciToPlc );
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.15 ItpGetGroupId



The function ItpGetGroupId determines the group ID from the cyclic interface.

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetGroupId	UINT	Group ID

Example

```
VAR
    nGrpId      : UINT;
    sNciToPlc AT%I* : NCTOPLC_NCICHANNEL_REF;
END_VAR

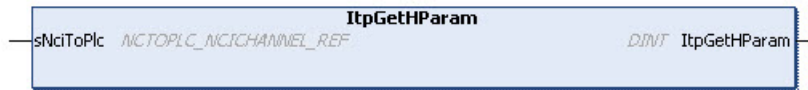
nGrpId := ItpGetGroupId( sNciToPlc );
```

See also: [ItpGetChannelId](#) [► 217]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.16 ItpGetHParam



The function ItpGetHParam returns the current H-parameter.

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetHParam	DINT	H parameter



ItpGetHParam evaluates the variable 'nHFuncValue' from the cyclic interface.

Example

```

VAR
    nHParam      : DINT;
    sNciToPlc AT%I*: NCTOPLC_NCICHANNEL_REF;
END_VAR

nHParam := ItpGetHParam( sNciToPlc );

```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.17 ItpGetHskMFunc



The function ItpGetHskMFunc supplies the number of the M-function of type handshake.

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetHskMFunc	INT	Number of the M-function



ItpGetHskMFunc evaluates the variable 'nHskMFuncNo' from the cyclic interface.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.18 ItpGetItfVersion



The function ItpGetItfVersion determines the version number of the cyclic interface.

Inputs/Outputs

```
VAR_IN_OUT
  sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetItfVersion	UINT	Version number of the cyclic interface

Example

```
VAR
  nItfVer      : UINT;
  sNciToPlc AT%I*: NCTOPLC_NCICHANNEL_REF;
END_VAR

nItfVer := ItpGetItfVersion( sNciToPlc );
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.19 ItpGetOverridePercent



The `ItpGetOverridePercent` function returns the axis channel override as a percentage. It is essential to remember that this is not a value from the NC. The value, which is transferred as set value to the NC, is evaluated.

Inputs/Outputs

```
VAR_IN_OUT
  sPlcToNci          : PLCTONC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sPlcToNci	PLCTONC_NCICHANNEL_REF	Structure of cyclic channel interface between PLC and NCI (type: <code>PLCTONC_NCICHANNEL_REF</code> ▶ 345)

Return value

Name	Type	Description
<code>ItpGetOverridePercent</code>	LREAL	Override in percent

Example

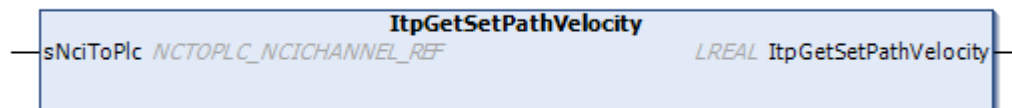
```
VAR
  sPlcToNci AT%Q*: PLCTONC_NCICHANNEL_REF;
  fOverride   : LREAL;
END_VAR

fOverride := ItpGetOverridePercent( sPlcToNci );
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.20 ItpGetSetPathVelocity



The function `ItpGetSetPathVelocity` reads the current path set velocity from the cyclic interface.

Inputs/Outputs

```
VAR_IN_OUT
  sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: <code>NCTOPLC_NCICHANNEL_REF</code> ▶ 344).

Return value

Name	Type	Description
<code>ItpGetSetPathVelocity</code>	LREAL	Current bath set velocity

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.21 ItpGetSParam



The function ItpGetSParam returns the current S-parameter.

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetSParam	UINT	S parameter



ItpGetSParam evaluates the variable 'nSpindleRpm' from the cyclic interface.

Example

```

VAR
    nSParam          : UINT;
    sNciToPlc AT%I* : NCTOPLC_NCICHANNEL_REF;
END_VAR

nSParam := ItpGetSParam( sNciToPlc );

```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.22 ItpGetStateInterpreter



The function ItpGetStateInterpreter returns the interpreter state.

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetStateInterpreter	UDINT	Current Interpreter state [► 17]



ItpGetStateInterpreter evaluates the variable 'nItpState' from the cyclic interface.

Example

```
VAR
    nItpState      : UDINT;
    sNciToPlc AT%I*: NCTOPLC_NCICHANNEL_REF;
END_VAR
nItpState := ItpGetStateInterpreter( sNciToPlc );
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.23 ItpGetTParam



The function ItpGetTParam returns the current T-parameter.

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpGetTParam	UINT	T parameter



ItpGetTParam evaluates the variable 'nTool' from the cyclic interface.

Example

```

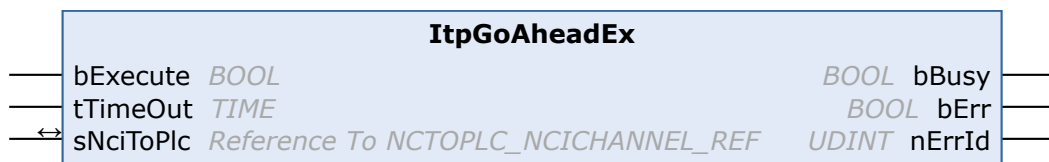
VAR
    nTParam      : UINT;
    sNciToPlc AT%I*: NCTOPLC_NCICHANNEL_REF;
END_VAR

nTParam := ItpGetTParam( sNciToPlc );

```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.24 ItpGoAheadEx

The function block ItpGoAheadEx may only be used in association with the decoder stop '@717' [► 170]. There is a more detailed description of this decoder stop in the [interpreter documentation](#) [► 127].

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    tTimeOut      : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```

VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR

```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.

Name	Type	Description
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.25 ItpHasError



The function ItpHasError determines whether the interpreter is in an error state.

Inputs/Outputs

```
VAR_IN_OUT
  sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpHasError	BOOL	If there is an error, the function returns TRUE.



ItpHasError evaluates the variable 'nItpErrCode' from the cyclic interface. If this value does not equal 0, TRUE is returned.

Example

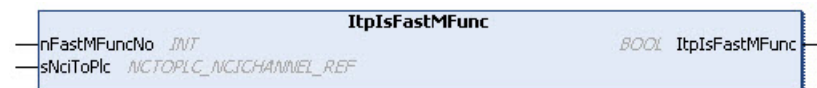
```
VAR
  bItpError      : BOOL;
  sNciToPlc AT%I*: NCTOPLC_NCICHANNEL_REF;
END_VAR

bItpError := ItpHasError( sNciToPlc );
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.26 ItpIsFastMFunc



The function ItpIsFastMFunc determines whether the fast M-function is set for the supplied M-function number.

Inputs

```
FUNCTION ItpIsFastMFunc
```

```
VAR_IN
    nFastMFuncNo    : INT;
END_VAR
```

Name	Type	Description
nFastMFuncNo	BOOL	Number of the M-function that is to be checked.

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF ▶ 344).

Return value

Name	Type	Description
ItpIsFastMFunc	BOOL	The function returns TRUE if the fast bit of the M-function is set.



ItpIsFastMFunc evaluates the variable 'nFastMFuncMask' from the cyclic interface.

Example

```
(*this enum is defined by the user *)

TYPE FastMFuncs:
(
    M10_CoolingFluidOn := 10, (*fast M-Funktion M10*)
    M11_CoolingFluidOff := 11,
    M12_FanOn := 12,
    M13_FanOff := 13
);
END_TYPE

VAR
    sNciToPlc AT%I*: NCTOPLC_NCICHANNEL_REF
    enFastMFuncs : FastMFuncs;
    bTurnFanOn   : BOOL;
END_VAR

bTurnFanOn := ItpIsFastMFunc( M12_FanOn, sNciToPlc );
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.27 ItplsEStopEx



The function ItplsEStopEx indicates whether an EStop command was triggered.

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItplsEStopEx	BOOL	If the return value is TRUE, then an EStop was previously executed (e.g. ItpEStopEx). The flag does not provide information as to whether the axes have already stopped or are still on the deceleration ramp. After execution of ItpStepOnAfterEStopEx , ItplsEStopEx returns FALSE again.



ItplsEStopEx evaluates the cyclic interface.

See also:

[ItpEStopEx \[► 213\]](#)

[ItpStepOnAfterEStopEx \[► 256\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.28 ItplsHskMFunc



The function ItplsHskMFunc determines whether an M-function of type handshake is present.

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [▶ 344]).

Return value

Name	Type	Description
ItpIsHskMFunc	BOOL	The function returns TRUE if an M-function of type handshake is present.



ItpIsHskFunc evaluates the variable 'nHskMFuncReq' from the cyclic interface.

Example

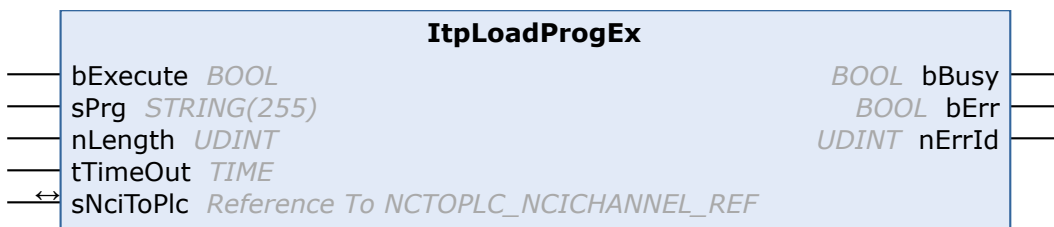
```
VAR
    bMFuncRequest      : BOOL;
    sNciToPlc AT%I*    : NCTOPLC_NCICHANNEL_REF;
END_VAR

bMFuncRequest := ItpIsHskMFunc( sNciToPlc );
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.29 ItpLoadProgEx



The ItpLoadProgEx function block loads the desired NC program.

The text file containing the NC program must be coded in ANSI or UTF-8 format. Other text encodings (e.g. UTF-8-BOM) may contain hidden special characters that lead to syntax errors.

If no file path is specified, the NC program is searched for in the default directory.

This is from TwinCAT 3.1 Build 4026:

C:\ProgramData\Beckhoff\TwinCAT\Mc\Nci
and for previous versions: C:\TwinCAT\Mc\Nci.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    sPrg          : STRING(255);
    nLength       : UDINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The function block reads the NC program when a rising edge is encountered.
sPrg	STRING(255)	Name of the NC program that is loaded.

Name	Type	Description
nLength	UDINT	String length of the program name
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [▶ 344]).

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Example

```
VAR
    in_stItpToPlc AT %I*      : NCTOPLC_NCICHANNEL_REF;
    fbLoadProg               : ItpLoadProgEx;
    sProgramPath              : STRING (255) := 'TestIt.nc';
END_VAR

fbLoadProg(
    bExecute := TRUE,
    sPrg     := sProgramPath,
    nLength  := LEN(sProgramPath),
    tTimeOut := t#200ms,
    sNciToPlc := in_stItpToPlc
);
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.30 ItpReadCyclicLRealParam1



The function ItpReadCyclicLRealParam1 reads the first LREAL parameter from the cyclic channel interface. This parameter is configured previously with [ItpSetCyclicLRealOffsets](#) [► 246].

Parameter 2 to 4 are read via the same mechanism (e.g. ItpReadCyclicLRealParam2).

Inputs/Outputs

```
VAR_IN_OUT
  sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpReadCyclicLRealParam1	LREAL	Return value Parameter 1 of type LREAL

See also:

- [ItpReadCyclicUdintParam1](#) [► 236]
- [ItpSetCyclicLRealOffsets](#) [► 246]
- [ItpGetCyclicLRealOffsets](#) [► 218]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.31 ItpReadCyclicUdintParam1



The function ItpReadCyclicUdintParam1 reads the first UDINT parameter from the cyclic channel interface. This parameter is configured previously with [ItpSetCyclicUdintOffsets](#) [► 247].

Parameter 2 to 4 are read via the same mechanism (e.g. ItpReadCyclicUdintParam2).

Inputs/Outputs

```
VAR_IN_OUT
  sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Return value

Name	Type	Description
ItpReadCyclicUdintParam1	UDINT	Return value Parameter 1 of type UDINT

See also:

- [ItpReadCyclicLRealParam1 \[► 236\]](#)
- [ItpSetCyclicUdintOffsets \[► 247\]](#)
- [ItpGetCyclicUdintOffsets \[► 220\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.32 ItpReadRParamsEx



The function block ItpReadRParamsEx reads arithmetic parameters, in short R-parameters, of the NC, see [exact description of the arithmetic parameters \[► 135\]](#). A total of 1000 R-parameters are available, of which the first 900 (0..899) are local, so that they are only visible in the current NC channel. The other 100 (900..999) R-parameters are global, and are thus visible from anywhere in the NC.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    pAddr         : PVOID;
    nIndex        : DINT;
    nCount        : DINT;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	A rising edge starts the read operation.
pAddr	PVOID	Address of the target variables of the data to be read. Data are written directly from the specified address, i.e. nIndex is not to be interpreted as offset from pAddr. The data are usually stored in an array of type LREAL, which has to be defined by the user.
nIndex	DINT	Describes the index of the R-parameter to be read from an NC perspective.
nCount	DINT	Number of R-parameters to be read
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

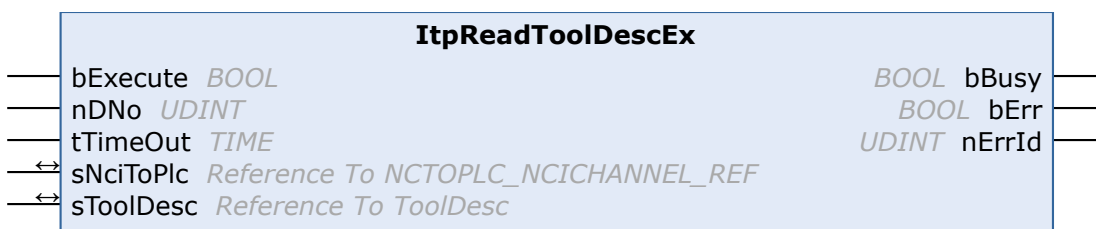
```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.33 ItpReadToolDescEx



The function block ItpReadToolDescEx reads the tool parameters for the supplied D-word.

Inputs

```
VAR_INPUT
    bExecute    : BOOL;
    nDNo        : UDINT;
    tTimeOut    : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	A rising edge starts the read operation.
nDNo	UDINT	D-word for which the tool parameters are to be read. nDNo can have values between 1 and 255.
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
    sToolDesc      : ToolDesc;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is only accessed for reading.
sToolDesc	ToolDesc	A structure into which the tool parameters of nDNo are written. The meaning of the parameters depends on the tool type, and can be found in the tool data [► 181] (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```
TYPE ToolDesc:
STRUCT
    nToolNumber    : UDINT; (*valid range from 0 .. 65535*)
    nToolType      : UDINT;
    fParam         : ARRAY [2..15] OF LREAL;
END_STRUCT
END_TYPE
```

See also:

[ltpWriteToolDescEx \[► 259\]](#)

[ltpSetToolDescNullEx \[► 251\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.34 ItpReadZeroShiftEx



The function block ItpReadZeroShiftEx reads the shift components X, Y and Z for the given zero offset shift.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nZsNo         : UDINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	A rising edge starts the read operation.
nZsNo	UDINT	Number of the zero offset shift. G54 to G59 are zero offset shifts at the NC. The valid range of values for 'nZsNo' is therefore from 54 to 59.
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
    sZeroShiftDesc : ZeroShiftDesc;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).
sZeroShiftDesc	ZeroShiftDesc	The structure containing the components of the zero offset shift

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.

Name	Type	Description
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```

TYPE ZeroShiftDesc:
STRUCT
    fShiftX      : LREAL;
    fShiftY      : LREAL;
    fShiftZ      : LREAL;
END_STRUCT
END_TYPE

```



For reasons of compatibility, there are two entries (coarse and fine) for each axis in each zero offset shift (e.g. G54). These two entries must be added together. This function block evaluates both the entries and adds them together automatically.

See also:

[ItpWriteZeroShiftEx](#) [► 260]

[ItpSetZeroShiftNullEx](#) [► 252]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.35 ItpResetEx2



The function block 'ItpResetEx2' executes a channel reset, which deletes all existing tables of the NC channel. In contrast to the outdated function block ItpReset, an active channel is stopped first, before the reset is executed. This simplifies programming in the PLC, since no explicit check is necessary to ascertain whether the axes are still in motion.

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    tTimeout      : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeout	TIME	ADS timeout delay (the bBusy signal can be active for longer than tTimeout)

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

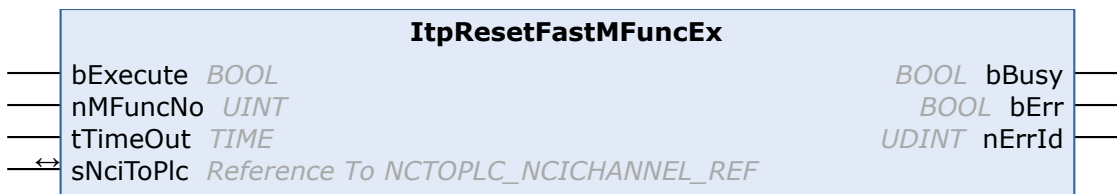
```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.36 ItpResetFastMFuncEx



The fast M-function [► 165] nMFuncNo is reset with a rising edge at input bExecute. In the event of the M-function not being available, **no** error is returned.

The function block ItpResetFastMFuncExItpResetFastMFuncEx represents an alternative to Auto-reset or reset with another M-function (reset list during parameterization of the M-function). For reasons of transparency, mixed resets using an M-function and this function block should be avoided.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nMFuncNo      : UINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.

Name	Type	Description
nMFuncNo	UINT	Flying M-function that is to be reset.
tTimeOut	TIME	ADS timeout delay (the bBusy signal can be active for longer than tTimeOut)

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

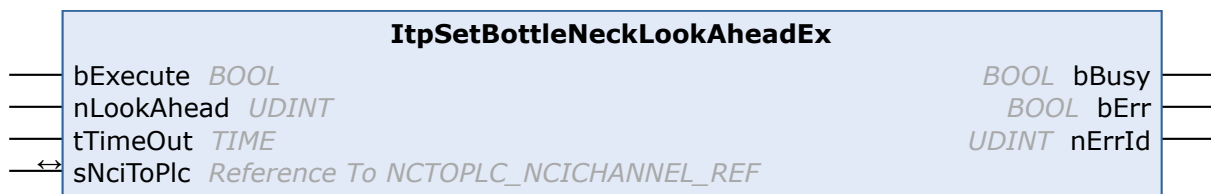
```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.37 ItpSetBottleNeckLookAheadEx



The function block ItpSetBottleNeckLookAheadEx determines the maximum number of segments the system may look ahead for bottleneck detection (contour collision monitoring). Note that segments, which were added as a result of radius compensation (e.g. additional segments at acute angles) are taken into account.

A more detailed description can be found in the [Interpreter \[\[► 193\]\(#\)\]](#) documentation.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nLookAhead    : UDINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nLookAhead	UDINT	Specifies the look-ahead value
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF ▶ 344).

Outputs

```
VAR_OUTPUT
    bBusy          : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).



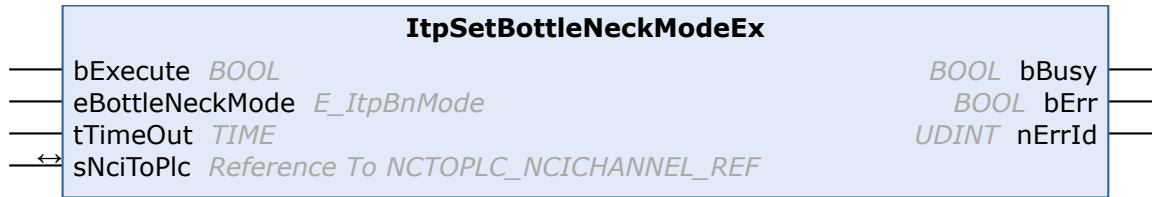
Not available for GST

This function block is not available if the GST interpreter is used.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.38 ItpSetBottleNeckModeEx



The function block ItpSetBottleNeckModeEx reads the behavior in the event of a contour collision (bottleneck).

A more detailed description can be found in the [Interpreter \[► 193\]](#) documentation.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    eBottleNeckMode : E_ItpBnMode;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
eBottleNeckMode	E_ItpBnMode	Enum for the behavior in the event of a contour collision
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```

TYPE E_ItpBnMode:
(
    ItpBnm_Abort    := 0,
    ItpBnm_Adjust  := 1,
    ItpBnm_Leave    := 2
);
END_TYPE

```



Not available for GST

This function block is not available if the GST interpreter is used.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.39 ItpSetCyclicLrealOffsets



The function block ItpSetCyclicLrealOffsets is used to describe the cyclic channel interface for the 4 freely configurable LREAL variables. Variables (index offsets) can be selected from the group state.

The functionality is only active if nIndexOffsetParam1 is not equal 0.

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    tTimeOut      : TIME;
    nIndexOffsetParam1 : UDINT;
    nIndexOffsetParam2 : UDINT;
    nIndexOffsetParam3 : UDINT;
    nIndexOffsetParam4 : UDINT;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeOut	TIME	ADS Timeout-Delay
nIndexOffsetParam 1	UDINT	Group state (<u>Index Offset</u>) for parameter 1
nIndexOffsetParam 2	UDINT	Group state (<u>Index Offset</u>) for parameter 2
nIndexOffsetParam 3	UDINT	Group state (<u>Index Offset</u>) for parameter 3
nIndexOffsetParam 4	UDINT	Group state (<u>Index Offset</u>) for parameter 4

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

See also:

- [ItpReadCyclicLRealParam1 \[► 236\]](#)
- [ItpGetCyclicLRealOffsets \[► 218\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.40 ItpSetCyclicUdintOffsets



The function block ItpSetCyclicUdintOffsets is used to describe the cyclic channel interface for the 4 freely configurable UDINT variables. Variables (index offsets) can be selected from the group state.

The functionality is only active if nIndexOffsetParam1 is not equal 0.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    tTimeOut      : TIME;
```

```

nIndexOffsetParam1 : UDINT;
nIndexOffsetParam2 : UDINT;
nIndexOffsetParam3 : UDINT;
nIndexOffsetParam4 : UDINT;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeOut	TIME	ADS Timeout-Delay
nIndexOffsetParam 1	UDINT	Group state (Index Offset) for parameter 1
nIndexOffsetParam 2	UDINT	Group state (Index Offset) for parameter 2
nIndexOffsetParam 3	UDINT	Group state (Index Offset) for parameter 3
nIndexOffsetParam 4	UDINT	Group state (Index Offset) for parameter 4

Inputs/Outputs

```

VAR_IN_OUT
  sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```

VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR

```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

See also:

- [ItpReadCyclicUdintParam1](#) [\[► 236\]](#)
- [ItpGetCyclicUdintOffsets](#) [\[► 220\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.41 ItpSetOverridePercent



The function ItpSetOverridePercent writes the axes channel override into the cyclic interface of the NCI. The override is passed as a percentage.

Inputs

```

FUNCTION ItpSetOverridePercent
VAR_INPUT
    fOverridePercent : LREAL;
END_VAR
  
```

Name	Type	Description
fOverridePercent	LREAL	Axis channel override as a percentage

Inputs/Outputs

```

VAR_IN_OUT
    sPlcToNci : PLCTONC_NCICHANNEL_REF;
END_VAR
  
```

Name	Type	Description
sPlcToNci	PLCTONC_NCICHANNEL_REF	Structure of cyclic channel interface between PLC and NCI (type: PLCTONC_NCICHANNEL_REF [► 345])

Return value

Name	Type	Description
ItpSetOverridePercent	BOOL	always TRUE

Example

```

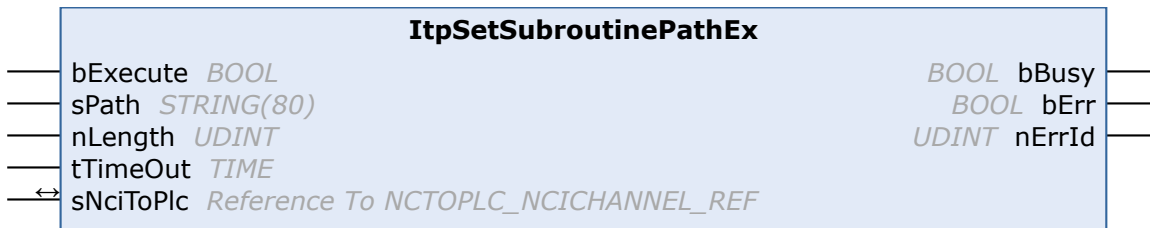
VAR
    sPlcToNci AT%Q*: PLCTONC_NCICHANNEL_REF;
    fOverride : LREAL;
END_VAR

fOverride := 47.11;
ItpSetOverridePercent( fOverride, sPlcToNci );
  
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.42 ItpSetSubroutinePathEx



With function block ItpSetSubroutinePathEx, the search path for subroutines can optionally be set.

If a subroutine still has to be integrated, the file is searched in the following order:

1. Optional search path (ItpSetSubroutinePath)
2. Path from which the main program was loaded
3. *TwinCAT\Mc\Nci* directory

Only one optional path can take effect, which remains active until it is overwritten with another path or an empty string.

After a TwinCAT restart, the path has to be re-assigned.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    sPath         : STRING;
    nLength       : UDINT;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
sPath	STRING	Optional path for subroutines. Is disabled with an empty string.
nLength	UDINT	String length
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
    bBusy         : BOOL;
    bErr          : BOOL;
    nErrId        : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new

Name	Type	Description
		command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).



Not available for GST

This function block is not available if the GST interpreter is used.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.43 ItpSetToolDescNullEx



The function block ItpSetToolDescNullEx overwrites all tool parameters (incl. number & type) of the channel with zero.



Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	A rising edge results in overwriting of all tool parameters of the NC channel with zero.
tTimeout	TIME	ADS Timeout-Delay



Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [▶ 344]).

🔌 Outputs

```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

See also:

[ItpWriteToolDescEx](#) [► 259]

[ItpReadToolDescEx](#) [► 238]



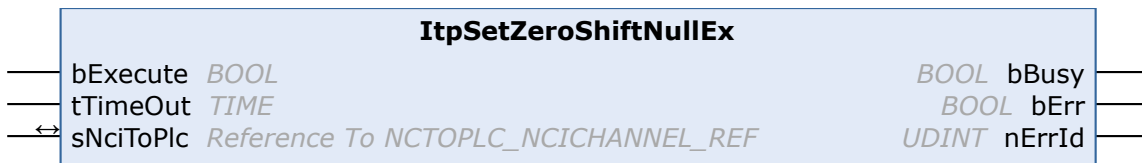
Not available for GST

This function block is not available if the GST interpreter is used.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.44 ItpSetZeroShiftNullEx



The function block ItpSetZeroShiftNullEx overwrites all zero offset shifts of the channel with zero.

🔌 Inputs

```
VAR_INPUT
  bExecute      : BOOL;
  tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	A rising edge results in overwriting of all zero offset shifts of the NC channel with zero.
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
  sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

See also:

- [ItpWriteZeroShiftEx](#) [► 260],
- [ItpReadZeroShiftEx](#) [► 240].



Not Available for GST

This function block is not available if the GST interpreter is employed.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.45 ItpSingleBlock



The function block ItpSingleBlock enables or disables single block mode in the NCI. Block relaying can be triggered directly from the PLC with the input 'bTriggerNext'. Alternatively the Start button of the interpreter (F5) can be used in the XAE.

A more detailed description can be found in the [Interpreter documentation](#) [► 134].

Inputs

```
VAR_INPUT
    bExecuteModeChange : BOOL;
    nMode                : E_ItpSingleBlockMode;
    bTriggerNext         : BOOL;
    tTimeout             : TIME;
END_VAR
```

Name	Type	Description
bExecuteModeChange	BOOL	Single block mode (nMode) is activated through a rising edge at this input.
nMode	E_ItpSingleBlockMode	Operation mode for single block (cf. single block mode): - ItpSingleBlockOff: Single block off - ItpSingleBlockNck: Single block in NC kernel - ItpSingleBlockIntp: Single block in interpreter
bTriggerNext	BOOL	Block relaying is triggered by a rising edge at this input.
tTimeout	TIME	ADS Timeout-Delay



ItpSingleBlockIntp is not available when using the GST interpreter.

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

```
TYPE E_ItpSingleBlockMode:
(
    ItpSingleBlockOff := 0,
    ItpSingleBlockNck := 1,
    ItpSingleBlockIntp := 16#4000
);
END_TYPE
```

Outputs

```
VAR_OUTPUT
    bBusy : BOOL;
    bErr  : BOOL;
    nErrId : UDINT;
END_VAR
```

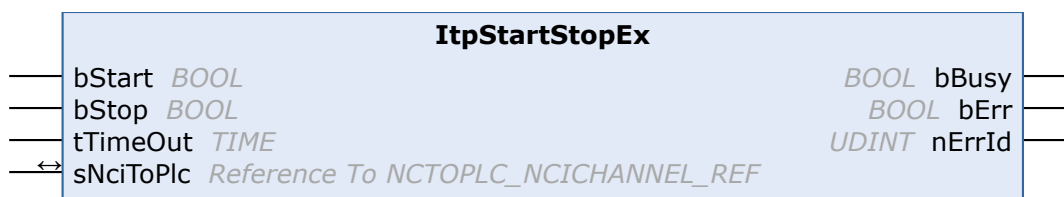
Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.

Name	Type	Description
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.46 ItpStartStopEx



The function block ItpStartStopEx starts or stops the NC channel.

Inputs

```

VAR_INPUT
    bStart      : BOOL;
    bStop       : BOOL;
    tTimeOut    : TIME;
END_VAR
  
```

Name	Type	Description
bStart	BOOL	A positive edge starts the NC channel.
bStop	BOOL	A positive edge stops the NC channel. A stop command deletes all the tables in the NC and brings the axes to a controlled halt.
tTimeOut	TIME	ADS Timeout-Delay



The bStop input has a higher priority than the bStart input, so that if both inputs receive a positive edge, a channel stop will be executed.

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
  
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

🔌 Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.47 ItpStepOnAfterEStopEx



The function block ItpStepOnAfterEStopEx enables further processing of the parts program after a programmed EStopEx.

🔌 Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeOut	TIME	ADS Timeout-Delay

🔌 / 🔌 Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

🔌 Outputs

```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

See also:

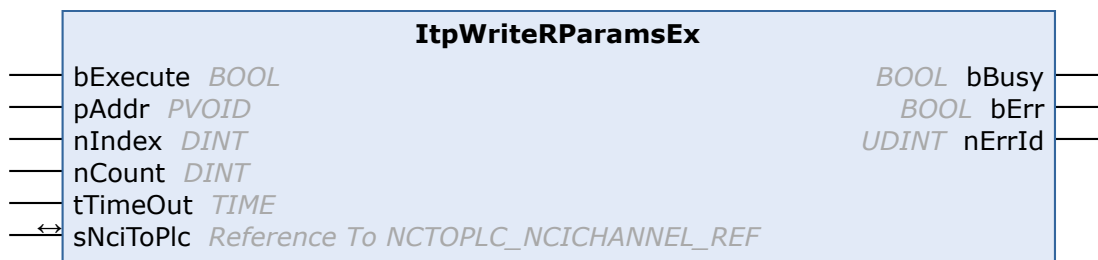
[ItpEStopEx \[► 213\]](#)

[ItpIsEStopEx \[► 233\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.48 ItpWriteRParamsEx



The function block ItpWriteRParamsEx writes R-parameters into the NC.

🔌 Inputs

```
VAR_INPUT
  bExecute    : BOOL;
  pAddr       : DWORD;
  nIndex      : DINT;
  nCount      : DINT;
  tTimeOut    : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	A rising edge starts the write operation.

Name	Type	Description
pAddr	DWORD	Address of the variables containing the data to be written. Data are used directly from the specified address, i.e. nIndex is not to be interpreted as offset from pAddr. The data are usually read from an array of type LREAL, which has to be defined by the user.
nIndex	DINT	Describes the index of the R-parameter to be written from an NC perspective.
nCount	DINT	Number of R-parameters to be written
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
  sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Example

```
VAR
  arrfRParam90to99 : ARRAY[0..9] OF LREAL;
  fbWriteRParam     : ItpWriteRParamsEx;
  n                 : INT := 0;
  bWriteParam       : BOOL := FALSE;
  sNciToPlc AT%I*   : NCTOPLC_NCICHANNEL_REF;
END_VAR

FOR n:=0 TO 9 DO
  arrfRParam90to99[n] := 90 + n;
END_FOR

fbWriteRParam(
  bExecute := bWriteParam,
  pAddr := ADR( arrfRParam90to99[0] ),
  nIndex := 90,
```

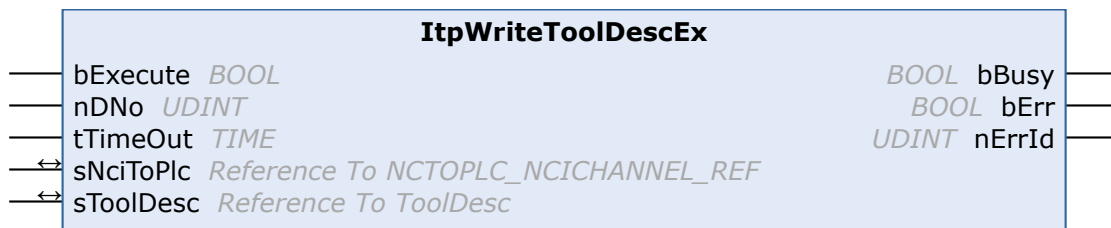
```
nCount := 10,
tTimeout := T#200ms,
sNciToPlc := sNciToPlc );
```

In this example the parameters R90 to R99 are written from an NC perspective.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.49 ItpWriteToolDescEx



The function block ItpWriteToolDescEx writes a block of tool parameters.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nDNo          : UDINT;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nDNo	UDINT	D-word for which the tool parameters are to be read. nDNo can have values between 1 and 255.
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
    sToolDesc      : ToolDesc;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).
sToolDesc	ToolDesc	The structure that contains the new tool parameters. This structure is only accessed for reading. The meaning of the parameters depends on the tool type, and can be found in the tool data [► 181].

Outputs

```
VAR_OUTPUT
    bBusy          : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```

TYPE ToolDesc:
STRUCT
    nToolNumber    : UDINT; (*valid range from 0 .. 65535*)
    nToolType      : UDINT;
    fParam         : ARRAY [2..15] OF LREAL;
END_STRUCT
END_TYPE

```

See also:

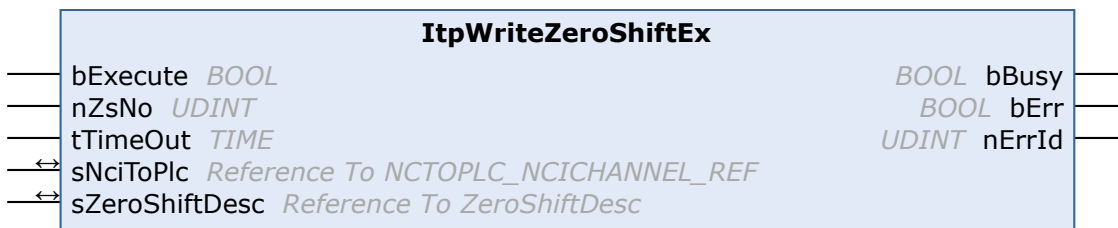
[ItpReadToolDescEx \[► 238\]](#)

[ItpSetToolDescNullEx \[► 251\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.50 ItpWriteZeroShiftEx



The function block ItpWriteZeroShiftEx writes the shift components X, Y and Z for the specified zero offset shift.

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    nZsNo         : UDINT;
    tTimeOut      : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nZsNo	UDINT	Number of the zero offset shift G54 to G59 are zero offset shifts at the NC. G58 and G59 can only be edited from the NC program. The valid range of values for 'nZsNo' is therefore from 54 to 57.

Name	Type	Description
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc AT%I*: NCTOPLC_NCICHANNEL_REF;
    sZeroShiftDesc : ZeroShiftDesc;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).
sToolDesc	ToolDesc	The structure containing the components of the zero offset shift. This structure is only accessed for reading.

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```
TYPE ZeroShiftDesc:
STRUCT
    fShiftX      : LREAL;
    fShiftY      : LREAL;
    fShiftZ      : LREAL;
END_STRUCT
END_TYPE
```



For reasons of compatibility every zero offset shift that can be set has two parameters (coarse and fine) for each axis. When using this function block to write a new zero offset shift, the new value is written into the 'fine parameter'. A value of 0.0 is entered into the 'coarse parameter'.

This makes it possible to use a function block such as [ltpReadZeroShiftEx \[► 240\]](#) to read and modify a zero offset shift and to send it back to the NC.

See also:

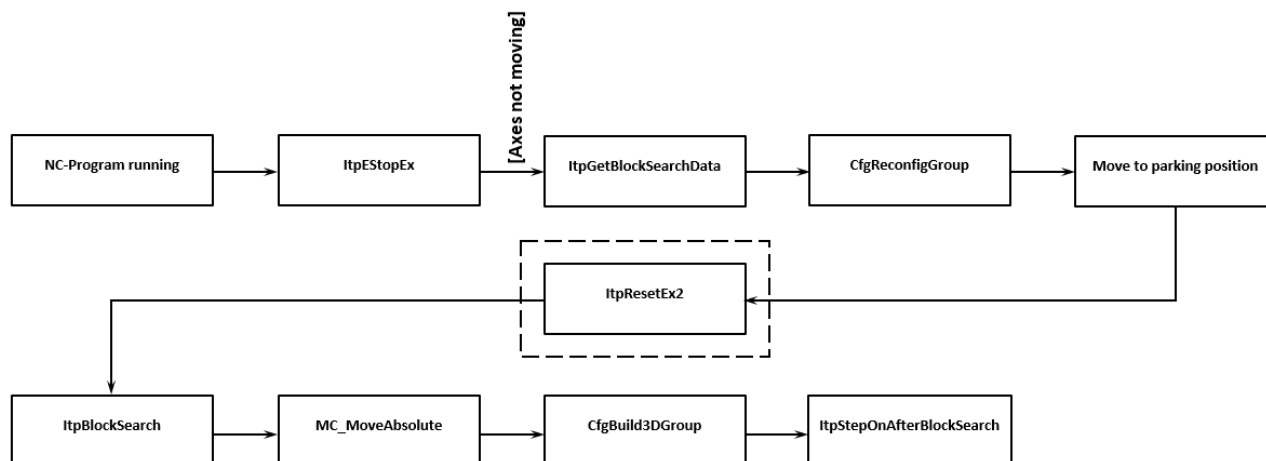
- [ltpReadZeroShiftEx \[► 240\]](#)
- [ltpSetZeroShiftNullEx \[► 252\]](#)

Requirements

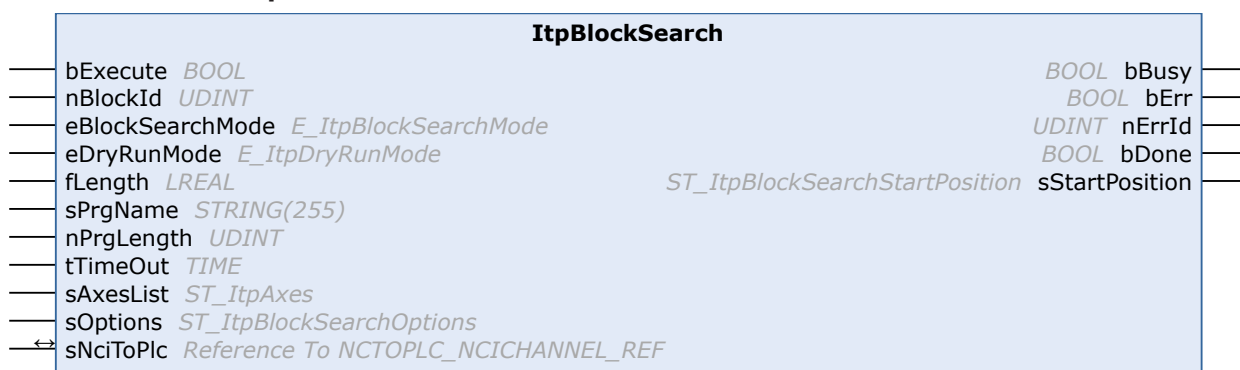
Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.2.51 Blocksearch

Blocksearch can be used to interrupt a program for a tool change or at the end of a shift. After the interruption the program can continue at the previous position. The diagram illustrates how the Blocksearch is used.



7.1.2.51.1 ItpBlocksearch



The function block ItpBlocksearch sets the interpreter to the point defined at the inputs.

If Blocksearch is executed during the first segment that contains a movement, the output sStartPosition of the function block ItpBlocksearch may return wrong values. For this reason, Blocksearch should only be used from the second segment.

The input values can be taken from function block ItpGetBlocksearchData [► 265] or set manually. Once the interpreter has been set to the defined location with ItpBlocksearch, the motion can continue with ItpStepOnAfterBlocksearch [► 266] at the position indicated at output sStartPosition.

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    nBlockId      : UDINT;
    eBlockSearchMode : E_ItpBlockSearchMode;
    eDryRunMode   : E_ItpDryRunMode;
    fLength       : LREAL;
    sPrgName      : STRING(255);
    nPrgLength    : UDINT;
    tTimeOut      : TIME;
  
```

```

    sAxesList      : ST_ItpAxes;
    sOptions       : ST_ItpBlockSearchOptions;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nBlockId	UDINT	Block number or EntryCounter of the segment in the NC program used as starting point.
eBlockSearchMode	E_ItpBlockSearchMode	Defines whether the specified nBlockId is a block number (e.g. N4711) or continuous EntryCounter. A prerequisite for using the block number is that it is unique. See E_ItpBlockSearchMode [► 264].
eDryRunMode	E_ItpDryRunMode	Defines which program lines are executed and which are skipped. See E_ItpDryRunMode [► 264].
fLength	LREAL	Entry point within the segment selected with nBlockId in percent.
sPrgName	STRING(255)	Name or path of the program to be executed.
nPrgLength	UDINT	Indicates the length of string <i>sPrgName</i> .
tTimeOut	TIME	ADS timeout delay
sAxesList	ST_ItpAxes	Definition of the axes in the NCI group. See ST_ItpAxes [► 264].
sOptions	ST_ItpBlockSearchOptions	ST_ItpBlockSearchOptions

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```

VAR_OUTPUT
    bBusy          : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
    bDone          : BOOL;
    sStartPosition : ST_ItpBlockSearchStartPosition;
END_VAR

```

Name	Type	Description
bBusy	BOOL	Remains TRUE until the function block has executed a command request, but no longer than the time specified at the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs.
bErr	BOOL	Becomes TRUE if an error occurs during command execution. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).
bDone	BOOL	The output becomes TRUE when the command was executed successfully.

Name	Type	Description
sStartPosition	ST_ItpBlockSearchStartPosition	Indicates the start position from which the NC program continues. The individual axes should be moved to this position before ItpStepOnAfterBlocksearch [► 266] is executed. See ST_ItpBlockSearchStartPosition [► 265].

E_ItpBlockSearchMode

E_ItpBlockSearchMode is used to define in which way the block search is executed.

```

TYPE E_ItpBlockSearchMode :
(
    ItpBlockSearchMode_Disable      := 0,
    ItpBlockSearchMode_BlockNo     := 1,
    ItpBlockSearchMode_EntryCounter := 2
);
END_TYPE

```

ItpBlockSearchMode_Disable: Block search disabled (initial value).

ItpBlockSearchMode_BlockNo: The block search is executed via the block number (e.g. N4711) programmed by the user in the NC program. A prerequisite is that the user-defined block number is unique.

ItpBlockSearchMode_EntryCounter: The block search is executed via a unique EntryCounter. This EntryCounter is implicitly unique, but it is not visible to the user in the NC program.

E_ItpDryRunMode

The enumeration E_ItpDryRunMode enumerates those ways how the programmed blocks from the beginning of the program up to the place searched for shall be handled.

```

TYPE E_ItpDryRunMode :
(
    ItpDryRunMode_Disable           := 0,
    ItpDryRunMode_SkipAll           := 1,
    ItpDryRunMode_SkipMotionOnly    := 2,
    ItpDryRunMode_SkipDwellAndMotion := 3
);
END_TYPE

```

ItpDryRunMode_Disable: DryRun disabled (initial value).

ItpDryRunMode_SkipAll: All previous blocks are skipped. R-parameters are written.

ItpDryRunMode_SkipMotionOnly: Only movement blocks are skipped. R-parameters are written, and dwell times and M-functions are executed.

ItpDryRunMode_SkipDwellAndMotion: Movement blocks and dwell times are skipped. R-parameters are written and M-functions are executed.

ST_ItpAxes

The structure ST_ItpAxes contains the axes that were in the NCI group during program execution. The interpolation group should not be built when blocksearch is executed. In order to still have a reference to the group axes, the structure ST_ItpAxes must be filled with the group axes.

```

TYPE ST_ItpAxes :
STRUCT
    nAxisIds      : ARRAY[1..8] OF UDINT;
END_STRUCT
END_TYPE

```

nAxisIds: Array of axes that were in the NCI group. The order is nAxisIds[1]=X, nAxisIds[2]=Y, nAxisIds[3]=Z, nAxisIds[4]=Q1, nAxisIds[5]=Q2... The axis ID can be read from the cyclic axis interface.

St_ItpBlockSearchOptions

The structure contains additional Blocksearch options.


```

TYPE ST_ItpBlockSearchOptions :
STRUCT
    bIsRetrace          : BOOL:= FALSE;
    bRetraceBackward    : BOOL:= FALSE;
    bScanStartPos       : BOOL:= FALSE;
END_STRUCT
END_TYPE

```

bIsRetrace: Indicates whether the retrace functionality is active.

bRetraceBackward: Indicates whether backward movement took place on the path.

bScanStartPos: bScanStartPos: Specifies whether or not the current axis positions should be read at the start of the program. In combination with ST_ItpAxesList, please set this input to TRUE. Setting this input to FALSE only makes sense for old projects (compatibility reasons).

ST_ItpBlockSearchStartPosition

The structure indicates the position at which the NC program continues after a block search. The user is responsible for moving the axes to the corresponding positions.

```

TYPE ST_ItpBlockSearchStartPosition :
STRUCT
    sStartPosition      : ARRAY[1..8] OF LREAL;
END_STRUCT
END_TYPE

```

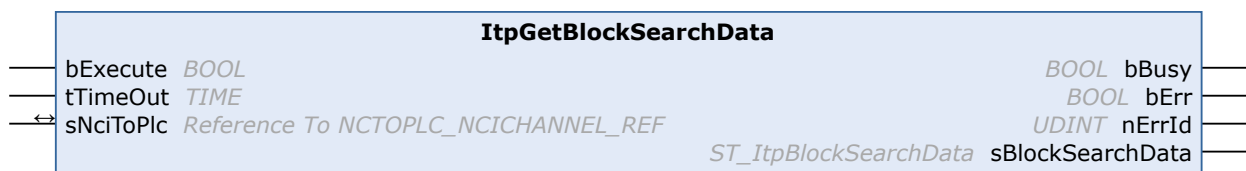
sStartPosition: Array of axis positions at which the NC program continues.

The order is sStartPosition[1]=X, sStartPosition [2]=Y, sStartPosition [3]=Z, sStartPosition [4]=Q1, sStartPosition [5]=Q2...

Voraussetzungen

Entwicklungsumgebung	Zielformat	Einzubindende SPS Bibliotheken
Classic Dialect Interpreter: TwinCAT V3.1.0 GST Interpreter: TwinCAT V3.1.4024.20	PC oder CX (x86 oder x64)	Tc2_NCI

7.1.2.51.2 ItpGetBlocksearchData



The function block ItpGetBlocksearchData reads the current position on the path. Usually this command is called at standstill. Subsequently [ItpBlockSearch](#) [262] can be used to set the interpreter to the position stored in sBlockSearchData.

Inputs

```

VAR_INPUT
    bExecute          : BOOL;
    tTimeout          : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
  sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

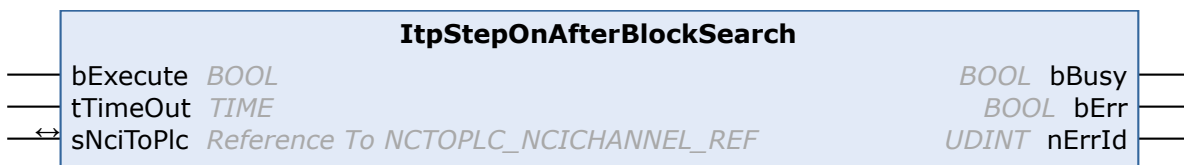
Outputs

```
VAR_OUTPUT
  bBusy          : BOOL;
  bErr           : BOOL;
  nErrId         : UDINT;
  sBlockSearchData : ST_ItpBlockSearchData;
END_VAR
```

Name	Type	Description
bBusy	BOOL	Remains TRUE until the function block has executed a command request, but no longer than the time specified at the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs.
bErr	BOOL	Becomes TRUE if an error occurs during command execution. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).
sBlockSearchData	ST_ItpBlockSearchData	Contains information on the current position on the path.

```
TYPE ST_ItpBlockSearchData :
STRUCT
  fLength          : LREAL; (* remaining distance of actual movement block in percent*)
  nBlockNo         : UDINT; (* number of the actual block *)
  nBlockCounter    : UDINT; (* counter value of the actual block *)
  bIsRetrace       : BOOL; (* indicates whether Retrace is active*)
  bRetraceBackward : BOOL; (* indicates whether backward movement took place on the path*)
END_STRUCT
END_TYPE
```

7.1.2.51.3 ItpStepOnAfterBlocksearch



The function block ItpStepOnAfterBlocksearch starts the movement after a Blocksearch has been executed. The axes first have to be moved to the positions output by [ItpBlocksearch \[► 262\]](#).

Inputs

```
VAR_INPUT
  bExecute          : BOOL;
  tTimeOut          : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [▶ 344]).

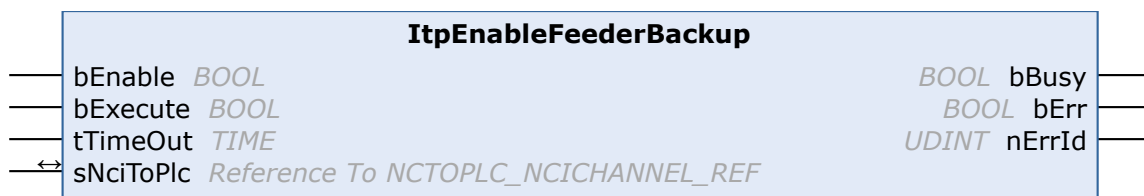
Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

7.1.2.52 Retrace

7.1.2.52.1 ItpEnableFeederBackup



The function block ItpEnableFeederBackup enables storing of the path for retracing. It has to be activated once before the NC program (G-Code) is started. If the functionality [Blocksearch](#) [[▶ 262](#)] is used, ItpEnableFeederBackup has to be activated before [ItpBlocksearch](#) [[▶ 262](#)] is called. Feeder backup is executed as long as a TwinCAT restart or bEnable = FALSE is triggered with a rising edge at bExecute.

If feeder backup is not enabled, retracing does not work. This can be verified via [ItpIsFeederBackupEnabled](#) [[▶ 269](#)].

Inputs

```
VAR_INPUT
    bEnable      : BOOL;
    bExecute     : BOOL;
    tTimeout     : TIME;
END_VAR
```

Name	Type	Description
bEnable	BOOL	TRUE: Enables feeder backup FALSE: Disables feeder backup
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

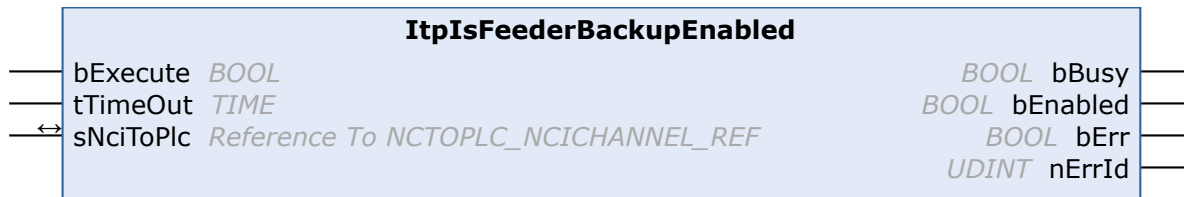
```
VAR_OUTPUT
    bBusy          : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Voraussetzungen

Entwicklungsumgebung	Zielplattform	Einzubindende SPS-Bibliotheken
TwinCAT V3.1.0 Classic Interpreter TwinCAT V3.1.4024.40 GST Interpreter	PC oder CX (x86 oder x64)	Tc2_NCI

7.1.2.52.2 ItpIsFeederBackupEnabled



The function block ItpIsFeederBackupEnabled indicates whether feeder backup is enabled. Feeder backup must be enabled before reversing can take place. This activates storing of the path.

 Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeOut	TIME	ADS Timeout-Delay

 Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

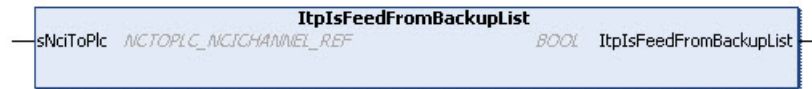
 Outputs

```
VAR_OUTPUT
    bBusy          : BOOL;
    bEnabled       : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	The bBusy output remains TRUE until the function block has executed a command, with the maximum duration specified by the time associated with the 'Timeout' input. While bBusy = TRUE, no new instruction will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bEnabled	BOOL	TRUE: Backup list for tracing is enabled. FALSE: Backup list for tracing is disabled.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. If the function block has a timeout error, 'Error' is TRUE and 'nErrId' is 1861 (hexadecimal 0x745). Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Voraussetzungen

Entwicklungsumgebung	Zielformat	Einzubindende SPS-Bibliotheken
TwinCAT V3.1.0 Classic Interpreter TwinCAT V3.1.4024.40 GST Interpreter	PC oder CX (x86 oder x64)	Tc2_NCI

7.1.2.52.3 ItplsFeedFromBackupList

The function `ItplsFeedFromBackupList` becomes TRUE when the feed entries (SAF & SVB) were sent from the backup list. During backward movement all entries are sent from the backup list. If the program is executed in forward mode, the first entries usually also originate from the backup list. This is dependent of the number of retraced entries and the number of entries in the SVB and SAF tables at the time at which tracing was called. All further commands originate from the 'original' code.

While the NCI is processing the backup list, not all functions are available or meaningful. Here are a few examples:

- Decoder stops such as @714 are not evaluated
- Modifications of R-parameters do not take effect as long as the motion takes place on the backup path (forward or backward). R-parameters modifications take effect again as soon as the path data no longer come from the backup list.

Inputs/Outputs

```

VAR_IN_OUT
  sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Voraussetzungen

Entwicklungsumgebung	Zielformat	Einzubindende SPS-Bibliotheken
TwinCAT V3.1.0 Classic Interpreter TwinCAT V3.1.4024.40 GST Interpreter	PC oder CX (x86 oder x64)	Tc2_NCI

7.1.2.52.4 ItplsFirstSegmentReached

The function `ItplsFirstSegmentReached` determines whether the program start position is reached during retracing, based on the cyclic channel interface.

Inputs/Outputs

```

VAR_IN_OUT
  sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

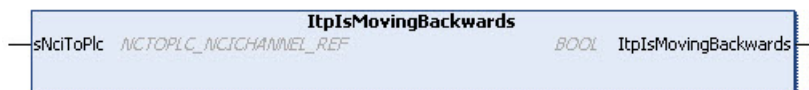
Return value

Name	Type	Description
ItplsFirstSegmentReached	BOOL	The function returns TRUE when the start position of the G-Code program is reached. If the version number of the cyclic channel interface is less than 6, the return value is always FALSE.

Voraussetzungen

Entwicklungsumgebung	Zielplattform	Einzubindende SPS-Bibliotheken
TwinCAT V3.1.0 Classic Interpreter TwinCAT V3.1.4024.40 GST Interpreter	PC oder CX (x86 oder x64)	Tc2_NCI

7.1.2.52.5 ItplsMovingBackwards



The function ItplsMovingBackwards determines whether backward movement takes place on the path of the current G-Code program, based on the cyclic channel interface.

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

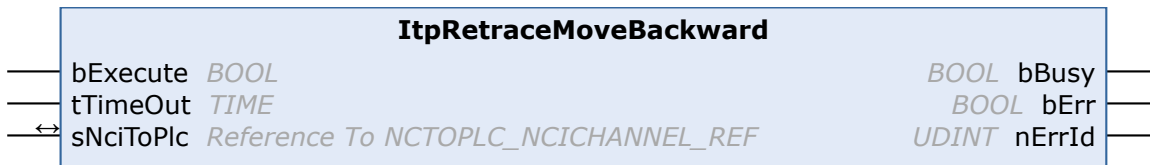
Return value

Name	Type	Description
ItplsMovingBackwards	BOOL	The function returns TRUE when backward movement takes place on the path. If the version number of the cyclic channel interface is less than 6, the return value is always FALSE.

Voraussetzungen

Entwicklungsumgebung	Zielplattform	Einzubindende SPS-Bibliotheken
TwinCAT V3.1.0 Classic Interpreter TwinCAT V3.1.4024.40 GST Interpreter	PC oder CX (x86 oder x64)	Tc2_NCI

7.1.2.52.6 ItpRetraceMoveBackward



The function block ItpRetraceMoveBackward deals with the geometric entries at the actual position at the start of the part program (G-Code).

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```
VAR_OUTPUT
    bBusy          : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Procedure

1. Enable feeder backup list (see [ItpEnableFeederBackup \[► 267\]](#)).
 ⇒ The NC program is stopped with [ItpEStopEx \[► 213\]](#).

2. Wait and ensure that all axes in the group are at standstill.
3. Call `ItpRetraceMoveBackward`.
4. Stop backward movement with `ItpEStop`, otherwise the program returns to the start.
5. Call `ItpRetraceMoveForward` [► 273] to move forward again.
6. Call `ItpEStopEx` and `ItpRetraceMoveBackward` etc., if required.

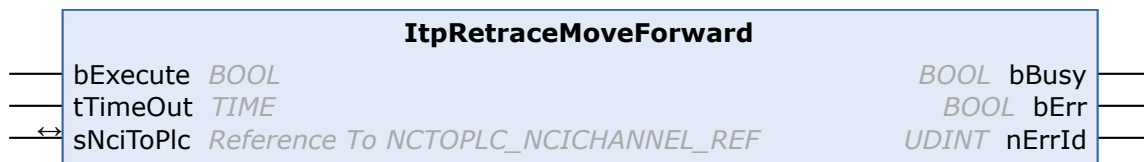
NOTICE

Do not use in conjunction with vertex blending. M-functions are suppressed during backward movement.

Voraussetzungen

Entwicklungsumgebung	Zielplattform	Einzubindende SPS-Bibliotheken
TwinCAT V3.1.0 Classic Interpreter	PC oder CX (x86 oder x64)	Tc2_NCI
TwinCAT V3.1.4024.40 GST Interpreter		

7.1.2.52.7 ItpRetraceMoveForward



The function block `ItpRetraceMoveForward` transfers all entries from the current block (e.g. position) in forward travel direction to the NC kernel. It is called to reverse the direction after `ItpRetraceMoveBackward` [► 272] was called.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sNciToPlc      : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: <code>NCTOPLC_NCICHANNEL_REF</code> [► 344]).

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

See also: [ItpRetraceMoveBackward \[► 272\]](#)

Voraussetzungen

Entwicklungsumgebung	Zielpattform	Einzubindende SPS-Bibliotheken
TwinCAT V3.1.0 Classic Interpreter TwinCAT V3.1.4024.40 GST Interpreter	PC oder CX (x86 oder x64)	Tc2_NCI

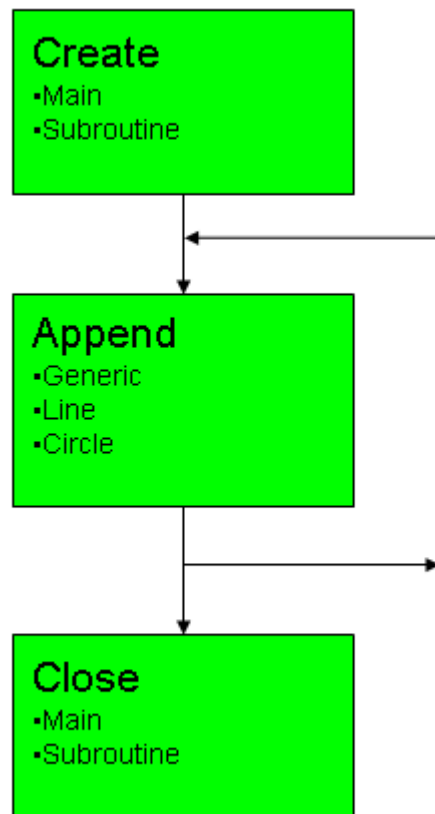
7.1.3 Parts program generator

The function blocks ItpPpg* provide an option for creating a parts program (G-Code file) from the PLC. During program generation a distinction is made between a main program ([ItpPpgCreateMain \[► 281\]](#)) and a subroutine ([ItpPpgCreateSubroutine \[► 282\]](#)).

Subsequently ItpPpgAppend* can be used to add various NC lines. The following function blocks are available:

- [ItpPpgAppendGeoLine \[► 278\]](#) adds a linear motion.
- [ItpPpgAppendGeoCircleByRadius \[► 276\]](#) adds a circle with radius specification.
- [ItpPpgAppendGenericBlock \[► 275\]](#) inserts a self-defined line, such as activation of rounding or M-functions.

Once the parts program is complete, it is closed with the routines [ItpPpgCloseMain \[► 279\]](#) or [ItpPpgCloseSubroutine \[► 280\]](#).



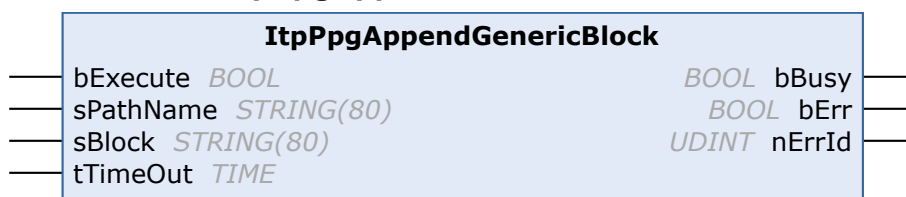
The following function blocks can be used:

Function block	Description
ItpPpgAppendGenericBlock [► 275]	Appends a generic NC line to a specified parts program.
ItpPpgAppendGeoCircleByRadius [► 276]	Adds a circle to a specified parts program.
ItpPpgAppendGeoLine [► 278]	Adds a linear motion to a specified parts program.
ItpPpgCloseMain [► 279]	Closes a previously opened parts program.
ItpPpgCloseSubroutine [► 280]	Closes a previously opened subroutine.
ItpPpgCreateMain [► 281]	Opens or generates a parts program.
ItpPpgCreateSubroutine [► 282]	Opens or generates a subroutine.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.3.1 ItpPpgAppendGenericBlock



The function block ItpPpgAppendGenericBlock adds a generic line to the parts program. It can be used to activate an M-function or rounding, for example.

Before the actual call, call [ItpPpgCreateMain](#) [► 281] or [ItpPpgCreateSubroutine](#) [► 282].

Inputs

```
VAR_INPUT
  bExecute      : BOOL;
  sPathName     : STRING;
  sBlock        : STRING;
  tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
sPathName	STRING	Name of the parts program including path name
sBlock	STRING	Generic line to be added to the parts program.
tTimeout	TIME	ADS Timeout-Delay

Outputs

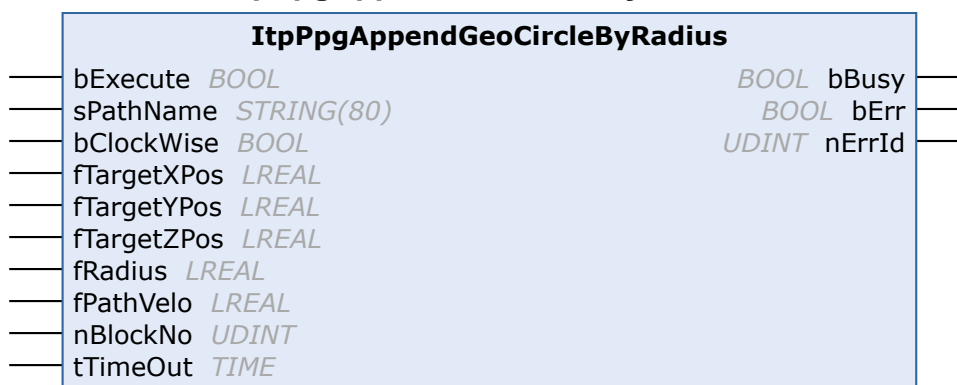
```
VAR_OUTPUT
  bBusy         : BOOL;
  bErr          : BOOL;
  nErrId        : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.3.2 ItpPpgAppendGeoCircleByRadius



The function block `ItpPpgAppendGeoCircleByRadius` adds a circular motion to the parts program. The circle is parameterized by the radius.

Before the actual call, call `ItpPpgCreateMain` [► 281] or `ItpPpgCreateSubroutine` [► 282].

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    sPathName     : STRING;
    bClockWise    : BOOL;
    fTargetXPos   : LREAL;
    fTargetYPos   : LREAL;
    fTargetZPos   : LREAL;
    fRadius       : LREAL;
    fPathVelo     : LREAL;
    nBlockNo      : UDINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
sPathName	STRING	Name of the parts program including path name
bClockWise	BOOL	If TRUE, the movement along the circle is clockwise, otherwise counter-clockwise.
fTargetXPos	LREAL	Target position of the X axis
fTargetYPos	LREAL	Target position of the Y axis
fTargetZPos	LREAL	Target position of the Z axis
fRadius	LREAL	Circle radius
fPathVelo	LREAL	Path velocity
nBlockNo	UDINT	Line number in the parts program
tTimeOut	TIME	ADS Timeout-Delay

Outputs

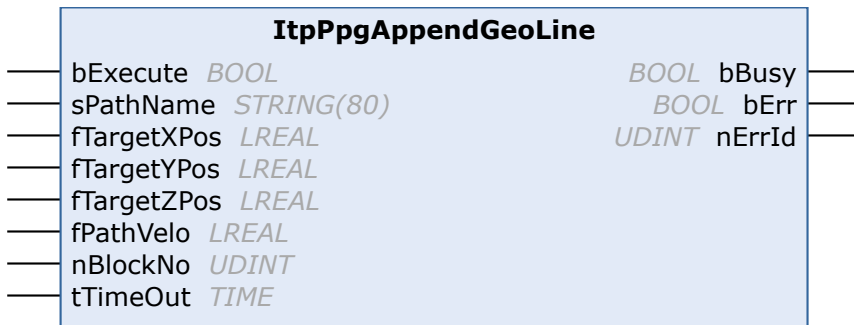
```
VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.3.3 ItpPpgAppendGeoLine



The function block ItpPpgAppendGeoLine adds a linear motion to the parts program. In addition to the actual target position, the path velocity and the line number are transferred.

Before the actual call, call [ItpPpgCreateMain](#) [► 281] or [ItpPpgCreateSubroutine](#) [► 282].

Inputs

```
VAR_INPUT
  bExecute      : BOOL;
  sPathName     : STRING;
  fTargetXPos   : LREAL;
  fTargetYPos   : LREAL;
  fTargetZPos   : LREAL;
  fPathVelo     : LREAL;
  nBlockNo      : UDINT;
  tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
sPathName	STRING	Name of the parts program including path name
fTargetXPos	LREAL	Target position of the X axis
fTargetYPos	LREAL	Target position of the Y axis
fTargetZPos	LREAL	Target position of the Z axis
fPathVelo	LREAL	Path velocity
nBlockNo	UDINT	Line number in the parts program
tTimeOut	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
  bBusy         : BOOL;
  bErr          : BOOL;
  nErrId        : UDINT;
END_VAR
```

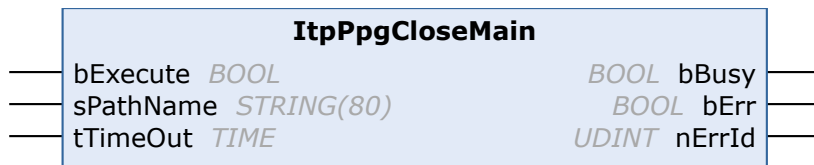
Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.

Name	Type	Description
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.3.4 ItpPpgCloseMain



The function block ItpPpgCloseMain completes the main program with the corresponding code for the interpreter (M02).

Before the actual call, call [ItpPpgCreateMain](#) [► 281].

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    sPathName     : STRING;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
sPathName	STRING	Name of the parts program including path name
tTimeout	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
```

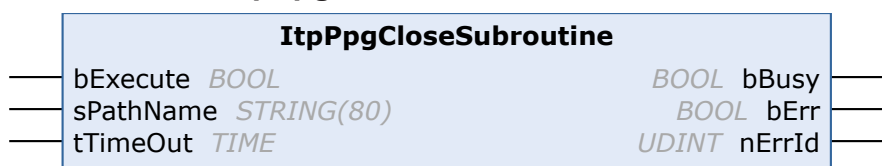
Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.

Name	Type	Description
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.3.5 ItpPpgCloseSubroutine



The function block ItpPpgCloseSubroutine completes the subroutine with the corresponding code for the interpreter (M17).

Before the actual call, call [ItpPpgCreateSubroutine](#) [► 282].

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    sPathName     : STRING;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
sPathName	STRING	Name of the parts program including path name
tTimeout	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
```

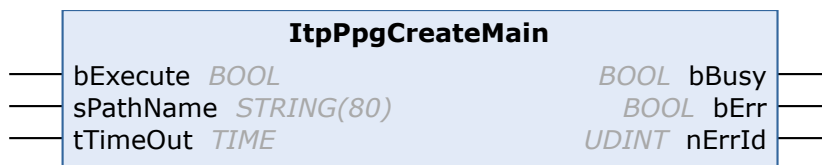
Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.

Name	Type	Description
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.3.6 ItpPpgCreateMain



The function block ItpPpgCreateMain generates a new file, which can later be processed as main program. If the file does not yet exist, it is created, otherwise it is overwritten.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    sPathName     : STRING;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
sPathName	STRING	Name of the parts program including path name
tTimeOut	TIME	ADS Timeout-Delay

Outputs

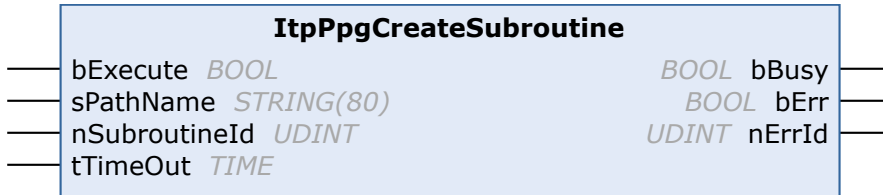
```
VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.3.7 ItpPpgCreateSubroutine



The function block ItpPpgCreateSubroutine generates a new file, which can later be processed as subroutine. If the file does not yet exist, it is created, otherwise it is overwritten.

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    sPathName     : STRING;
    nSubroutineId : UDINT;
    tTimeout      : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
sPathName	STRING	Name of the parts program including path name
nSubroutineId	UDINT	Number of the subroutine
tTimeout	TIME	ADS Timeout-Delay

Outputs

```

VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR

```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4 Function blocks for compatibility with existing programs

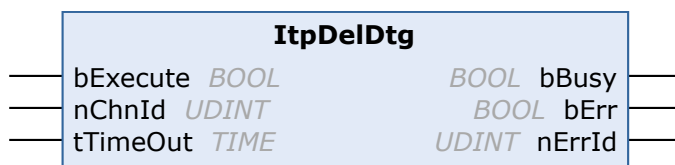


Function blocks for compatibility

The purpose of the function blocks listed is to ensure compatibility with existing projects. For new projects it is recommended **not** to use these function blocks and to use the equivalent function blocks instead, see [Overview of the library Tc2 NCI \[► 207\]](#).

Function block	Description
ItpDelDtg [► 283]	Triggers "Delete Distance to go" in the NC.
ItpEStop [► 284]	Triggers the NCI EStop.
ItpGetBottleNeckLookAhead [► 286]	Provides the value of the look-ahead for bottleneck detection.
ItpGetBottleNeckMode [► 287]	Provides the response mode for bottleneck detection.
ItpGetGeoInfoAndHParam [► 288]	Reads information of the currently active segment and past and future segments.
ItpGoAhead [► 289]	Triggers the GoAhead function.
ItpIsEStop [► 290]	Determines whether an EStop is executed or pending.
ItpLoadProg [► 291]	Loads an NC program using program names.
ItpReadRParams [► 292]	Reads arithmetic parameters.
ItpReadToolDesc [► 293]	Reads the tool description from the NC.
ItpReadZeroShift [► 295]	Reads the zero offset shift from the NC.
ItpReset [► 296]	Carries out a reset of the interpreter or of the NC channel.
ItpResetEx [► 297]	Carries out a reset of the interpreter or of the NC channel.
ItpResetFastMFunc [► 298]	Resets a fast signal bit.
ItpSetBottleNeckLookAhead [► 299]	Sets the value of the look-ahead for bottleneck detection.
ItpSetBottleNeckMode [► 300]	Sets the response mode when bottleneck detection is switched on.
ItpSetSubroutinePath [► 301]	Optionally sets the search path for subroutines.
ItpSetToolDescNull [► 303]	Sets all tool parameters (including number and type) to null.
ItpSetZeroShiftNull [► 304]	Sets all zero points to null.
ItpStartStop [► 305]	Starts or stops the interpreter (NC channel).
ItpStepOnAfterEStop [► 306]	Enables further processing of the parts program after an NCI Estop.
ItpWriteRParams [► 307]	Writes arithmetic parameters.
ItpWriteToolDesc [► 308]	Writes the tool description into the NC.
ItpWriteZeroShift [► 310]	Writes the zero offset shift into the NC.

7.1.4.1 ItpDelDtg



The function block ItpDelDtg triggers "Delete distance to go". There is a more detailed description in the [Interpreter \[► 160\]](#) documentation.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpDelDtgEx](#) [► 210].

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	Channel ID
tTimeOut	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.2 ItpEStop



The function block ItpEStop triggers the NCI EStop and enables a controlled stop on the path. The limit values for the deceleration and the jerk are transferred as parameters. If these are smaller than the currently active dynamic parameters, the transferred parameters are rejected.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ltpEStopEx](#) [► 213].

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nGrpId        : UDINT;
    fDec          : LREAL;
    fJerk         : LREAL;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nGrpId	UDINT	Group ID
fDec	LREAL	Max. deceleration during stopping. If fDec is smaller than the currently active deceleration, fDec is rejected. This ensures that the deceleration occurs with the standard ramp as a minimum.
fJerk	LREAL	Max. jerk during stopping. If fJerk is smaller than the currently active jerk, fJerk is rejected.
tTimeOut	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

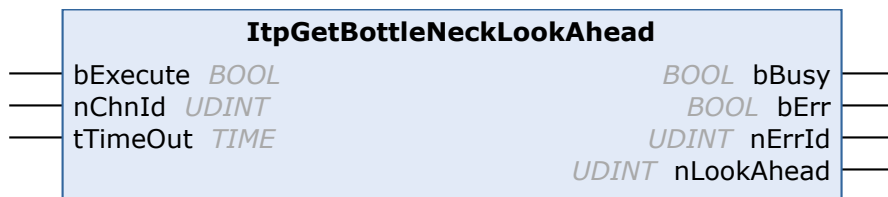
See also:

[ltpStepOnAfterEStop](#) [► 306]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.3 ItpGetBottleNeckLookAhead



The function block `ItpGetBottleNeckLookAhead` determines the maximum size of the LookAhead for the bottleneck detection (contour collision monitoring).

A more detailed description can be found in the [Interpreter \[► 193\]](#) documentation.

● **Outdated version**

I The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block `ItpGetBottleNeckLookAheadEx` [► 214].

Inputs

```
VAR_INPUT
    bExecute          : BOOL;
    nChnId            : UDINT;
    tTimeOut          : TIME;
END VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	Channel ID
tTimeOut	TIME	ADS Timeout-Delay

Outputs

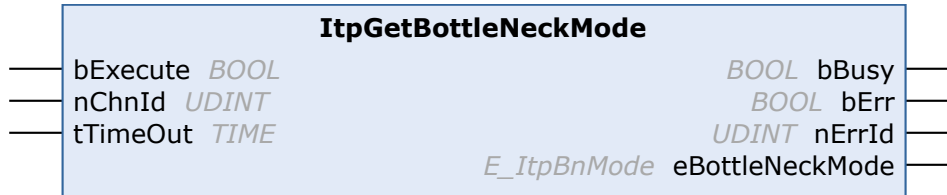
```
VAR_OUTPUT
    bBusy          : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
    nLookAhead     : UDINT;
END VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. If the function block has a timeout error, 'Error' is TRUE and 'nErrId' is 1861 (hexadecimal 0x745). Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).
nLookAhead	UDINT	Value of the look-ahead for bottleneck detection

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.4 ItpGetBottleNeckMode



The function block ItpGetBottleNeckMode reads the behavior in the event of a contour collision (bottleneck).

A more detailed description can be found in the [Interpreter](#) [► 193] documentation.

Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpGetBottleNeckModeEx](#) [► 216].

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	Channel ID
tTimeout	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
    bBusy         : BOOL;
    bErr          : BOOL;
    nErrId        : UDINT;
    eBottleNeckMode : E_ItpBnMode;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. If the function block has a timeout error, 'Error' is TRUE and 'nErrId' is 1861 (hexadecimal 0x745). Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Name	Type	Description
eBottleNeckMode	E_ItpBnMode	Enum for the behavior in the event of a contour collision

```

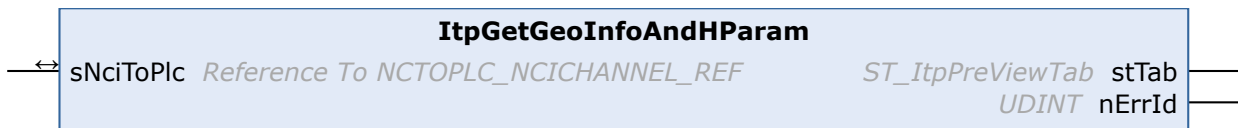
TYPE E_ItpBnMode:
(
    ItpBnm_Abort    := 0,
    ItpBnm_Adjust  := 1,
    ItpBnm_Leave    := 2
);
END_TYPE

```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.5 ItpGetGeoInfoAndHParam



The function block ItpGetGeoInfoAndHParam reads information of the currently active segment and past and future segments. These include block number, H-parameter and residual path length on the segment.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpGetGeoInfoAndHParamEx](#) [► 222].

Inputs/Outputs

```

VAR_IN_OUT
    sNciToPlc          : NCTOPLC_NCICHANNEL_REF;
END_VAR

```

Name	Type	Description
sNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface from the NCI to the PLC. This structure is read-only (type: NCTOPLC_NCICHANNEL_REF [► 344]).

Outputs

```

VAR_OUTPUT
    stTab          : ST_ItpPreViewTabEx;
    nErrId         : UDINT;
END_VAR

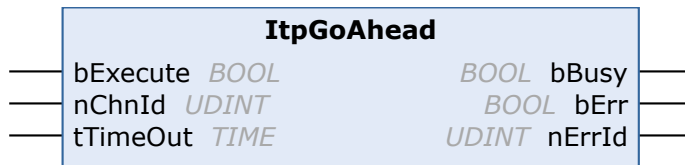
```

Name	Type	Description
stTab	ST_ItpPreViewTabEx	Structure containing the segment data.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.6 ItpGoAhead



The function block ItpGoAhead may only be used in association with the decoder stop '@717' [► 170]. There is a more detailed description of this decoder stop in the [interpreter documentation](#) [► 127].



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpGoAheadEx](#) [► 230].



Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	Channel ID
tTimeOut	TIME	ADS Timeout-Delay



Outputs

```
VAR_OUTPUT
    bBusy         : BOOL;
    bErr          : BOOL;
    nErrId        : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.7 ItplsEStop



Via bEStop, the function block ItplsEStop provides information as to whether an EStop command was triggered. If bEStop is TRUE, then an EStop was initiated (e.g. ItpEStop). The flag does **not** provide information as to whether the axes have already stopped or are still on the deceleration ramp.

After the execution of ItpStepOnAfterEStop, ItplsEStop will once again return FALSE.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItplsEStopEx](#) [► 233].

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nGrpId        : UDINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nGrpId	UDINT	Group ID
tTimeOut	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
    bBusy         : BOOL;
    bEStop        : BOOL;
    bErr          : BOOL;
    nErrId        : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bEStop	BOOL	TRUE: EStop command was executed. FALSE: No EStop present.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

See also:

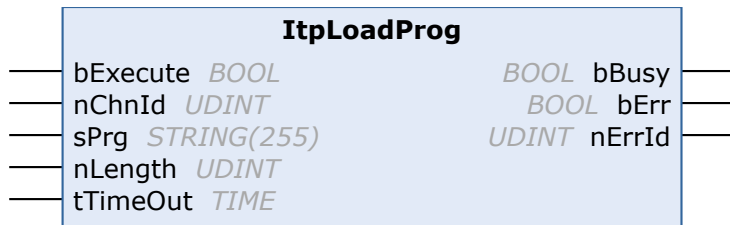
[ItpEStop](#) [► 284]

[ItpStepOnAfterEStop](#) [► 306]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.8 ItpLoadProg



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpLoadProgEx](#) [► 234].



Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    sPrg          : STRING;
    nLength       : UDINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	A rising edge at this input triggers execution of the NC program.
nChnId	UDINT	Channel ID
sPrg	STRING	Name of the NC program that is executed.
nLength	UDINT	String length of the program name
tTimeOut	TIME	ADS Timeout-Delay



The NC program is looked up in directory *TwinCAT\McWci*, if no further information is available. It is however also possible to give an absolute path.



Outputs

```
VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
```

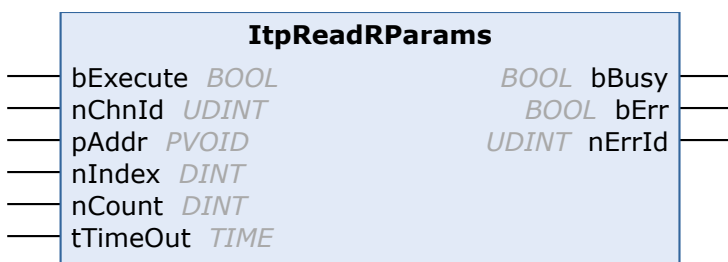
Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.

Name	Type	Description
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.9 ItpReadRParams



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpReadRParamsEx](#) [► 237].

The ItpReadRParams function block reads the NC's arithmetic parameters, also known as R-parameters. A more detailed description of the arithmetic parameters can be found [here](#) [► 135]. A total of 1000 R-parameters are available, of which the first 900 (0..899) are local, so that they are only visible in the current NC channel. The other 100 (900..999) R-parameters are global, and are thus visible from anywhere in the NC.

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    pAddr         : PVOID;
    nIndex        : DINT;
    nCount        : DINT;
    tTimeout      : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	A rising edge starts the read operation.
nChnId	UDINT	ID of the NC channel whose R-parameters are to be read.
pAddr	PVOID	Address of the target variables of the data to be read. The data are written by the NC directly from the specified address. i.e. nIndex is not to be interpreted as offset from pAddr. The data are usually in an array of type LREAL, which has to be defined by the user.
nIndex	DINT	Describes the index of the R-parameter to be read from an NC perspective.
nCount	DINT	Number of R-parameters to be read
tTimeout	TIME	ADS Timeout-Delay

🔌 Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

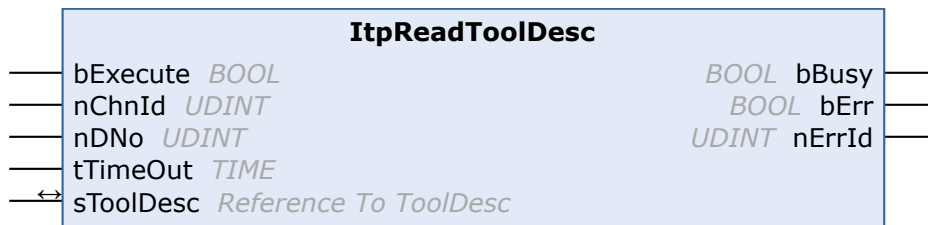
See also:

[ItpWriteRParams](#) [► 307]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.10 ItpReadToolDesc



The function block ItpReadToolDesc reads the tool parameters for the supplied D-word.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpReadToolDescEx](#) [► 238].

🔌 Inputs

```
VAR_INPUT
    bExecute    : BOOL;
    nChnId      : UDINT;
    nDNo        : UDINT;
    tTimeOut    : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	A rising edge starts the read operation.
nChnId	UDINT	Channel ID

Name	Type	Description
nDNo	UDINT	D-word for which the tool parameters are to be read. nDNo can have values between 1 and 255.
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sToolDesc      : ToolDesc;
END_VAR
```

Name	Type	Description
sToolDesc	ToolDesc	A structure into which the tool parameters of nDNo are written. The meaning of the parameters depends on the tool type, and can be found in the tool data [► 181].

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```
TYPE ToolDesc:
STRUCT
    nToolNumber    : UDINT; (*valid range from 0 .. 65535*)
    nToolType      : UDINT;
    fParam         : ARRAY [2..15] OF LREAL;
END_STRUCT
END_TYPE
```

See also:

[ltpWriteToolDesc](#) [[► 308](#)]; [ltpSetToolDescNull](#) [[► 303](#)]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.11 ItpReadZeroShift



The **ItpReadZeroShift** function block reads the offset shift components X, Y and Z for the given zero offset shift.



For reasons of compatibility, there are two entries (coarse and fine) for each axis in each zero offset shift (e.g. G54). These two entries must be added together. This function block evaluates both the entries and adds them together automatically.

**Outdated version**

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpReadZeroShiftEx](#) [► 240].

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    nZsNo         : UDINT;
    tTimeOut      : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	A rising edge starts the read operation.
nChnId	UDINT	Channel ID
nZsNo	UDINT	Number of the zero offset shift; on the NC side G54 to G59 are zero offset shifts. The valid range of values for 'nZsNo' is therefore from 54 to 59.
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```

VAR_IN_OUT
    sZeroShiftDesc : ZeroShiftDesc;
END_VAR

```

Name	Type	Description
sZeroShiftDesc	ZeroShiftDesc	The structure containing the components of the zero offset shift.

Outputs

```

VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR

```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new

Name	Type	Description
		command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```

TYPE ZeroShiftDesc:
STRUCT
  fShiftX      : LREAL;
  fShiftY      : LREAL;
  fShiftZ      : LREAL;
END_STRUCT
END_TYPE

```

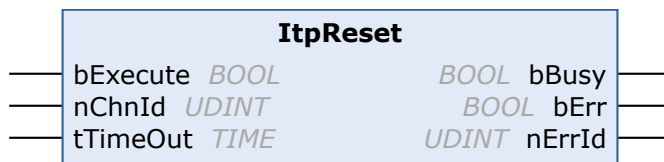
See also:

[ltpWriteZeroShift \[► 310\]](#); [ltpSetZeroShiftNull \[► 304\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.12 ltpReset



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ltpResetEx2 \[► 241\]](#).

Inputs

```

VAR_INPUT
  bExecute      : BOOL;
  nChnId        : UDINT;
  tTimeOut      : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	A rising edge starts the read operation.
nChnId	UDINT	Channel ID
tTimeOut	TIME	ADS Timeout-Delay

NOTICE

A reset deletes all tables in the NC. The axes are halted immediately. For this reason a reset should only be carried out either in the event of an error or when the axes are stationary.

🔧 Outputs

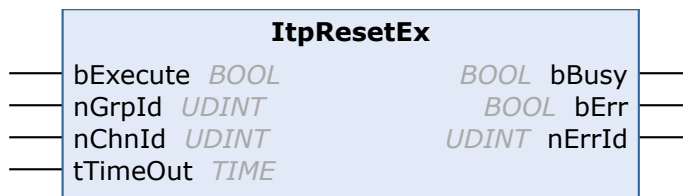
```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.13 ItpResetEx



The function block 'ItpResetEx' executes a channel reset, which deletes all existing tables of the NC channel. In contrast to the conventional [ItpReset](#) [► 296], an active channel is stopped first, before the reset is executed. This simplifies programming in the PLC, since no explicit check is necessary to ascertain whether the axes are still in motion.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpResetEx2](#) [► 241].

🔧 Inputs

```
VAR_INPUT
  bExecute    : BOOL;
  nGrpId      : UDINT;
  nChnId      : UDINT;
  tTimeOut    : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nGrpId	UDINT	Group ID
nChnId	UDINT	Channel ID

Name	Type	Description
tTimeOut	TIME	ADS timeout delay (the bBusy signal can be active for longer than tTimeOut)

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

See also: [ItpStartStop](#) [► 305]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.14 ItpResetFastMFunc



This function block represents an alternative to Auto-reset or reset with another M-function (reset list during parameterization of the M-function). For the sake of clarity, mixed operation involving resetting with an M-function and this function block should be avoided.

The [fast M-function](#) [► 165] **nMFuncNo** is reset with a rising edge at input **bExecute**. In the event of the M-function not being available, **no** error is returned.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpResetFastMFuncEx](#) [► 242].

Inputs

```
VAR_INPUT
    bExecute    : BOOL;
    nChnId      : UDINT;
```

```

    nMFuncNo      : UINT;
    tTimeOut      : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	Channel ID
nMFuncNo	UINT	Flying M-function that is to be reset.
tTimeOut	TIME	ADS Timeout-Delay

🔌 Outputs

```

VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR

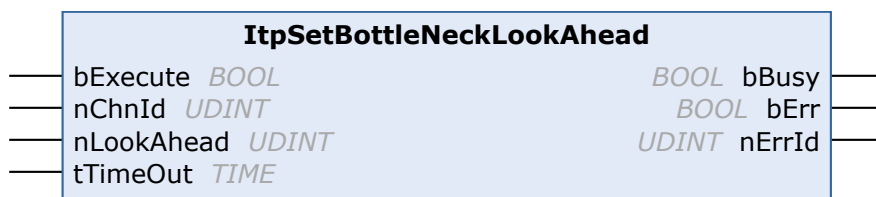
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.15 ItpSetBottleNeckLookAhead



The function block ItpSetBottleNeckLookAhead determines the maximum number of segments the system may look ahead for bottleneck detection (contour collision monitoring). Note that segments, which were added as a result of radius compensation (e.g. additional segments at acute angles) are taken into account.

A more detailed description can be found in the [Interpreter \[► 193\]](#) documentation.

● Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpSetBottleNeckLookAheadEx \[► 243\]](#).

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    nLookAhead    : UDINT;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	Channel ID
nLookAhead	UDINT	Specifies the look-ahead value.
tTimeout	TIME	ADS Timeout-Delay

Outputs

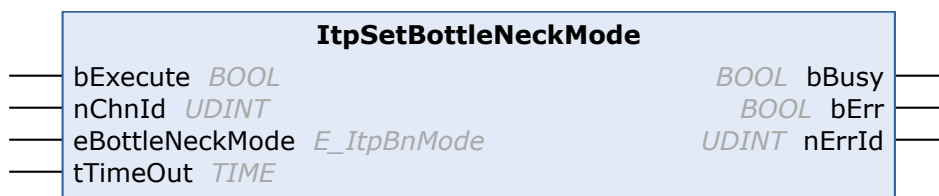
```
VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.16 ItpSetBottleNeckMode



The function block ItpSetBottleNeckMode reads the behavior in the event of a contour collision (bottleneck).

A more detailed description can be found in the [Interpreter \[► 193\]](#) documentation.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpSetBottleNeckModeEx \[► 245\]](#).

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    eBottleNeckMode: E_ItpBnMode;
    tTimeout       : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	Channel ID
eBottleNeckMode	E_ItpBnMode	Enum for the behavior in the event of a contour collision
tTimeout	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

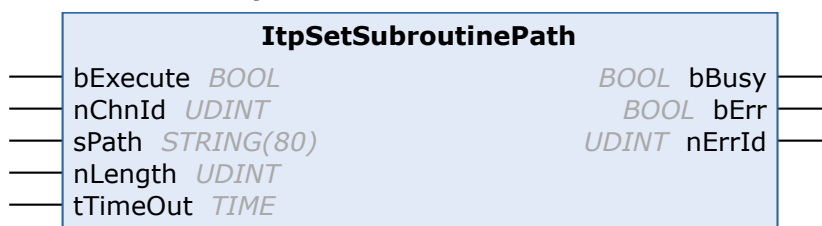
Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```
TYPE E_ItpBnMode:
(
    ItpBnm_Abort   := 0,
    ItpBnm_Adjust := 1,
    ItpBnm_Leave    := 2
);
END_TYPE
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.17 ItpSetSubroutinePath



With function block ItpSetSubroutinePath, the search path for subroutines can optionally be set.

If a subroutine still has to be integrated, the file is searched in the following order:

- Optional search path (ItpSetSubroutinePath)
- Path from which the main program was loaded
- TwinCAT\Mc\Nci directory

Only one optional path can be active at a time and it will remain active until it is overwritten with:

- another path or
- with an empty string

After a TwinCAT restart, the path has to be re-assigned.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpSetSubroutinePathEx](#) [► 250].

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    sPath          : STRING;
    nLength        : UDINT;
    tTimeout       : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	Channel ID
sPath	STRING	Optional path for subroutines; is disabled with an empty string.
nLength	UDINT	String length
tTimeout	TIME	ADS Timeout-Delay

Outputs

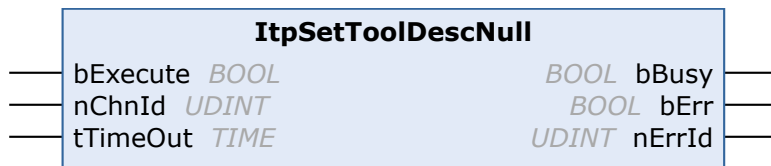
```
VAR_OUTPUT
    bBusy         : BOOL;
    bErr          : BOOL;
    nErrId        : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.18 ItpSetToolDescNull



The function block ItpSetToolDescNull overwrites all tool parameters (incl. number & type) of the channel with null.

**Outdated version**

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpSetToolDescNullEx](#) [► 251].

 Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	A rising edge results in overwriting of all tool parameters of the NC channel with zero.
nChnId	UDINT	ID of the NC channel
tTimeout	TIME	ADS Timeout-Delay

 Outputs

```
VAR_OUTPUT
    bBusy         : BOOL;
    bErr          : BOOL;
    nErrId        : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

See also:

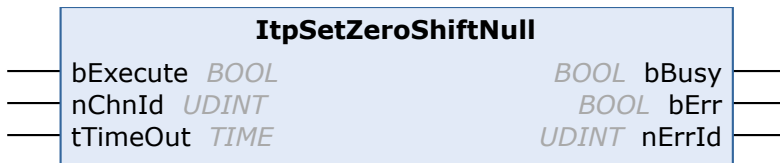
- [ItpWriteToolDesc](#) [► 308],

- [ItpReadToolDesc](#) [► 293]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.19 ItpSetZeroShiftNull



The function block ItpSetZeroShiftNull overwrites all zero offset shifts of the channel with zero.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block ItpSetZeroShiftNullEx.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	A rising edge results in overwriting of all zero offset shifts of the NC channel with zero.
nChnId	UDINT	ID of the NC channel
tTimeOut	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
    bBusy        : BOOL;
    bErr         : BOOL;
    nErrId       : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

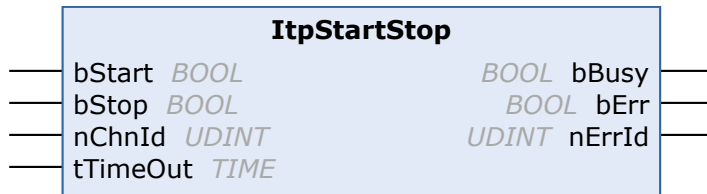
See also:

- [ItpWriteZeroShift \[► 310\]](#)
- [ItpReadZeroShift \[► 295\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.20 ItpStartStop



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpStartStopEx \[► 255\]](#).

Inputs

```
VAR_INPUT
  bStart      : BOOL;
  bStop       : BOOL;
  nChnId      : UDINT;
  tTimeOut    : TIME;
END_VAR
```

Name	Type	Description
bStart	BOOL	A positive edge starts the NC channel.
bStop	BOOL	A positive edge stops the NC channel. A stop command deletes all the tables in the NC and brings the axes to a controlled halt.
nChnId	UDINT	Channel ID
tTimeOut	TIME	ADS Timeout-Delay



The bStop input has a higher priority than the bStart input, so that if both inputs receive a positive edge, a channel stop will be executed.

Outputs

```
VAR_OUTPUT
  bBusy       : BOOL;
  bErr        : BOOL;
  nErrId      : UDINT;
END_VAR
```

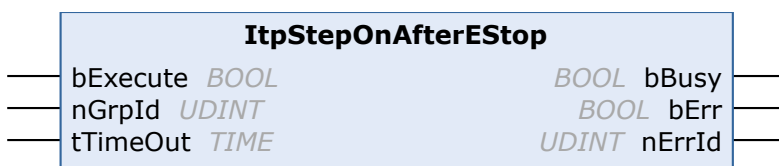
Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.

Name	Type	Description
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.21 ItpStepOnAfterEStop



The function block ItpStepOnAfterEStop enables further processing of the parts program after a programmed EStop.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpStepOnAfterEStopEx](#) [► 256].

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nGrpId        : UDINT;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nGrpId	UDINT	Group ID
tTimeout	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
    bBusy         : BOOL;
    bErr          : BOOL;
    nErrId        : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.

Name	Type	Description
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

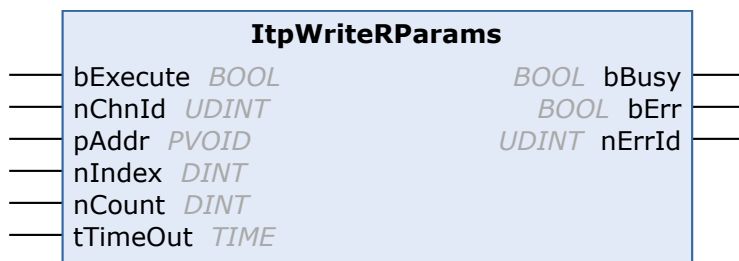
See also:

- [ltpEStop](#) [► 284]
- [ltpIsEStop](#) [► 290]

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.22 ItpWriteRParams



The function block ItpWriteRParams writes R-parameters into the NC.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpWriteRParamsEx](#) [► 257].

Inputs

```

VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    pAddr         : PVOID;
    nIndex        : DINT;
    nCount        : DINT;
    tTimeOut      : TIME;
END_VAR

```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	ID of the NC channel whose R-parameters are to be written.
pAddr	PVOID	Address of the variables containing the data to be written. Data are used directly from the specified address, i.e. nIndex is not to be interpreted as offset from pAddr. The data are usually in an array of type LREAL, which has to be defined by the user.
nIndex	DINT	Describes the index of the R-parameter to be written from an NC perspective.
nCount	DINT	Number of R-parameters to be written

Name	Type	Description
tTimeOut	TIME	ADS Timeout-Delay

Outputs

```
VAR_OUTPUT
  bBusy      : BOOL;
  bErr       : BOOL;
  nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

Sample

In this example the parameters R90 to R99 are written from an NC perspective.

```
VAR
  arrfRParam90to99 : ARRAY[0..9] OF LREAL;
  fbWriteRParam     : ItpWriteRParams;
  n                 : INT := 0;
  bWriteParam       : BOOL := FALSE;
END_VAR

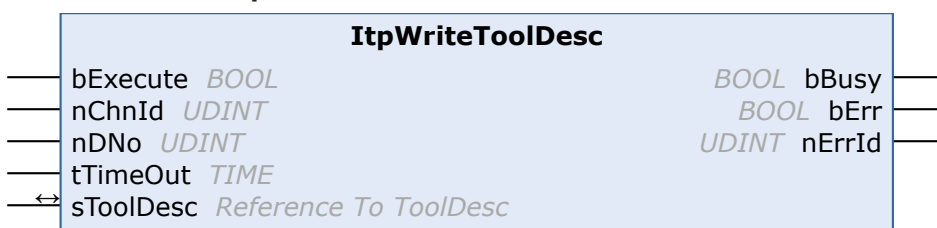
FOR n:=0 TO 9 DO
  arrfRParam90to99[n] := 90 + n;
END_FOR

fbWriteRParam(
  bExecute := bWriteParam,
  nChnId   := 2,
  pAddr    := ADR( arrfRParam90to99[0] ),
  nIndex   := 90,
  nCount   := 10,
  tTimeOut := T#200ms );
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.23 ItpWriteToolDesc



The function block `ItpWriteToolDesc` writes a block of tool parameters.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block `ItpWriteToolDescEx` [► 259].

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    nDNo          : UDINT;
    tTimeOut      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	Channel ID
nDNo	UDINT	D-word for which the tool parameters are to be read. nDNo can have values between 1 and 255.
tTimeOut	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sToolDesc      : ToolDesc;
END_VAR
```

Name	Type	Description
sToolDesc	ToolDesc	The structure that contains the new tool parameters. This structure is only accessed for reading. The meaning of the parameters depends on the tool type, and can be found in the tool data [► 181].

Outputs

```
VAR_OUTPUT
    bBusy          : BOOL;
    bErr           : BOOL;
    nErrId         : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```
TYPE ToolDesc:
STRUCT
    nToolNumber    : UDINT; (*valid range from 0 .. 65535*)
    nToolType      : UDINT;
```

```
fParam      : ARRAY [2..15] OF LREAL;
END_STRUCT
END_TYPE
```

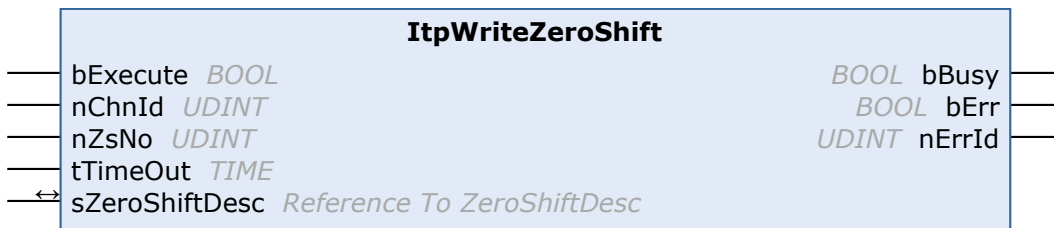
See also:

- [ItpReadToolDesc \[► 293\]](#)
- [ItpSetToolDescNull \[► 303\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.4.24 ItpWriteZeroShift



The function block ItpWriteZeroShift writes the shift components X, Y and Z for the specified zero offset shift.

For reasons of compatibility every zero offset shift that can be set has two parameters (coarse and fine) for each axis. When using this function block to write a new zero offset shift, the new value is written into the 'fine parameter'. A value of 0.0 is entered into the 'coarse parameter'. This makes it possible to use a function block such as [ItpReadZeroShift \[► 295\]](#) to read and modify a zero offset shift and to send it back to the NC.



Outdated version

The sole purpose of the function block is to ensure compatibility with existing projects. For new projects please use the function block [ItpWriteZeroShiftEx \[► 260\]](#).

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    nChnId        : UDINT;
    nZsNo         : UDINT;
    tTimeout      : TIME;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
nChnId	UDINT	Channel ID
nZsNo	UDINT	Number of the zero offset shift On the NC side G54 to G59 are zero offset shifts; G58 and G59 can only be edited from the NC program. The valid range of values for 'nZsNo' is therefore from 54 to 57.
tTimeout	TIME	ADS Timeout-Delay

Inputs/Outputs

```
VAR_IN_OUT
    sZeroShiftDesc : ZeroShiftDesc;
END_VAR
```

Name	Type	Description
sZeroShiftDesc	ZeroShiftDesc	sZeroShiftDesc: The structure containing the components of the zero offset shift. This structure is only accessed for reading.

🔌 Outputs

```
VAR_OUTPUT
    bBusy      : BOOL;
    bErr       : BOOL;
    nErrId     : UDINT;
END_VAR
```

Name	Type	Description
bBusy	BOOL	This output remains TRUE until the function block has executed a command, but at the longest for the duration supplied to the 'Timeout' input. While Busy = TRUE, no new command will be accepted at the inputs. Please note that it is not the execution of the service but its acceptance whose time is monitored.
bErr	BOOL	This output is switched to TRUE as soon as an error occurs during the execution of a command. The command-specific error code is contained in 'nErrId'. Is reset to FALSE by the execution of a command at the inputs.
nErrId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

```
TYPE ZeroShiftDesc:
STRUCT
    fShiftX : LREAL;
    fShiftY : LREAL;
    fShiftZ : LREAL;
END_STRUCT
END_TYPE
```

See also:

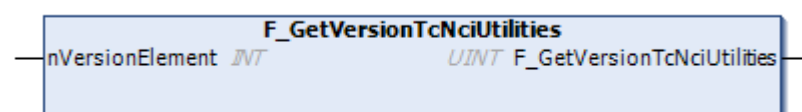
- [ItpReadZeroShift \[► 295\]](#)
- [ItpSetZeroShiftNull \[► 310\]](#)

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.5 Obsolete

7.1.5.1 F_GetVersionTcNciUtilities



This function returns a part of the three-part version number of the TcNciUtilities.lib TwinCAT 2 PLC library as UINT.

**Outdated version**

The sole purpose of this function is to assure compatibility with existing projects. For new projects, please use the stLibVersion_Tc2_NCI global structure.

Interface

```
FUNCTION F_GetVersionNciUtilities
```

```
VAR_INPUT
    nVersionElement      : INT;
END_VAR
```

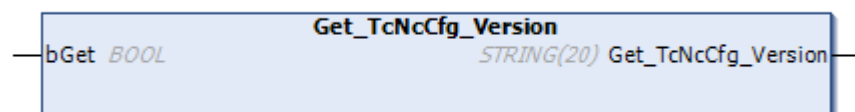
Name	Type	Description
nVersionElement	INT	Part of the version number to be read out (range: [1..3]).

Return value

Name	Type	Description
F_GetVersionNciUtilities	UINT	Version number

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.5.2 Get_TcNcCfg_Version

This function returns the version number of the TcNcCfg.lib TwinCAT 2 PLC library as a string.

**Outdated version**

The sole purpose of this function is to assure compatibility with existing projects. For new projects, please use the stLibVersion_Tc2_NCI global structure.

Interface

Name	Type	Description
bGet	BOOL	Signal to execute the command

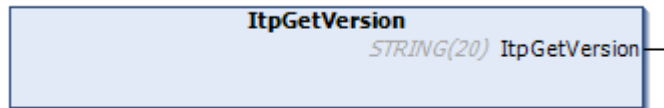
Return value

Name	Type	Description
Get_TcNcCfg_Version	STRING(20)	Version number

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.1.5.3 ItpGetVersion



ItpGetVersion is a function that returns the version number of the TcNC.lib TwinCAT 2 PLC library as a string.



Outdated version

The sole purpose of this function is to assure compatibility with existing projects. For new projects, please use the stLibVersion_Tc2_NCI global structure.

Interface

```
FUNCTION ItpGetVersion
VAR_INPUT
END_VAR
```

Return value

Name	Type	Description
ItpGetVersion	String(20)	Version number

Sample

```
VAR
    strVersion: STRING(20);
END_VAR
strVersion := ItpGetVersion();
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_NCI

7.2 PLC Library: Tc2_PlcInterpolation

The Tc2_PlcInterpolation library offers an alternative to the application of G-Code (DIN 66025). This library can be used to execute interpolated movement commands directly from the PLC, without using G-Code.



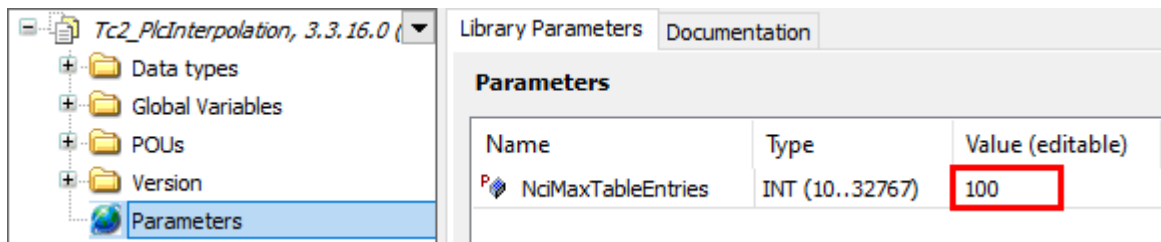
Alternative for Pick-and-Place Applications

TF5420 TwinCAT 3 Motion Pick-and-Place executes multi-dimensional motions. It was specially developed for the requirements of pick-and-place applications and is an alternative to the Tc2_PlcInterpolation library for this use case. The [Tc3_McCoordinatedMotion library](#) contains all associated function blocks.

In a first step a table of different movement commands and additional functions is written. To this end structures such as ST_NciGeoLine are transferred to the FB NciFeedTablePreparation. This appends the movement command to the table. Once the table is full or all required entries have been added, NciFeedTable is called in order to transfer the table content to the NC kernel. The data transfer directly starts the execution.

NciMaxTableEntries can be edited

From library version 3.3.16.0 (included from TC3.1.4024.11) the maximum number of table entries can be edited in the range from 10 to 32767. The default value is 100 entries.



Function blocks

Function blocks that are required for grouping of axes (or for channel control (channel override) can be found in the PLC Library: Tc2 NCI [► 199].

Function Block	Description
FB_NciFeedTablePreparation [► 315]	Fills a table with NCI movements in the PLC
FB_NciFeedTable [► 316]	Transfers a previously written table to the NC kernel and starts the motion

Data structures

The following structures can be used as input parameters for the function block NciFeedTablePreparation:

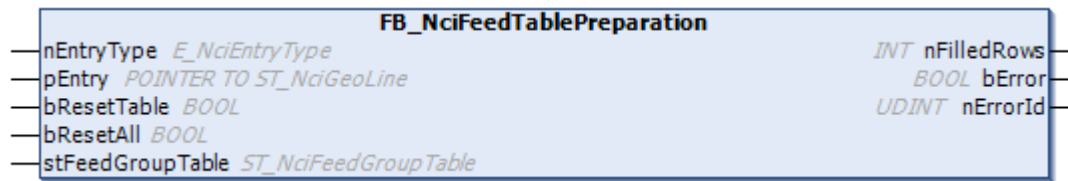
Structures	Enum	Description
Organization		
	E_NciEntryTypeNone	No function
ST_NciGeoStart [► 319]	E_NciEntryTypeGeoStart	Sets the start position for the first geometry entry
ST_NciEndOfTables [► 329]	E_NciEntryTypeEndOfTables	Indicates the end of the geometry table
Movement commands		
ST_NciGeoLine [► 319]	E_NciEntryTypeGeoLine	Describes a straight line
ST_NciGeoCirclePlane [► 320]	E_NciEntryTypeGeoCirclePlane	Describes a circle in the main plane (center point programming)
ST_NciGeoCircleCIP [► 321]	E_NciEntryTypeGeoCircleCIP	Describes a circle anywhere in the space
ST_NciGeoBezier3 [► 322]	E_NciEntryTypeGeoBezier3	Describes a 3rd order Bezier with control points
ST_NciGeoBezier5 [► 323]	E_NciEntryTypeGeoBezier5	Describes a 5th order Bezier with control points
ST_NciDwellTime [► 328]	E_NciEntryTypeDwellTime	Describes a dwell time
Path parameters		
ST_NciBaseFrame [► 326]	E_NciEntryTypeBaseFrame	Describes a zero shift and rotation
ST_NciVertexSmoothing [► 326]	E_NciEntryTypeVertexSmoothing	Activates blending at segment transitions
ST_NciTangentialFollowingDesc [► 328]	E_NciEntryTypeTfDesc	Activates tangential following of the tool
Dynamics		
ST_NciDynOvr [► 325]	E_NciEntryTypeDynOvr	Modifies the dynamic override
ST_NciAxisDynamics [► 327]	E_NciEntryTypeAxisDynamics	Limits the axis dynamics
ST_NciPathDynamics [► 327]	E_NciEntryTypePathDynamics	Limits the path dynamics
ST_NciFeedratelpol [► 328]	E_NciEntryTypeFeedratelpol	Sets the feed interpolation type
Parameter commands		
ST_NciHParam [► 325]	E_NciEntryTypeHParam	Sets an H-parameter (DINT)
ST_NciSParam [► 325]	E_NciEntryTypeSParam	Sets an S-parameter (WORD)

Structures	Enum	Description
ST_NciTParam [► 325]	E_NciEntryTypeTParam	Sets a T-parameter (WORD)
ST_NciMFuncFast [► 324]	E_NciEntryTypeMFuncFast	Parameterizes a fast M-function (no handshake)
ST_NciMFuncHsk [► 324]	E_NciEntryTypeMFuncHsk	Parameterizes an M-function with handshake
ST_NciMFuncResetAllFast [► 325]	E_NciEntryTypeResetAllFast	Resets all fast M-functions

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_PlcInterpolation

7.2.1 FB_NciFeedTablePreparation



The function block FB_NciFeedTablePreparation appends an entry of a specific type to the feed table (stFeedGroupTable). An appended entry can generate more than one row in the table. If the table has not enough free rows, an error is returned and no entry is added to the table. In this case the entry either has to be added to another table or to the same table, after FB_NciFeedTable was executed. This function block deals with modal functions, such as tangential following. It is therefore important to always use the same instance of this function block. The function block can be called repeatedly in a PLC cycle.

Inputs

```

VAR_INPUT
    nEntryType      : E_NciEntryType;
    pEntry          : POINTER TO ST_NciGeoLine;
    bResetTable     : BOOL;
    bResetAll       : BOOL;
END_VAR

```

Name	Type	Description
nEntryType	E_NciEntryType	Specifies the entry type, e.g. line, circle, tangential following.
pEntry	POINTER TO ST_NciGeoLine	Pointer to entry structure – must match nEntryType.
bResetTable	BOOL	If bResetTable is TRUE, the table 'stFeedGroupTable' is set to zero and nFilledRows is also set to zero. If nErrorId = ErrNciFeedTableFull, this error is reset. All modal flags (such as tangential following) remain constant.
bResetAll	BOOL	Like bResetTable. In addition, all modal flags are set to their default values, and all error IDs are reset.

Inputs/Outputs

```

VAR_IN_OUT
    stFeedGroupTable : ST_NciFeedGroupTable;
END_VAR

```

Name	Type	Description
stFeedGroupTable	ST_NciFeedGroupTable	Table containing the rows for the NC kernel.

Outputs

```
VAR_OUTPUT
  nFilledRows      : INT;
  bError           : BOOL;
  nErrorId         : UDINT;
END_VAR
```

Name	Type	Description
nFilledRows	INT	Number of filled rows
bError	BOOL	Becomes TRUE as soon as an error has occurred.
nErrorId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation (error codes above 0x4000).

i

- If bResetTable, bResetAll, or bError is true, no further entries are accepted.
- The error code 0x4B72 indicates that the table is full and the last entry was not accepted.

Sample:

```
stGeoLine.nDisplayIndex := 1;
stGeoLine.fEndPosX := 0;
stGeoLine.fEndPosY := 400;
stGeoLine.fEndPosZ := 100;
stGeoLine.fEndPosQ1 := -90;
stGeoLine.fVelo := 1000; (*mm per sec*)
```

```
fbFeedTablePrep(
  nEntryType := E_NciEntryTypeGeoLine,
  pEntry := ADR(stGeoLine),
  bResetTable := FALSE,
  stFeedGroupTable := stNciFeedGroupTable,
  nFilledRows => nFilledRows,
  bError => bError,
  nErrorId => nErrorId);
```

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_PlcInterpolation

7.2.2 FB_NciFeedTable



The function block **FB_NciFeedTable** transfers a given table to the NC kernel. If the override is set and the approvals are enabled, execution is started immediately. bFeedingDone becomes TRUE when the transfer is complete. This signal can be used for overwriting the table with [NciFeedTablePreparation](#) [► 315]. In NciFeedTablePreparation the table first has to be reset.

bChannelDone indicates complete execution of the tables in the NC kernel. The identifier [ST_NciEndOfTables](#) [► 318] must therefore be placed at the end of the last table.

Inputs

```
VAR_INPUT
    bExecute      : BOOL;
    bReset        : BOOL;
    bLogFeederEntries : BOOL;
END_VAR
```

Name	Type	Description
bExecute	BOOL	The command is triggered by a rising edge at this input.
bReset	BOOL	Triggers a channel reset and also resets the function block.
bLogFeederEntries	BOOL	If TRUE, a log file 'PlcItpFeed.log' is written in the TwinCAT\Mc\Nci folder. It contains all entries that are sent to the NC kernel via ADS. If bLogFeederEntries = TRUE, more time is required until bFeedingDone becomes TRUE.

Inputs/Outputs

```
VAR_IN_OUT
    stFeedGroupTable : ST_NciFeedGroupTable;
    stNciToPlc       : NCTOPLC_NCICHANNEL_REF;
END_VAR
```

Name	Type	Description
stFeedGroupTable	ST_NciFeedGroupTable	Table containing the rows for the NC kernel.
stNciToPlc	NCTOPLC_NCICHANNEL_REF	The structure of the cyclic channel interface between NCI and PLC.

Outputs

```
VAR_OUTPUT
    bFeedingDone      : BOOL;
    bChannelDone      : BOOL;
    bFeedBusy         : BOOL;
    bResetBusy        : BOOL;
    bError             : BOOL;
    nErrorId           : UDINT;
END_VAR
```

Name	Type	Description
bFeedingDone	BOOL	Becomes TRUE once all table rows have been sent to the NC kernel.
bChannelDone	BOOL	Becomes TRUE once all entries of the table in the NC kernel were executed and ST_NciEndOfTables was detected.
bFeedBusy	BOOL	Becomes TRUE when the function block sends entries to the NC kernel.
bResetBusy	BOOL	Becomes TRUE when a reset is executed.
bError	BOOL	Becomes TRUE as soon as an error has occurred.
nErrorId	UDINT	Contains the command-specific error code of the most recently executed command. Is reset to 0 by the execution of a command at the inputs. The error numbers in ErrId can be looked up in the ADS error documentation or in the NC error documentation.

Requirements

Development environment	Target platform	PLC libraries to be linked
TwinCAT v3.1.0	PC or CX (x86 or x64)	Tc2_PlcInterpolation

7.2.3 Types and Enums

E_NciEntryType

```

TYPE E_NciEntryType :
(
    E_NciEntryTypeNone := 0,
    E_NciEntryTypeGeoStart := 1,
    E_NciEntryTypeGeoLine := 2,
    E_NciEntryTypeGeoCirclePlane := 3,
    E_NciEntryTypeGeoCircleCIP := 4,
    E_NciEntryTypeGeoBezier3 := 10,
    E_NciEntryTypeGeoBezier5 := 11,
    E_NciEntryTypeMFuncHsk := 20,
    E_NciEntryTypeMFuncFast := 21,
    E_NciEntryTypeMFuncResetAllFast := 23,
    E_NciEntryTypeHParam := 24,
    E_NciEntryTypeSParam := 25,
    E_NciEntryTypeTParam := 26,
    E_NciEntryTypeDynOvr := 50,
    E_NciEntryTypeVertexSmoothing := 51,
    E_NciEntryTypeBaseFrame := 52,
    E_NciEntryTypePathDynamics := 53,
    E_NciEntryTypeAxisDynamics := 55,
    E_NciEntryTypeDwellTime := 56,
    E_NciEntryTypeFeedrateIpol := 57,
    E_NciEntryTypeTfDesc := 100,
    E_NciEntryTypeEndOfTables := 1000
);
END_TYPE

```

Structures	Enum	Description
Organization		
	E_NciEntryTypeNone	No function
ST_NciGeoStart [► 319]	E_NciEntryTypeGeoStart	Sets the start position for the first geometry entry
ST_NciEndOfTables [► 329]	E_NciEntryTypeEndOfTables	Indicates the end of the geometry table
Movement commands		
ST_NciGeoLine [► 319]	E_NciEntryTypeGeoLine	Describes a straight line
ST_NciGeoCirclePlane [► 320]	E_NciEntryTypeGeoCirclePlane	Describes a circle in the main plane (center point programming)
ST_NciGeoCircleCIP [► 321]	E_NciEntryTypeGeoCircleCIP	Describes a circle anywhere in the space
ST_NciGeoBezier3 [► 322]	E_NciEntryTypeGeoBezier3	Describes a 3rd order Bezier with control points
ST_NciGeoBezier5 [► 323]	E_NciEntryTypeGeoBezier5	Describes a 5th order Bezier with control points
ST_NciDwellTime [► 328]	E_NciEntryTypeDwellTime	Describes a dwell time
Path parameters		
ST_NciBaseFrame [► 326]	E_NciEntryTypeBaseFrame	Describes a zero shift and rotation
ST_NciVertexSmoothing [► 326]	E_NciEntryTypeVertexSmoothing	Activates blending at segment transitions
ST_NciTangentialFollowingDesc [► 328]	E_NciEntryTypeTfDesc	Activates tangential following of the tool
Dynamics		
ST_NciDynOvr [► 325]	E_NciEntryTypeDynOvr	Modifies the dynamic override
ST_NciAxisDynamics [► 327]	E_NciEntryTypeAxisDynamics	Limits the axis dynamics
ST_NciPathDynamics [► 327]	E_NciEntryTypePathDynamics	Limits the path dynamics
ST_NciFeedrateIpol [► 328]	E_NciEntryTypeFeedrateIpol	Sets the feed interpolation type
Parameter commands		

Structures	Enum	Description
ST_NciHParam [► 325]	E_NciEntryTypeHParam	Sets an H-parameter (DINT)
ST_NciSParam [► 325]	E_NciEntryTypeSParam	Sets an S-parameter (WORD)
ST_NciTParam [► 325]	E_NciEntryTypeTParam	Sets a T-parameter (WORD)
ST_NciMFuncFast [► 324]	E_NciEntryTypeMFuncFast	Parameterizes a fast M-function (no handshake)
ST_NciMFuncHsk [► 324]	E_NciEntryTypeMFuncHsk	Parameterizes an M-function with handshake
ST_NciMFuncResetAllFast [► 325]	E_NciEntryTypeResetAllFast	Resets all fast M-functions

ST_NciGeoStart

Sets the start position for the first geometry entry. This is necessary, if the first geometry entry is a circle or if tangential following in the first segment is ON. This structure can optionally be written at each start of the first table.

```

TYPE ST_NciGeoStart :
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypeGeoStart; (*do not override this parameter *)
    fPosX: LREAL;
    fPosY: LREAL;
    fPosZ: LREAL;
    fPosQ1: LREAL;
    fPosQ2: LREAL;
    fPosQ3: LREAL;
    fPosQ4: LREAL;
    fPosQ5: LREAL;
END_STRUCT
END_TYPE

```

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [► 318])

fPosX: Start position X

fPosY: Start position Y

fPosZ: Start position Z

fPosQ1: Start position Q1

fPosQ2: Start position Q2

fPosQ3: Start position Q3

fPosQ4: Start position Q4

fPosQ5: Start position Q5

ST_NciGeoLine

Describes a straight line with specified velocity.

```

TYPE ST_NciGeoLine :
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypeGeoLine; (*do not override this parameter *)
    nDisplayIndex: UDINT;
    fEndPosX: LREAL;
    fEndPosY: LREAL;
    fEndPosZ: LREAL;
    fEndPosQ1: LREAL;
    fEndPosQ2: LREAL;
    fEndPosQ3: LREAL;
    fEndPosQ4: LREAL;
    fEndPosQ5: LREAL;
    fVelo: LREAL;
    bRapidTraverse: BOOL;
    bAccurateStop: BOOL; (* VeloEnd := 0 *)
END_STRUCT
END_TYPE

```

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [[► 318](#)])

nDisplayIndex: For display purposes, such as block number in G-Code

fEndPosX: Target position X

fEndPosY: Target position Y

fEndPosZ: Target position Z

fEndPosQ1: Target position Q1

fEndPosQ2: Target position Q2

fEndPosQ3: Target position Q3

fEndPosQ4: Target position Q4

fEndPosQ5: Target position Q5

fVelo: Target path velocity, like F in G-Code, but in basic units per second (e.g. mm/s)

bRapidTraverse: TRUE has the same effect as G0, FALSE treats this entry like G01

bAccurateStop: Accurate stop (TRUE has the same effect as G09)

ST_NciGeoCirclePlane

Describes a circle in the main plane. The center point is specified in absolute coordinates.

The orthogonal component at the center is assigned internally. If a circle is programmed in the XY plane, for example, `fCenterZ` is assigned internally. If the user has assigned the value explicitly, the value is nevertheless overwritten by the function block. A helix can be described by programming the height. If helix is programmed in the XY plane, for example, the lifting height of the helix is specified absolutely with `fEndPosZ`.

```

TYPE ST_NciGeoCirclePlane :
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypeGeoCirclePlane; (*do not override this parameter *)
    nDisplayIndex: UDINT;
    fEndPosX: LREAL;
    fEndPosY: LREAL;
    fEndPosZ: LREAL;
    fCenterX: LREAL;
    fCenterY: LREAL;
    fCenterZ: LREAL;
    fEndPosQ1: LREAL;
    fEndPosQ2: LREAL;
    fEndPosQ3: LREAL;
    fEndPosQ4: LREAL;
    fEndPosQ5: LREAL;
    fVelo: LREAL;
    bClockwise: BOOL;
    bAccurateStop: BOOL; (* VeloEnd := 0 *)
    nPlane: E_NciGeoPlane := E_NciGeoPlaneXY;
END_STRUCT
END_TYPE

```

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [[► 318](#)])

nDisplayIndex: For display purposes, such as block number in G-Code

fEndPosX: Target position X

fEndPosY: Target position Y

fEndPosZ: Target position Z

fCenterX: Centre position X in absolute coordinates

fCenterY: Centre position Y in absolute coordinates

fCenterZ: Centre position Z in absolute coordinates

fEndPosQ1: Target position Q1

fEndPosQ2: Target position Q2

fEndPosQ3: Target position Q3

fEndPosQ4: Target position Q4

fEndPosQ5: Target position Q5

fVelo: Target path velocity in basic units per second (e.g. mm/s), like F in G-Code

bClockwise: If TRUE, the circle is drawn clockwise, otherwise counter-clockwise (similar to G02, G03)

bAccurateStop: accurate stop [[▶ 142](#)] (TRUE has the same effect as G09)

nPlane: Specifies the plane: XY, YZ, or ZX (similar to G17..G19) (type: [E_NciGeoPlane](#) [[▶ 321](#)])



Circle segment as start segment

If the first geometry segment is a circle, the start position must set with [ST_NciGeoStart](#) [[▶ 319](#)].

E_NciGeoPlane

```
TYPE E_NciGeoPlane :
(
    E_NciGeoPlaneXY := 17,
    E_NciGeoPlaneZX := 18,
    E_NciGeoPlaneYZ := 19
);
END_TYPE
```

ST_NciGeoCircleCIP

The CIP circle can be used to describe a circle anywhere in space. It does not have to be in the main plane. In order for the circle to be described unambiguously, not all 3 points (the starting point is specified implicitly) may lie on straight line. It is thus not possible to program a full circle in this way.

```
TYPE ST_NciGeoCircleCIP :
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypeGeoCircleCIP;    (* do not overwrite this parameter *)
    nDisplayIndex: UDINT;
    fEndPosX: LREAL;
    fEndPosY: LREAL;
    fEndPosZ: LREAL;
    fCIPPosX: LREAL;
    fCIPPosY: LREAL;
    fCIPPosZ: LREAL;
    fEndPosQ1: LREAL;
    fEndPosQ2: LREAL;
    fEndPosQ3: LREAL;
    fEndPosQ4: LREAL;
    fEndPosQ5: LREAL;
    fVelo: LREAL;
    bAccurateStop: BOOL;    (* VeloEnd := 0 *)
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [[▶ 318](#)])

nDisplayIndex: For display purposes, such as block number in G-Code

fCIPPosX: X position in absolute coordinates (point on circular path)

fCIPPosY: Y position in absolute coordinates (point on circular path)

fCIPPosZ: Z position in absolute coordinates (point on circular path)

fEndPosX: Target position X

fEndPosY: Target position Y

fEndPosZ: Target position Z

fEndPosQ1: Target position Q1

fEndPosQ2: Target position Q2

fEndPosQ3: Target position Q3

fEndPosQ4: Target position Q4

fEndPosQ5: Target position Q5

fVelo: Target path velocity in basic units per second (e.g. mm/s), like F in G-Code

bAccurateStop: [accurate stop](#) [[142](#)] (TRUE has the same effect as G09)



Circle segment as start segment

If the first geometry segment is a circle, the start position must set with [ST_NciGeoStart](#) [[319](#)].

ST_NciGeoBezier3

Describes a third-order Bézier curve with the aid of control points. The start position results from the previous segment. The third control point is determined by the target position.

```
TYPE ST_NciGeoBezier3:
STRUCT
  nEntryType: E_NciEntryType := E_NciEntryTypeGeoBezier3; (*do not override this parameter *)
  nDisplayIndex: UDINT;
  fControlPoint1X: LREAL;
  fControlPoint1Y: LREAL;
  fControlPoint1Z: LREAL;
  fControlPoint2X: LREAL;
  fControlPoint2Y: LREAL;
  fControlPoint2Z: LREAL;
  fEndPosX: LREAL;
  fEndPosY: LREAL;
  fEndPosZ: LREAL;
  fEndPosQ1: LREAL;
  fEndPosQ2: LREAL;
  fEndPosQ3: LREAL;
  fEndPosQ4: LREAL;
  fEndPosQ5: LREAL;
  fVelo: LREAL;
  bAccurateStop: BOOL; (* VeloEnd := 0 *)
END_STRUCT
END_TYPE
```



A Bezier3 curve is not compatible with the type [ST_NciVertexSmoothing](#) of the type 3rd and 5th order Bezier. In this case, a different type must be selected for VertexSmoothing.

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [[318](#)])

nDisplayIndex: For display purposes, such as block number in G-Code

fControlPoint1X: X component control point 1

fControlPoint1Y: Y component control point 1

...

fControlPoint2Z: Z component control point 2

fEndPosX: Target position X

fEndPosY: Target position Y

fEndPosZ: Target position Z

fEndPosQ1: Target position Q1

fEndPosQ2: Target position Q2

fEndPosQ3: Target position Q3

fEndPosQ4: Target position Q4

fEndPosQ5: Target position Q5

fVelo: Target path velocity in basic units per second (e.g. mm/s), like F in G-Code

bAccurateStop: Accurate stop [[▶ 142](#)] (TRUE has the same effect as G09)

ST_NciGeoBezier5

Describes a 5th-order Bézier curve with the aid of control points. The start position results from the previous segment. The fifth control point is determined by the target position.

```

TYPE ST_NciGeoBezier5:
STRUCT
  nEntryType: E_NciEntryType := E_NciEntryTypeGeoBezier5; (*do not override this parameter *)
  nDisplayIndex: UDINT;
  fControlPoint1X: LREAL;
  fControlPoint1Y: LREAL;
  fControlPoint1Z: LREAL;
  fControlPoint2X: LREAL;
  fControlPoint2Y: LREAL;
  fControlPoint2Z: LREAL;
  fControlPoint3X: LREAL;
  fControlPoint3Y: LREAL;
  fControlPoint3Z: LREAL;
  fControlPoint4X: LREAL;
  fControlPoint4Y: LREAL;
  fControlPoint4Z: LREAL;
  fEndPosX: LREAL;
  fEndPosY: LREAL;
  fEndPosZ: LREAL;
  fEndPosQ1: LREAL;
  fEndPosQ2: LREAL;
  fEndPosQ3: LREAL;
  fEndPosQ4: LREAL;
  fEndPosQ5: LREAL;
  fVelo: LREAL;
  bAccurateStop: BOOL; (* VeloEnd := 0 *)
END_STRUCT
END_TYPE

```

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [[▶ 318](#)])

nDisplayIndex: For display purposes, such as block number in G-Code

fControlPoint1X: X component control point 1

fControlPoint1Y: Y component control point 1

...

fControlPoint4Z: Z component control point 4

fEndPosX: Target position X

fEndPosY: Target position Y

fEndPosZ: Target position Z

fEndPosQ1: Target position Q1

fEndPosQ2: Target position Q2

fEndPosQ3: Target position Q3

fEndPosQ4: Target position Q4

fEndPosQ5: Target position Q5

fVelo: Target path velocity in basic units per second (e.g. mm/s), like F in G-Code

bAccurateStop: accurate stop [► 142] (TRUE has the same effect as G09)

ST_NciMFuncHsk

Describes an M-function [► 165] of type handshake. The M-function number is between 0 and 159.

```
TYPE ST_NciMFuncHsk :
STRUCT
  nEntryType: E_NciEntryType := E_NciEntryTypeMFuncHsk; (*do not override this parameter *)
  nDisplayIndex: UDINT;
  nMFunc: INT;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: E_NciEntryType [► 318])

nDisplayIndex: For display purposes, such as block number in G-Code

nMFunc: M-function number (0..159)



M-functions in the PlcInterpolation library

If M-functions are used in the PlcInterpolation library, they do not have to be entered in the user interface of the XAE. An M-function always takes effect at the programmed location.

ST_NciMFuncFast

Parameterizes up to 8 fast M-functions [► 165]. The first M-function must be assigned nMFuncIn0, the second nMFuncIn1 etc. -1 indicates the end of the assignments.

```
TYPE ST_NciMFuncFast :
STRUCT
  nEntryType: E_NciEntryType := E_NciEntryTypeMFuncFast; (*do not override this parameter *)
  nDisplayIndex: UDINT;
  nMFuncIn0: INT;
  nMFuncIn1: INT;
  nMFuncIn2: INT;
  nMFuncIn3: INT;
  nMFuncIn4: INT;
  nMFuncIn5: INT;
  nMFuncIn6: INT;
  nMFuncIn7: INT;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: E_NciEntryType [► 318])

nDisplayIndex: For display purposes, such as block number in G-Code

nMFuncIn0: fast M-function number (0..159)

nMFuncIn1: Fast M-function number (0..159); -1 indicates the end of the list.

nMFuncIn2: Fast M-function number (0..159); -1 indicates the end of the list.

nMFuncIn3: Fast M-function number (0..159); -1 indicates the end of the list.

nMFuncIn4: Fast M-function number (0..159); -1 indicates the end of the list.

nMFuncIn5: Fast M-function number (0..159); -1 indicates the end of the list.

nMFuncIn6: Fast M-function number (0..159); -1 indicates the end of the list.

nMFuncIn7: Fast M-function number (0..159); -1 indicates the end of the list.



M-functions in the PlcInterpolation library

If M-functions are used in the PlcInterpolation library, they do not have to be entered in the user interface of the XAE. An M-function always takes effect at the programmed location.

ST_NciMFuncResetAllFast

Resets all fast M-functions [[► 165](#)].

```
TYPE ST_NciMFuncResetAllFast :
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypeMFuncResetAllFast; (*do not override this parameter *)
    nDisplayIndex: UDINT;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [[► 318](#)])

nDisplayIndex: For display purposes, such as block number in G-Code

ST_NciHParam

Sets an H-parameter [[► 169](#)] in the cyclic channel interface.

```
TYPE ST_NciHParam :
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypeHParam; (*do not override this parameter *)
    nDisplayIndex: UDINT;
    nHParam: UDINT;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [[► 318](#)])

nDisplayIndex: For display purposes, such as block number in G-Code

nHParam: H-parameter from NC to PLC

ST_NciSParam

Sets an S-parameter [[► 169](#)] in the cyclic channel interface.

```
TYPE ST_NciSParam :
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypeSParam; (*do not override this parameter *)
    nDisplayIndex: UDINT;
    nSParam: UINT;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [[► 318](#)])

nDisplayIndex: For display purposes, such as block number in G-Code

nSParam: S-parameter from NC to PLC

ST_NciTParam

Sets an T-parameter [[► 169](#)] in the cyclic channel interface.

```
TYPE ST_NciTParam :
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypeTParam; (*do not override this parameter *)
    nDisplayIndex: UDINT;
    nTParam: UINT;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [[► 318](#)])

nDisplayIndex: For display purposes, such as block number in G-Code

nTParam: T-parameter from NC to PLC

ST_NciDynOvr

Modal functions for changing the path dynamics.

See [DynOvr \[► 176\]](#) in the [interpreter documentation \[► 127\]](#).

```
TYPE ST_NciDynOvr :
STRUCT
  nEntryType: E_NciEntryType := E_NciEntryTypeDynOvr; (*do not override this parameter*)
  nDisplayIndex: UDINT;
  fDynOvr: LREAL;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType \[► 318\]](#))

nDisplayIndex: For display purposes, such as block number in G-Code

fDynOvr: Value for dynamic override ($1 < fDynOvr \leq 1$)

ST_NciVertexSmoothing

Modal function for activating blending at the segment transition. Blending is active until it is cancelled by setting the radius to 0.

A more detailed description of the parameter can be found in the [interpreter documentation \[► 127\]](#). ([paramVertexSmoothing \[► 153\]](#)).

```
TYPE ST_NciVertexSmoothing :
STRUCT
  nEntryType: E_NciEntryType := E_NciEntryTypeVertexSmoothing; (*do not override this parameter *)
  nDisplayIndex: UDINT;
  nType: UDINT; (*type of smoothing, e.g. parabola, bi-quad *)
  nSubtype: UDINT; (*e.g. adaptive, constant radius *)
  fRadius: LREAL; (*max. radius for tolerance ball *)
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType \[► 318\]](#))

nDisplayIndex: For display purposes, such as block number in G-Code

nType: Blending type: 2: parabola, 3: Bi-quadratic, 4: Bezier 3rd order, 5: 5th order Bezier

nSubtype: 1: constant tolerance radius, 2: distance between intersection and vertex, 3: Adaptive tolerance radius

fRadius: Radius of the blending sphere in basic units (e.g. mm)

ST_NciBaseFrame

The structure ST_NciBaseFrame describes a modal zero shift and rotation. The operating principle is the same as for zero shift and rotation in the interpreter, i.e. the point of rotation is the current origin (see [rotation \[► 149\]](#) in the [interpreter documentation \[► 127\]](#)).

```
TYPE ST_NciBaseFrame:
STRUCT
  nEntryType: E_NciEntryType := E_NciEntryTypeBaseFrame; (*Do not override this parameter *)
  nDisplayIndex: UDINT;
  fShiftX: LREAL;
  fShiftY: LREAL;
  fShiftZ: LREAL;
  fRotX: LREAL;
  fRotY: LREAL;
  fRotZ: LREAL;
  fShiftQ1: LREAL;
  fShiftQ2: LREAL;
  fShiftQ3: LREAL;
  fShiftQ4: LREAL;
  fShiftQ5: LREAL;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType \[► 318\]](#))

nDisplayIndex: For display purposes, such as block number in G-Code

fShiftX: Zero shift in X direction

fShiftY: Zero shift in Y direction

fShiftZ: Zero shift in Z direction

fRotX: Rotation of the X axis

fRotY: Rotation of the Y axis

fRotZ: Rotation of the Z axis

fShiftQ1: Offset of the Q1 axis

fShiftQ2: Offset of the Q2-axis

fShiftQ3: Offset of the Q3-axis

fShiftQ4: Offset of the Q4-axis

fShiftQ5: Offset of the Q5-axis

ST_NciPathDynamics

The structure *ST_NciPathDynamics* sets the path dynamics (acceleration, deceleration, jerk). The operating principle is the same as for *paramPathDynamics* in the interpreter (see [paramPathDynamics \[► 176\]](#) in the [interpreter documentation \[► 127\]](#)).

```
TYPE ST_NciPathDynamics:
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypePathDynamics; (*do not override this parameter *)
    nDisplayIndex: UDINT;
    fAcc: LREAL;
    fDec: LREAL;
    fJerk: LREAL;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType \[► 318\]](#))

nDisplayIndex: For display purposes, such as block number in G-Code

fAcc: Maximum permitted path acceleration

fDec: Maximum permitted path deceleration

fJerk: Maximum permitted path jerk

ST_NciAxisDynamics

The structure *ST_NciAxisDynamics* sets the path axis dynamics (acceleration, deceleration, jerk). The operating principle is the same as for *paramAxisDynamics* in the interpreter (see [paramAxisDynamics \[► 176\]](#) in the [interpreter documentation \[► 127\]](#)).

```
TYPE ST_NciAxisDynamics:
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypeAxisDynamics; (*Do not override this parameter*)
    nDisplayIndex: UDINT;
    nAxis: UDINT;
    fAcc: LREAL;
    fDec: LREAL;
    fJerk: LREAL;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType \[► 318\]](#))

nDisplayIndex: For display purposes, such as block number in G-Code

nAxis: Axis in interpolation group X:0 Y:1 Z:2 Q1:3 ... Q5:7

fAcc: Maximum permitted axis acceleration

fDec: Maximum permitted axis deceleration

fJerk: Maximum permitted axis jerk

ST_NciDwellTime

The structure *ST_NciDwellTime* is used to activate a dwell time in seconds (see [dwell time \[► 142\]](#) in the [interpreter documentation \[► 127\]](#))

```
TYPE ST_NciDwellTime:
STRUCT
  nEntryType: E_NciEntryType := E_NciEntryTypeDwellTime; (*Do not override this parameter *)
  nDisplayIndex: UDINT;
  fDwellTime: LREAL;
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType \[► 318\]](#))

nDisplayIndex: For display purposes, such as block number in G-Code

fDwellTime: Dwell time in seconds

ST_NciFeedrateIpol

The structure *ST_NciFeedrateIpol* can be used to set the feed interpolation (see [Feed interpolation \[► 142\]](#)).

```
TYPE ST_NciFeedrateIpol :
STRUCT
  nEntryType: E_NciEntryType := E_NciEntryTypeFeedrateIpol; (*Do not overwrite this parameter*)
  nDisplayIndex: UDINT;
  eFeedrateIpol: E_NciFeedrateIpol; (*E_NciFeedrateIpolConstant = FCONST,
  E_NciFeedrateIpolLinear=FLIN *)
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType \[► 318\]](#))

eFeedrateIpol: specifies the feed interpolation.

```
TYPE E_NciFeedRateIpol : (
  E_NciFeedrateIpolConstant,
  E_NciFeedrateIpolLinear
)
END_TYPE
```

ST_NciTangentialFollowingDesc

This is a modal command for switching tangential following on or off.

```
TYPE ST_NciTangentialFollowingDesc :
STRUCT
  nEntryType: E_NciEntryType := E_NciEntryTypeTfDesc; (*do not override this parameter *)
  bTangOn: BOOL;
  nTangAxis: E_NciAxesInGroup; (*axis used for tangential following *)
  nPathAxis1: E_NciAxesInGroup; (*describing the plane e.g. x*)
  nPathAxis2: E_NciAxesInGroup; (*e.g. y ==> g17, xy plane*)
  fOffset: LREAL; (*geo tangent is 0 degree, counting is mathematical positive *)
  fCriticalAngle1: LREAL;
  nTfBehavior: E_TangentialFollowingBehavior; (*what to do if angle becomes bigger than critical
angle 1 *)
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType \[► 318\]](#))

bTangOn: If TRUE, tangential following is switched on.

nTangAxis: Axis (Q1..Q5) that is used as tangential axis (type: [E_NciAxesInGroup \[► 329\]](#)).

nPathAxis1: First path axis describing the plane and orientation for calculating the tangent.

nPathAxis2: Second path axis describing the plane and orientation for calculating the tangent.

fOffset: Offset of the tangential axis

fCriticalAngle1: Critical angle 1. The response in cases where the angle between two segments is greater than fCriticalAngle1 is specified with nTfBehavior.

nTfBehavior: see fCriticalAngle1 (type: [E_TangentialFollowingBehavior](#) [► 329])

E_NciAxesInGroup

```
TYPE E_NciAxesInGroup :
(
    NoneAxis := 0,
    XAxis,
    YAxis,
    ZAxis,
    Q1Axis,
    Q2Axis,
    Q3Axis,
    Q4Axis,
    Q5Axis
);
END_TYPE
```

E_TangentialFollowingBehavior

```
TYPE E_TangentialFollowingBehavior :
(
    E_TfIgnoreAll, (*ignore critical angle *)
    E_TfErrorOnCritical1 (*if angle becomes bigger than critical angle 1 ==> error *)
);
END_TYPE
```

E_TfIgnoreAll: The critical angle is ignored.

E_TfErrorOnCritical1: An error is returned if the critical angle is exceeded.

ST_NciEndOfTables

Indicates the last entry of the last table. Is used for signaling the bChannelDone flag in [FB_NciFeedTable](#) [► 316].

```
TYPE ST_NciEndOfTables :
STRUCT
    nEntryType: E_NciEntryType := E_NciEntryTypeEndOfTables; (*do not override this parameter *)
END_STRUCT
END_TYPE
```

nEntryType: Do not override this parameter (type: [E_NciEntryType](#) [► 318])

8 Samples

NCI: NCISimpleSample

Download:

https://infosys.beckhoff.com/content/1033/TF5100_TC3_NC_I/Resources/3438746891.zip

The example NCISimpleSample shows how an G-Code program is loaded from the PLC and processing is started.

You need to copy the enclosed parts program first.nc into the TwinCAT\Mc\Nci directory. Otherwise the parts program will not be found during loading. Alternatively you can adjust the path in the PLC program.

PLC interpolation: PlcInterpolationSimpleSample

Download:

https://infosys.beckhoff.com/content/1033/TF5100_TC3_NC_I/Resources/2944140171.zip

The sample shows how a movement can be affected with the library Tc2_PlcInterpolation directly from the PLC.

9 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

Download finder

Our [download finder](#) contains all the files that we offer you for downloading. You will find application reports, technical documentation, technical drawings, configuration files and much more.

The downloads are available in various formats.

Beckhoff's branch offices and representatives

Please contact your Beckhoff branch office or representative for [local support and service](#) on Beckhoff products!

The addresses of Beckhoff's branch offices and representatives round the world can be found on our internet page: www.beckhoff.com

You will also find further documentation for Beckhoff components there.

Beckhoff Support

Support offers you comprehensive technical assistance, helping you not only with the application of individual Beckhoff products, but also with other, wide-ranging services:

- support
- design, programming and commissioning of complex automation systems
- and extensive training program for Beckhoff system components

Hotline: +49 5246 963-157
e-mail: support@beckhoff.com

Beckhoff Service

The Beckhoff Service Center supports you in all matters of after-sales service:

- on-site service
- repair service
- spare parts service
- hotline service

Hotline: +49 5246 963-460
e-mail: service@beckhoff.com

Beckhoff Headquarters

Beckhoff Automation GmbH & Co. KG

Huelshorstweg 20
33415 Verl
Germany

Phone: +49 5246 963-0
e-mail: info@beckhoff.com
web: www.beckhoff.com

10 Appendix

10.1 Display of the parts program

Reading of the current NC line via ADS

This ADS Read command returns a maximum of three lines of the current parts program, i.e. the current line of code and perhaps two previously processed lines.

Function	ADS-Read
Port	500 (dec)
Index Group	0x2300 + channel ID
Index Offset	0x2000 0001
Data	string (30 bytes min.)

General Interpreter M-Functions R-Parameter Zero Points Tools Editor MDI

C:\TwinCAT\Mc\Nci\1_1.nc

Browse...

```

N10 G01 X1000 F5200
N20 G01 X1000 Y1000
N30 G01 X0 Y0
N40 G01 X1000 Y1000
N40 M02

```

F5 F6 F7 F8 F9

Editor...

Name	Actual Pos.	Setp. Pos.	Lag Dist.	Setp. Velo	Er...
X (X)	288.0834	288.0834	0.0000	61.2810	0x0
Y (Y)	288.2060	288.2060	0.0000	61.2810	0x0
Z (Z)	0.0000	0.0000	0.0000	0.0000	0x0

Actual Program Line:

```

N20 G01 X1000 Y1000
N30 G01 X0 Y0
N40 G01 X1000 Y1000

```

Program Name: 1_1.nc

Interpreter State: RUNNING (5) Buffer Size (Byte): 65536

Channel State: 0 (0x0)

Reading of the current program name

This ADS Read command returns the program name of the current main NC program (in this case 1_1.nc).

Function	ADS-Read
Port	500 (dec)
Index Group	0x2100 + channel ID
Index Offset	0x7
Data	string, 100 characters max.

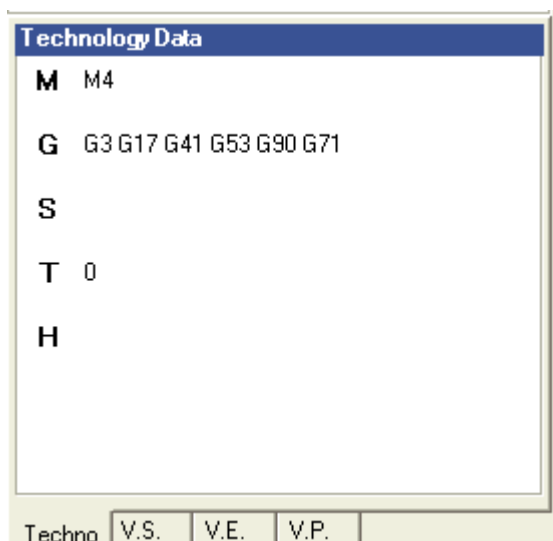
Reading of the current file information

In contrast to the 'Reading the current NC line' function, in this case not the line itself is read, but associated line information. The return value is the current program name (e.g. file name of the subroutine) and a file offset. Based on this information, the user interface can open the associated file and highlight the respective line. The display is no longer limited to 3 rows, i.e. any number of lines can be displayed.

In the event of an NCI load or runtime error, information about the associated line of code can be obtained via this route.

Function	ADS-Read	
Port	500 (dec)	
Index Group	0x2100 + channel ID	
Index Offset	0x12	
Data	UINT32	Current display of 1: SAF- 2: Interpreter 3: Error offset
	UINT32	File offset
	char[260]	path + program name

10.2 Display of technology data



The currently active technology data such as G functions, zero shifts and rotation can be read via ADS.

Activation for reading the technology data

In order to read the above-mentioned parameters, activation via ADS is required first.

The function must be activated before the start of the NC program, or earlier. It remains active until either a TwinCAT restart is performed or the function is reset explicitly.

Function	ADS-Write	
Port	500 (dec)	
Index Group	0x2000 + channel ID	
Index Offset	0x0053	
Data	DWORD	
	0: disable (default)	
	1: enable	

Reading the currently active zero shift

This command reads the active zero shift of the segment currently in block execution (SAF). If no zero shift is active (G53), the structure for the individual components contains a zero vector. These data can be used for switching the display between machine coordinates and programming coordinates, for example.

The data, which are read with the function block 'ltpReadZeroShift', for example, may differ from these values, since the interpreter data are read with the function block, which may already take into account new offsets.

Function	ADS-Read	
Port	500 (dec)	
Index Group	0x2100 + channel ID	
Index Offset	0x0014	
Data	{	
	UINT32	block counter
	UINT32	dummy
	LREAL[3]	zero shift G54..G57
	LREAL[3]	zero shift G58
	LREAL[3]	zero shift G59
	}	



Error 0x706 (1798)

The reading of technology data was not activated.

Reading the currently active rotation

This command reads the active rotation of the segment currently in block execution (SAF).

Function	ADS-Read	
Port	500 (dec)	
Index Group	0x2100 + channel ID	
Index Offset	0x0015	
Data	{	
	UINT32	block counter
	UINT32	dummy
	LREAL[3]	rotation of X, Y & Z in degrees
	}	



Error 0x706 (1798)

The reading of technology data was not activated.

Reading the currently active G-Code

The G-Code is subdivided into groups. For example, the geometries types with modal effect (G01, G02...) and the plane selection (G17..G19) form separate groups. When the G-Code information is read, the enumerator for the groups is also read. These can then be displayed in an application-specific manner.

Since the read command comes with a parameter to be read, not all groups have to be read. The memory provided is always filled by group 1. If, for example, the transferred memory size is 3x8 bytes, the data for the block counter, group 1 and 2 are returned.

Function	ADS-Read
Port	500 (dec)
Index Group	0x2100 + channel ID

Index Offset	0x0013	
Data	{	
	UINT32	block counter
	UINT32	Group 1: ModalGeoTypes
	UINT32	Group 2: BlockwiseGeoTypes
	UINT32	Group 3: ModalPlaneSelection
	UINT32	Group 4: ModalToolCompensation
	UINT32	Group 5: ModalToolFeedDirection
	UINT32	Group 6: ModalZeroShift
	UINT32	Group 7: ModalAccurateStop
	UINT32	Group 8: BlockwiseAccurateStop
	UINT32	Group 9: ModalDesignationAbsInc
	UINT32	Group 10: ModalDesignationInchMetric
	UINT32	Group 11: ModalFeedRateInCurve
	UINT32	Group 12: ModalCenterpointCorr
	UINT32	Group 13: ModalCircleCpAbsInc
	UINT32	Group 14: ModalCollisionDetection
	UINT32	Group 15: ModalRotation
	UINT32	Group 16: ModalCalcExRot
	UINT32	Group 17: ModalDiam
	UINT32	Group 18: ModalFeedrateIppl
	UINT32	Group 19: ModalMirror
	}	

**Error 0x706 (1798)**

The reading of technology data was not activated.

```
#define GCodeOffset 0x1000
#define CommonIdentOffset 0x2000 // used for non-g-code commands, like rot, cfc...
```

Group 1: ModalGeoTypes

```
enum GCodeGroup_ModalGeoTypes
{
    ModalGeoTypeUndefined = 0,
    ModalGeoTypeG0 = 0 + GCodeOffset, // line - rapid traverse
    ModalGeoTypeG01 = 1 + GCodeOffset, // straight line
    ModalGeoTypeG02 = 2 + GCodeOffset, // circle clockwise
    ModalGeoTypeG03 = 3 + GCodeOffset // circle anticlockwise
};
```

Group 2: BlockwiseGeoTypes

```
enum GCodeGroup_BlockwiseGeoTypes
{
    BlockwiseGeoTypeNone = 0,
    BlockwiseGeoTypeG04 = 4 + GCodeOffset, // dwell time
    BlockwiseGeoTypeG74 = 74 + GCodeOffset, // homing
    BlockwiseGeoTypeCip = 1 + CommonIdentOffset // circle parametrized with 3 points
};
```

Group 3: ModalPlaneSelection

```
enum GCodeGroup_ModalPlaneSelection
{
    ModalPlaneSelectUndefined = 0,
    ModalPlaneSelectG17 = 17 + GCodeOffset, // xy-plane
    ModalPlaneSelectG18 = 18 + GCodeOffset, // zx-plane
    ModalPlaneSelectG19 = 19 + GCodeOffset // yz-plane
};
```

Group 4: ModalToolCompensation


```
enum GCodeGroup_ModalToolCompensation
{
ModalToolCompUndefined = 0,
ModalToolCompG40 = 40 + GCodeOffset, // tool compensation off
ModalToolCompG41 = 41 + GCodeOffset, // tool compensation left
ModalToolCompG42 = 42 + GCodeOffset // tool compensation right
};
```

Group 5: ModalToolFeedDirection

```
enum GCodeGroup_ModalToolFeedDirection
{
ModalToolFeedDirUndefined = 0,
ModalToolFeedDirPos = 2 + CommonIdentOffset, // tool feed direction positive
ModalToolFeedDirNeg = 3 + CommonIdentOffset // tool feed direction negative
};
```

Group 6: ModalZeroShift

```
enum GCodeGroup_ModalZeroShift
{
ModalZeroShiftUndefined = 0,
ModalZeroShiftG53 = 53 + GCodeOffset, // zero shift off
ModalZeroShiftG54G58G59 = 54 + GCodeOffset, // zero shift G54 + G58+ G59
ModalZeroShiftG55G58G59 = 55 + GCodeOffset, // zero shift G55 + G58+ G59
ModalZeroShiftG56G58G59 = 56 + GCodeOffset, // zero shift G56 + G58+ G59
ModalZeroShiftG57G58G59 = 57 + GCodeOffset // zero shift G57 + G58+ G59
};
```

Group 7: ModalAccurateStop

```
enum GCodeGroup_ModalAccurateStop
{
ModalAccurateStopNone = 0,
ModalAccurateStopG60 = 60 + GCodeOffset // modal accurate stop
};
```

Group 8: BlockwiseAccurateStop

```
enum GCodeGroup_BlockwiseAccurateStop
{
BlockwiseAccurateStopNone = 0,
BlockwiseAccurateStopG09 = 9 + GCodeOffset, // common accurate stop
BlockwiseAccurateStopTpm = 4 + CommonIdentOffset // target position monitoring
};
```

Group 9: ModalDesignationAbsInc

```
enum GCodeGroup_ModalDesignationAbsInc
{
ModalDesignAbsIncUndefined = 0,
ModalDesignAbsIncG90 = 90 + GCodeOffset, // absolute designation
ModalDesignAbsIncG91 = 91 + GCodeOffset // incremental designation
};
```

Group 10: ModalDesignationInchMetric

```
enum
GCodeGroup_ModalDesignationInchMetric
{
ModalDesignInchMetricUndefined = 0,
ModalDesignInchMetricG70 = 70 + GCodeOffset, // designation inch
ModalDesignInchMetricG71 = 71 + GCodeOffset, // designation metric
ModalDesignInchMetricG700 = 700 + GCodeOffset, // designation inch & feedrate recalculated
ModalDesignInchMetricG710 = 710 + GCodeOffset // designation metric & feedrate recalculated
};
```

Group 11: ModalFeedRateInCurve

```
enum GCodeGroup_ModalFeedRateInCurve
{
ModalFeedRateInCurveUndefined = 0,
ModalFeedRateInCurveCfc = 5 + CommonIdentOffset, // constant feed contour
ModalFeedRateInCurveCfin = 6 + CommonIdentOffset, // constant feed inner contour
ModalFeedRateInCurveCftcp = 7 + CommonIdentOffset // constant feed tool center point
};
```

Group 12: ModalCenterpointCorr

```
enum GCodeGroup_ModalCenterpointCorr
{
ModalCenterpointCorrUndefined = 0,
ModalCenterpointCorrOn = 8 + CommonIdentOffset, // circle centerpoint correction on
ModalCenterpointCorrOff = 9 + CommonIdentOffset // circle centerpoint correction off
};
```

Group 13: ModalCircleCpAbsInc

```
enum GCodeGroup_ModalCircleCpAbsInc
{
ModalCircleCpUndefined = 0,
ModalCircleCpIncremental = 10 + CommonIdentOffset, // circle centerpoint incremental to start point
ModalCircleCpAbsolute = 11 + CommonIdentOffset // circle centerpoint absolute
};
```

Group 14: ModalCollisionDetection

```
enum GCodeGroup_ModalCollisionDetection
{
ModalCollisionDetectionUndefined = 0,
ModalCollisionDetectionOn = 12 + CommonIdentOffset, //collision detection on
ModalCollisionDetectionOff = 13 + CommonIdentOffset //collision detection off
};
```

Group 15: ModalRotation

```
enum GCodeGroup_ModalRotation
{
ModalRotationUndefined = 0,
ModalRotationOn = 14 + CommonIdentOffset, // rotation is turned on
ModalRotationOff = 15 + CommonIdentOffset // rotation is turned off
};
```

Group 16: ModalCalcExRot

```
enum GCodeGroup_ModalCalcExRot
{
ModalCalcExRotUndefined = 0,
ModalCalcExRotOn = 16 + CommonIdentOffset, // extended calculation for rotation turned on
ModalCalcExRotOff = 17 + CommonIdentOffset // extended calculation for rotation turned off
};
```

Group 17: ModalDiam

```
enum GCodeGroup_ModalDiam
{
ModalDiamUndefined = 0,
ModalDiamOn = 18 + CommonIdentOffset, // diameter programming on
ModalDiamOff = 19 + CommonIdentOffset // diameter programming off
};
```

Group 18: ModalFeedrateIpol

```
enum GCodeGroup_ModalFeedrateIpol
{
ModalFeedrateIpolUndefined = 0,
ModalFeedrateIpolConst = 20 + CommonIdentOffset, // federate interpolation constant (default)
ModalFeedrateIpolLinear = 21 + CommonIdentOffset // federate interpoaltion linear to remaining path
};
```

Group 19: ModalMirror

```
enum GCodeGroup_ModalMirror
{
// value - (32+CommonIdentOffset) shows the bitmask for mirrored axes
// that's why the sequence seems to be strange...
//
ModalMirrorUndefined = 0,
ModalMirrorOff = 32 + CommonIdentOffset,
ModalMirrorX = 33 + CommonIdentOffset,
ModalMirrorY = 34 + CommonIdentOffset,
ModalMirrorXY = 35 + CommonIdentOffset,
ModalMirrorZ = 36 + CommonIdentOffset,
ModalMirrorZX = 37 + CommonIdentOffset,
ModalMirrorYZ = 38 + CommonIdentOffset,
ModalMirrorXYZ = 39 + CommonIdentOffset
};
```

10.3 Displaying the remaining path length

If calculation of the remaining path length is switched active, it is calculated up to as far as the next accurate stop, or as far as the last geometric segment in memory (block preparation). An accurate stop is, for instance, generated by G09 or by G60. However, M-functions of type handshake, decoder stops and G04 implicitly generate an accurate stop.

Activation:

Index Group: 0x3000 + Group ID
Index Offset: 0x0508

see index offset specification for group parameters

Reading the remaining path length:

Reading is again implemented through ADS, and can also be recorded with TwinCAT Scope.

Index Group: 0x3100 + Group ID
Index Offset: 0x0522

The remaining path length can be transferred with the cyclic channel interface to the PLC via [ltpSetCyclicLrealOffsets](#) [► 246].
see index offset specification for group state

10.4 Parameterisation

The parameterization of the NCI comprises the standard dynamic parameters (acceleration, deceleration, jerk) and their online changes, along with the minimum velocity and the parameters for the reduction of the path velocity including online change.

General characteristics at segment transitions

- Velocity: The segment set velocity VS changes at the segment transition from VS_in to VS_out. At the segment transition the velocity is always reduced to the lower of the two values.
- Acceleration: The current path acceleration is always returned to $a = 0$ at segment transition.
- Jerk: The jerk unit J changes according to the geometry at the segment transition. This can cause a significant step change in dynamics.
- It is possible to [smooth segment transitions](#) [► 130].

Table 1: NCI group parameters

Parameter	Meaning and boundary conditions
Curve velocity reduction mode [► 340]	Coulomb, cosine or VELOJUMP
Minimum velocity [► 340]	Path velocity which may not be less than this value (except peaks with movement reversal): $V_{min} \geq 0.0$
Reduction method for C1 transitions [► 340]	Reduction factor for C1 transitions: $C1 \geq 0.0$
VELOJUMP: C0 reduction factors C0X, C0Y, C0Z	Reduction factors for C0 transitions for X, Y, Z axis: $C0X \geq 0.0$, $C0Y \geq 0.0$, $C0Z \geq 0.0$ (axis parameters, online modification in interpreter [► 177] possible).
DEVIATIONANGLE: Reduction factor C0 C0	Path reduction factor for C0 transitions: $1.0 \geq C0 \geq 0.0$
DEVIATIONANGLE: Critical angle (low) φ_l	Angle from which a velocity reduction is applied at the segment transition: $0 \leq \varphi_l < \varphi_h \leq \pi$
DEVIATIONANGLE: Critical angle (high) φ_h	Angle from which the velocity at the segment transition (v_{link}) is reduced to 0.0: $0 \leq \varphi_l < \varphi_h \leq \pi$
Tolerance sphere radius [► 156] TBR	Radius of the tolerance spheres: $1000.0 \text{ mm} \geq TBR \geq 0.1 \text{ mm}$
C2 reduction factor [► 177] C2	Reduction factor for smoothed transitions: $C2 \geq 0.0$

Parameter	Meaning and boundary conditions
Global software limit positions for the path [► 341]	Switches monitoring of the global software end positions for the path axes

Minimum velocity

Each NCI group has a minimum path velocity $V_{min} \geq 0.0$. The actual velocity should always exceed this value. User-specified exceptions are: programmed stop at segment transition, path end and override requests which lead to a velocity below the minimum value. A systemic exception is a motion reversal. With the reduction method DEVIATIONANGLE the deflection angle is $\varphi \geq \varphi_h$, in which case the minimum velocity is ignored. V_{min} must be less than the set value for the path velocity (F word) of each segment.

The minimum velocity can be set to a new value $V_{min} \geq 0.0$ in the NC program at any time. The unit is mm/sec.

Classification of the segment transitions

In general, the transition from one segment to the next is not indefinitely smooth. Therefore, it is necessary to reduce the velocity at the transition point in order to avoid dynamic instability. For this purpose, the transitions are geometrically classified and the effective transition velocity - V_{link} - is determined in three categories.

Segments - as geographical objects - are defined here as curves in terms of differential geometry and are parameterized by the arc length.

A segment transition from a segment S_{in} to a segment S_{out} is classified in geometrical terms as type C_k , where k is a natural number (including 0), if each segment has k continuous arc length differentials and the k^{th} derivatives at the transition point correspond.

C0 transitions have a knee-point at the transition point.

C1 transitions appear smooth, but are not smooth in dynamic terms. One example is the straight line-semi circle transition in the stadium: at the transition point there is a step change in acceleration.

C2 transitions (and of course C_k transitions with $k > 2$) are dynamically smooth (jerk restricted).

Reduction method for C2 transitions

As at all transitions, at C2 transitions V_{link} is set to equal the minimum of both set segment velocities: $V_{link} = \min(V_{in}, V_{out})$. There is no further reduction.

Reduction method for C1 transitions

First, V_{link} is set to the lower of the two segment target velocities: $V_{link} = \min(V_{in}, V_{out})$. The geometrically induced absolute step change in acceleration $AccJump$ in the segment transition is calculated depending on the geometry types G_{in} and G_{out} , and the plane selection G_{in} and G_{out} of the segments to be connected, at velocity V_{link} . If this is greater than C1 times the path acceleration/(absolute) deceleration $AccPathReduced$ permissible for the geometries and planes, the velocity V_{link} is reduced until the resulting step change in acceleration is equal to $AccPathReduced$. If this value is less than V_{min} , then V_{min} takes priority.

Notice When changing the dynamic parameters, the permissible path acceleration for the geometries and planes and thereby the reaction of the reduction changes automatically.

Interface: XAE [► 25] and interpreter [► 177]

Reduction modes for C0 transitions

Several reduction methods are available for C0 transitions. The reduction method VELOJUMP reduces the velocity after permitted step changes in velocity for each axis. The reduction method DEVIATIONANGLE reduces the velocity depending on the deflection angle φ (angle between the normalized end tangent T_{in} of the incoming segment S_{in} and the normalized start tangent T_{out} of the outgoing segment S_{out}). The cosine reduction method is a purely geometrical method (see curve velocity reduction method [► 26]).

The VELOJUMP method is recommended for mechanically independent axes, while for mechanically coupled axes (the Y axis is attached to the X axis, for example) the DEVIATIONANGLE method is usually recommended.

Reduction method for C0 transitions: VELOJUMP

If $V_{link} = \min(V_{in}, V_{out})$, and for each axis $V_{jump}[i] = C0[i] * \min(A+[i], -A-[i]) * T$ is the permitted absolute step change in velocity for the axis $[i]$, wherein $C0[i]$ is the reduction factor and $A+[i]$, $A-[i]$ are the acceleration/deceleration limits for the axis $[i]$, and T is the cycle time. The VELOJUMP reduction method ensures that the path velocity is reduced at the segment transition V_{link} until the absolute step change in the set axis velocity of axis $[i]$ is at most $V_{jump}[i]$. V_{min} nevertheless has priority: if V_{link} is less than V_{min} , V_{link} is set to V_{min} . In the case of movement reversal with no programmed stop, there will be a jump in axis velocity.

Notice When changing the dynamic parameters, the maximum permissible step changes in axis velocity automatically change at the same time.

Reduction method for C0 transitions: DEVIATIONANGLE

Notice When changing the dynamic parameters, the reduction factors do not automatically change at the same time.

Changing the parameters for C0 transitions: DEVIATIONANGLE

Table 2: Parameter

Parameter	Meaning and boundary conditions
DEVIATIONANGLE: Reduction factor $C0C0$	Path reduction factor for C0 transitions: $1.0 \geq C0 \geq 0.0$
DEVIATIONANGLE: Critical angle (low) φ_l	Angle from which reduction takes effect: $0 \leq \varphi_l < \varphi_h \leq \pi$
DEVIATIONANGLE: Critical angle (high) φ_h	Angle from which reduction to $v_{link} = 0.0$ takes effect: $0 \leq \varphi_l < \varphi_h \leq \pi$

Interface: [Interpreter](#) [► 177]

Cosine reduction method

See [here](#) [► 26].

Tolerance sphere radius and C2 reduction factor

These parameters are described under the heading [Smoothing of segment transitions](#) [► 130].

Global software limit positions for the path

The 'Global software limit position monitoring for the path' offers two different ways of software position limit monitoring.

Limit position monitoring by the SAF task

This type of end position monitoring is always active if the limit position for the axis has been switched to active (axis parameter). The monitoring is carried out component for component by the SAF task. This means that if the end position is exceeded, the path velocity is instantly set to 0, and the entire interpolation group has an error.

This type of monitoring is activated through the axes parameters, and **not** by means of the group parameters described here.

Software limit positions on the path

To prevent the path velocity being set to 0 immediately when a violation of the software end positions is encountered, the function '*Global software end position monitoring of the path*' must be enabled. If this is active, the movement stops at the NC block in which the end positions were violated. The velocity is reduced via a ramp.

- So that the monitoring is only executed for the desired path axes, the software limit positions for the axis components must be selected (axis parameters).
- The monitoring is carried out for the standard geometry segments. These include
Straight line
Circle
Helix
- Curves with splines are not monitored. The set values associated with the splines are always within the tolerance sphere. Otherwise the limit position monitoring will make use of the SAF task.
- Because meaningful and generally applicable monitoring of the end positions can only be carried out at the NC program's run-time (before lookahead) it is possible that the path axes will move as far as (but not including) the NC block in which the limit positions are exceeded.
- If for some reason the axes are located outside the software limit positions it is possible to move back into the correct region in a straight line.

Parameterization:

XAE: [Group parameters](#) [► 25]

10.4.1 Path override (interpreter override types)

The path override is a velocity override. This means that changing the override creates a new velocity, but does not affect the ramps (acceleration or jerk). The used override types only differ in terms of reference velocity.

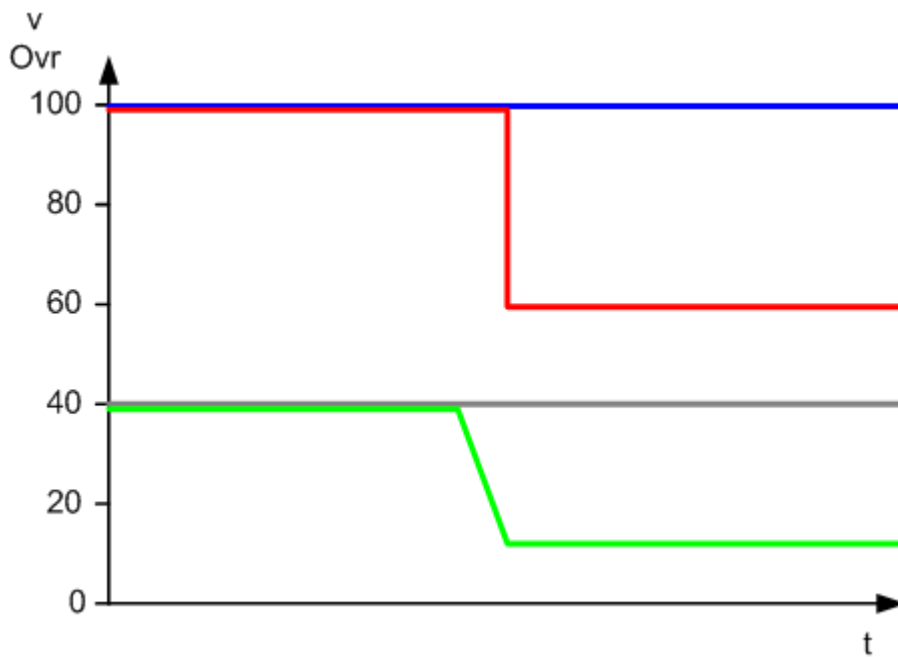
The parameterization takes place in the interpolation channel under the [group parameters](#) [► 26].

Option 'Reduced' - based on the reduced velocity (default)

Because of the relevant dynamic parameters (braking distance, acceleration etc.) it is not possible for the programmed velocity (the blue line) be achieved in every segment. For this reason a velocity, possibly reduced, (the red line) is calculated for each geometric segment. In the standard case, the override is made with reference to this segment velocity.

The advantage of this override type is that if override values are small the machine operates with an approximately linear reduction in velocity, and this is therefore the correct setting for most applications.

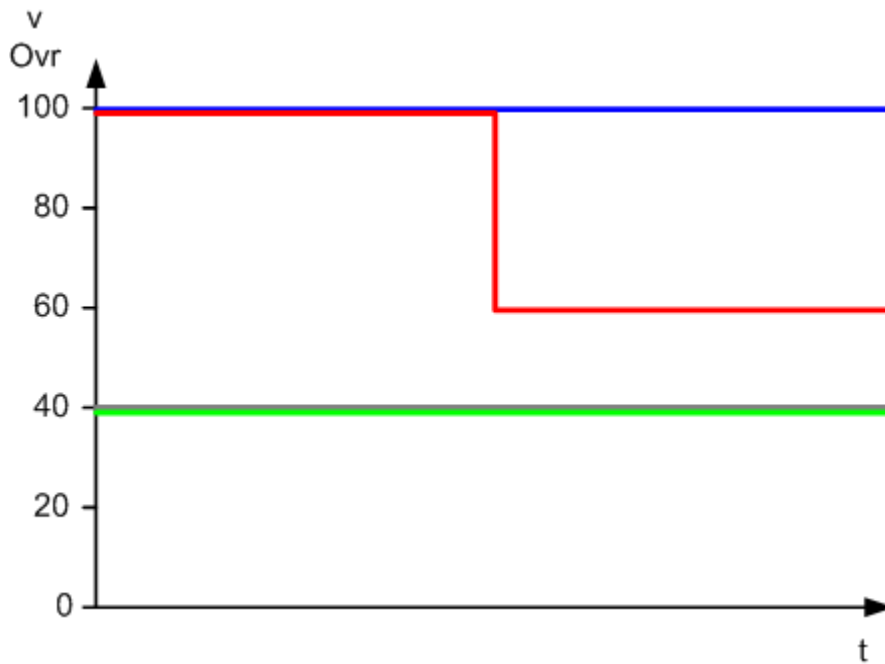
$v_{\text{res}} = v_{\text{max}} * \text{Override}$



- █ resulting path velo
- █ max. velo of segment
- █ override
- █ programmed path velo

Option 'Original' - based on the programmed path velocity

The override value is based on the velocity programmed by the user. The maximum segment velocity only has a limiting effect.



Selection 'Reduced [0 ... >100%]' - based on internally reduced velocity with the option to specify a value greater than 100%

The override type behaves like 'Reduced' [► 342]. With this override type it is possible to travel along the path more quickly than programmed in the G-Code. There is no limitation to 120%, for example. The maximum possible path velocity is limited by the maximum velocities of the axis components (G0 velocity) and their dynamics.

If limitation to a particular value, e.g. 120%, is required, this can be set in the PLC project.

10.5 Cyclic Channel Interface

The channel interface is responsible for the cyclic data exchange between the PLC and the NCI.

From the NCI to the PLC (160 bytes)

```

TYPE NCTOPLC_NCICHANNEL_REF :
STRUCT
BlockNo          : UDINT;
FastMFuncMask    : ARRAY [1..5] OF DWORD;
HskMFuncNo       : UINT;
HskMFuncReq      : WORD;
HFuncValue       : UDINT;
SpindleRpm       : UINT;
Tool             : UINT;
ChnState         : NCTOPLC_NCICHANNEL_REF_CHN_STATE;
IntParams        : ARRAY [0..3] OF UDINT;
DoubleParams     : ARRAY [0..3] OF LREAL;
PathVelo         : LREAL;
LoadedProg       : UDINT;
ItpMode          : WORD;
ItpState         : UINT;
ErrorCode        : UDINT;
ChnId            : UINT;
GrpId            : UINT;
ItfVersion       : UINT;
_reserved1       : UINT;
ChnOperationState : UDINT;
McsAxisIDs       : ARRAY [0..7] OF USINT;
AcsAxisIDs       : ARRAY [0..7] OF USINT;
_reserved2       : ARRAY [1..24] OF USINT;
END_STRUCT
END_TYPE

```

Variable name	Data type	Description
BlockNo	UDINT	block number
FastMFuncMask	ARRAY OF DWORD	Bit mask for evaluation of the fast M-functions [► 165]
HskMFuncNo	UINT	Number of synchronous M-function present (M-function with handshake)
HskMFuncReq	WORD	Flag indicating that a synchronous M-function is present 0: no synchronous M-function is present 1: a synchronous M-function is present
HFuncValue	DINT	Value of the auxiliary function
SpindleRpm	WORD	Spindle rotation speed
Tool	WORD	Tool number
ChnState	NCTOPLC_NCICHANNEL_REF_CHN_STATE	DWORD with status information for the channel (see status information for the channel (ChnState) [► 345])
IntParams	ARRAY [0..3] OF UDINT	Data of the freely configurable channel interface (see ItpSetCyclicUDintOffsets [► 247])

Variable name	Data type	Description
DoubleParams	ARRAY [0..3] OF LREAL	Data of the freely configurable channel interface (see ItpSetCyclicLrealOffsets [► 246])
PathVelo	LREAL	Current path set velocity
LoadedProg	UDINT	Name of the currently executed NC program. If the name is not a UDINT, this value is 0.
ItpMode	WORD	Bit mask that indicates execution in interpreter mode.
ItpState	UINT	Status [► 17] of the interpreter
ErrorCode	UDINT	Error code of the interpreter channel
ChnId	UINT	Channel ID
GrpId	UINT	group ID
ItpVersion	UINT	Version of this cyclic channel interface
ChnOperationState	UDINT	Channel state for a channel of the kinematic transformation; has no purpose for an interpolation channel.
McsAxisIDs	ARRAY [0..7] OF USINT	IDs of the MCS axes for a kinematic transformation channel; has no purpose for an interpolation channel.
AcsAxisIDs	ARRAY [0..7] OF USINT	IDs of the ACS axes for a kinematic transformation channel; has no purpose for an interpolation channel.

Channel status information (ChnState)

In the XAE the channel status information can only be read with a plain text name, from the PLC only via the bit number.

Name	Bit number (zero based)	Description
blsInterpolationChannel	0	Indicates that the linked channel is an interpolation channel.
blsKinematicChannel	1	Indicates that the structure is linked to a channel for the kinematic transformation.
blsEStopRequested	8	Indicates that an ItpEStop was called, without checking whether the axes are already at standstill.
blsFeedFromBackupList	10	For retracing the current entries from the interpreter backup list are sent.
blsMovingBackward	11	Indicates that the current motion is a reversing motion.
bRetraceStartPosReached	12	Indicates that the program start was reached during reversing.

From PLC to NCI (128 bytes)

```

TYPE PLCTONC_NCICHANNEL_REF :
STRUCT
SkipLine          : WORD; (* Mask to skip lines *)
ItpMode           : WORD;
MFuncGranted      : WORD; (* granted signal of the M-function *)
_reserved1        : UINT;

```

```

ChnAxesOvr      : UDINT; (* Channel override in percent * 100 *)
ChnSpindleOvr   : UDINT;
_reserved2      : ARRAY [1..112] OF USINT;
END_STRUCT
END_TYPE

```

Variable name	Data type	Description
SkipLine	WORD	Bit mask with which block skipping [► 128] of the NCI is parameterized from the PLC
ltpMode	WORD	Bit mask with which the interpreter execution mode can be altered. This is, for instance, required if the interpreter is to operate in <u>single block</u> [► 134] mode.
MFuncGranted	WORD	Flag with which an M-function of type 'Handshake' is confirmed. 0: Not acknowledged 1: Acknowledgement
ChnAxesOvr	UDINT	Channel override for the axes from 0...1000000 (corresponds to 0 - 100%)
ChnSpindleOvr	UDINT	Channel override for the spindle between 0 and 1000000 (corresponds to 0 - 100%); currently not supported.

Trademark statements

Beckhoff®, TwinCAT®, TwinCAT/BSD®, TC/BSD®, EtherCAT®, EtherCAT G®, EtherCAT G10®, EtherCAT P®, Safety over EtherCAT®, TwinSAFE®, XFC®, XTS® and XPlanar® are registered trademarks of and licensed by Beckhoff Automation GmbH.

Third-party trademark statements

Microsoft, Microsoft Azure, Microsoft Edge, PowerShell, Visual Studio, Windows and Xbox are trademarks of the Microsoft group of companies.

More Information:
www.beckhoff.com/tf5100

Beckhoff Automation GmbH & Co. KG
Hülshorstweg 20
33415 Verl
Germany
Phone: +49 5246 9630
info@beckhoff.com
www.beckhoff.com

